ROCZNIKI GLEBOZNAWCZE, T. XXXII, NR 3, WARSZAWA 1981

MICHAŁ LICZNAR, STANISŁAW KOWALIŃSKI, JERZY DROZD

CHANGES OF SOME PHYSICAL PROPERTIES OF SOILS OF THE GŁUBCZYCE PLATEAU UNDER THE WATER EROSION EFFECT

Department of Soil Science, Institute of Agricultural Chemistry, Soil Science and Microbiology, Agricultural University of Wrocław

INTRODUCTION

A characteristic relief of the Głubczyce Plateau area, typical for loess territories as well as a high susceptibility of silty soils, occurring there, to water erosion processes [11], contributed to the development of topogenic soils, the properties of which are resultant of soils processes, and the erosion degree of soil cover area. Lessivage and browning processes occurring in soils of the region in question as well as water erosion lead to qualitative changes of some soil bulk components, what undoubtedly affects their physical properties [7].

Therefore, the basic aim of the work was to recognize the erosion effect on formation of some physical properties in the area of occurrence of grey forest soils on the Głubczyce Plateau.

OBJECT AND METHODS OF INVESTIGATIONS

The object of investigations was toposequences of grey forest soils of the Głubczyce Plateau, occupying slopes with different average inclination (Table 1). In every toposequence samples for analyses were taken from three profiles characterizing soils occupying plateaus, slopes and valleys. Location of profiles on large fields and equal date of taking samples from particular slope parts, although different for definite inclinations, excluded the effect of agronomy measures on physical properties of soils within the toposequences.

To characterize the changes occurring under the erosion effect, the following determinations were made :

— mechanical composition of soils, areometrically,
— specific density, picnometrically,
— bulk density, by the Kopecky's method,

Table 1

Location and agronomy measures of the toposequence under study

Toposequence No.	Average inclination %	Agronomy measures
1	2.4	arable land /shallow ploughing/
2	5.2	arable land /winter ploughing/
3	6.4	arable land /field beans/
4	10.9	arable land /3-year cocks foot/

— capillary water capacity (CWC), by the Kopecky's method,

— field water capacity (FWC), on the basis of sucking power of soil at pF=2.54.

On the basis of the results obtained total and air porosity was calculated with reference to capillary water capacity and field water capacity.

The results are presented in Figures 1–4 in relative values of soils not undergoing erosion with the thickness of 0–50 and 0–150 cm. Moreover, numerical values characterizing the range of the feature analyzed were derived for soils located on plateaus as comparative object.

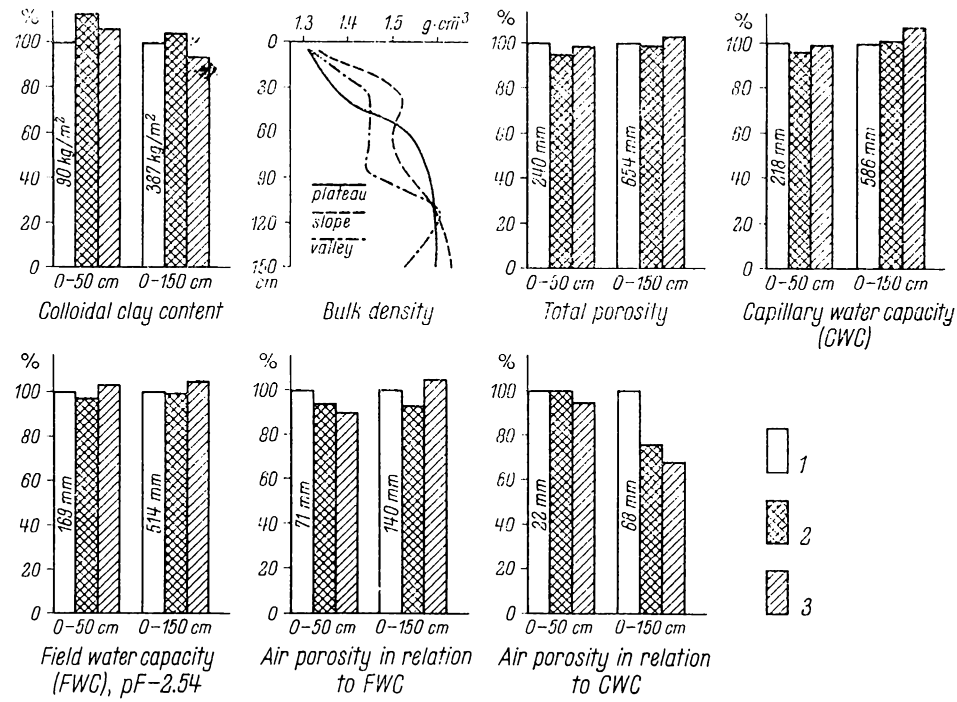

Fig. 1. Some physical properties of soils in the toposequence 1

1 — non-eroded soil (plateau), 2 — eroded soil (slope), 3 — deluvial (onwashed) soil (valley)

DISCUSSION OF RESULTS

Differentiation of percentage of particular features, and especially of colloidal clay within particular soil profiles in definite slope elements, occurred under the soil processes and erosion effect. The results obtained proved a growth of the colloidal clay fraction in eroded profiles on slopes and compared with soils situated on plateaus. It is to stress the occurrence of material little differentiated with regard to the amount of the fraction mentioned in deluvial soils, particularly in their onwashed segments. In the toposequence 4, with the highest slope inclination, non-uniform soil was formed on the slope, in which the silt-clay formation at the depth of 100 cm passes into heavy silty loam.

The above mechanical composition and the differentiation of the content of humus compounds under the action of erosion [8] affect the physical properties within the given toposequence.

In topogenic soils occurring on slopes in the Głubczyce Plateau region lessivage and erosion processes led to an increase of bulk density, what results in a reduction of their total porosity, in the horizon of 0–50 cm by 4–15% as compared with soils on plateaus. The range of the observed total porosity changes in topogenic soils does not correlate, however, with relative enrichment in the colloidal clay fraction. Quantitative changes of total porosity depend to a great extent on the condensation degree of solid phase of "initial" (starting line) soil situated on upland. It was confirmed by results of the investigations, among others, of Feuerlein [3] and Turski et al. [13], who proved that the density increasement, measured on the basis of total porosity and bulk density changes, is the stronger, the more friable is the given soil.

A detailed analysis of the above changes in particular toposequences (Figs. 1–4) against their different content of the colloidal clay fraction, proved that lessivage and erosion, though result in changes within particular groups of pores of eroded soils, depend, first of all, on the entirety of agronomy measures, under the effect of which a definite soil solid phase condensation state is forming.

In the soils investigated only in the toposequence 2 with the mean inclination of 5.2% (Fig. 2) the condensation of soil situated on slope (1.39 $g \cdot cm^{-3}$) caused a distinct reduction of pores responsible for the CWC value in relation to the soil on the plateau (1.14 $g \cdot cm^{-3}$). In the remaining toposequences, in which bulk density of soils of plateau in the A_p horizon is forming under the effect of agronomy measures within 1.31–1.54 $g \cdot cm^{-3}$, no significant erosion effect on relative changes of the water capacity analyzed were observed. It is particularly visible in the 0–50 cm layer.

The agronomy affects differently the formation of pores responsible for the FWC value. In toposequence of eroded soils, bulk density of

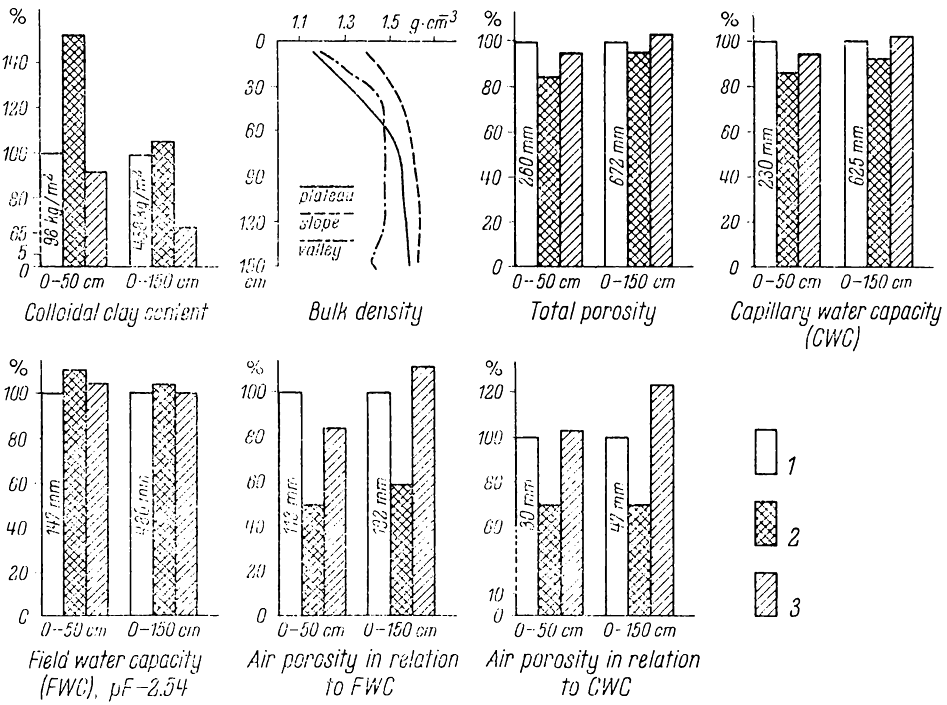

Fig. 2. Some physical properties of soil in the toposequence 2
explanation — as in Fig. 1

which on plateaus is less than 1.25 g • cm^{-3}, the condensation under the erosion effect led to a growth of the number of pores keeping up water by the force of pF 2.54 (Figs 2 and 3). At the lowest mean inclination of 2.4% (Fig. 1) and the bulk density value in the A_p horizon of the soil on plateau of 1.31 g • cm^{-3}, no significant changes in the FWC were proved. At a considerable condensation of the soil solid phase (Fig. 4) a relative reduction of pores of 10.0 (8.5) μm in dia by 8% took place.

Te above data prove that the erosion, while modifying total porosity, capillary and field water capacity, would affect distinctly the arrangement of water-air relations, particularly when calculated in relation FWC.

While considering the data within particular toposequences in relative values in relation to soils situated on plateaus, it has been proved that erosion would affect very unfavourably the above properties, particularly at low bulk density values the "initial" (starting line) soils on plateaus (Figs 2 and 3). In the toposequences in question air porosity expressed in relative numbers is sometimes by 50% lower in eroded soils situated on slopes. In the remaining toposequences, with the bulk density in

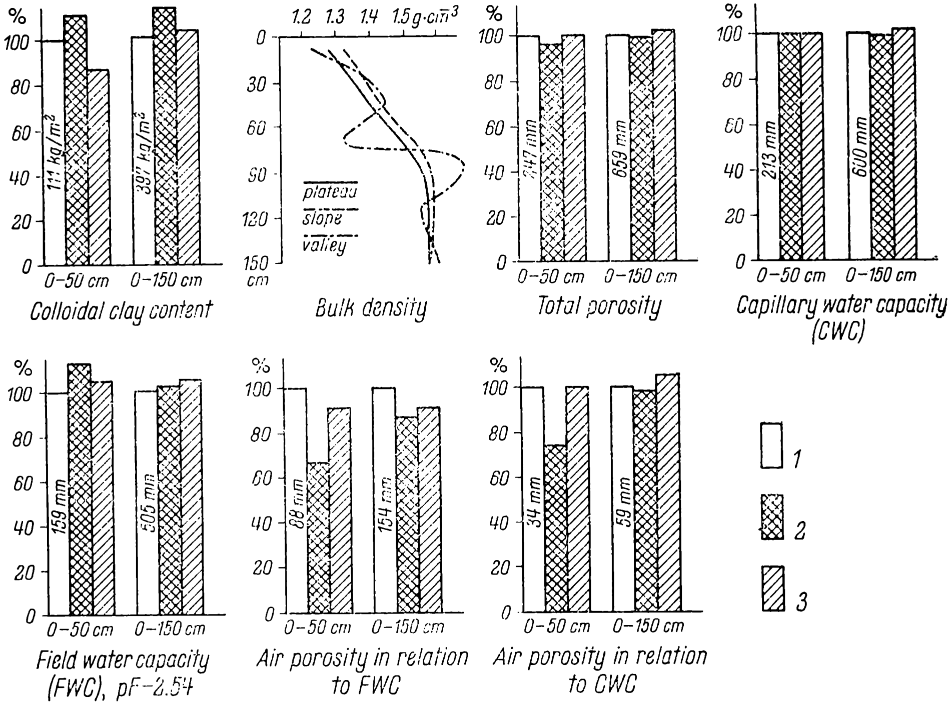

Fig. 3. Some physical properties of soil in the toposequence 3
explanation — as in Fig. 1

the A_p horizon of 1.31 and 1.54 g • cm^{-3}, no greater effect of erosion on relative values of air porosity has been found, what is evident particularly distinctly in the 0–50 cm layer.

While estimating water-air relations of the soils under study in the numbers corresponding with their retentional ability, expressed in terms of the water column, they should be estimated quite differently. They are unfavourable both for low and high bulk density values in the A_p horizon of the soils. Most favourable arrangement has been found in the profile of soil situated on the plateau in the toposequence 1, in which bulk density of the A_p horizon amounted to 1.31 g • cm^{-3}. Field water capacity for this soil in the 0–50 cm layer is e.g. 169 mm H_2O and air porosity corresponds with 71 mm of the water column. The above presumption is conformable with the literature data [2, 4, 5, 9] according to which the arrangement of physical properties in loess soils is most favourable when their bulk density does not exceed the value of 1.3 g • cm^{-3}.

While presenting the entirety of the above considerations on the arrangement of water-air relations in loess soils, it can be stated that changes in the soil solid phase condensation are not always of a negative

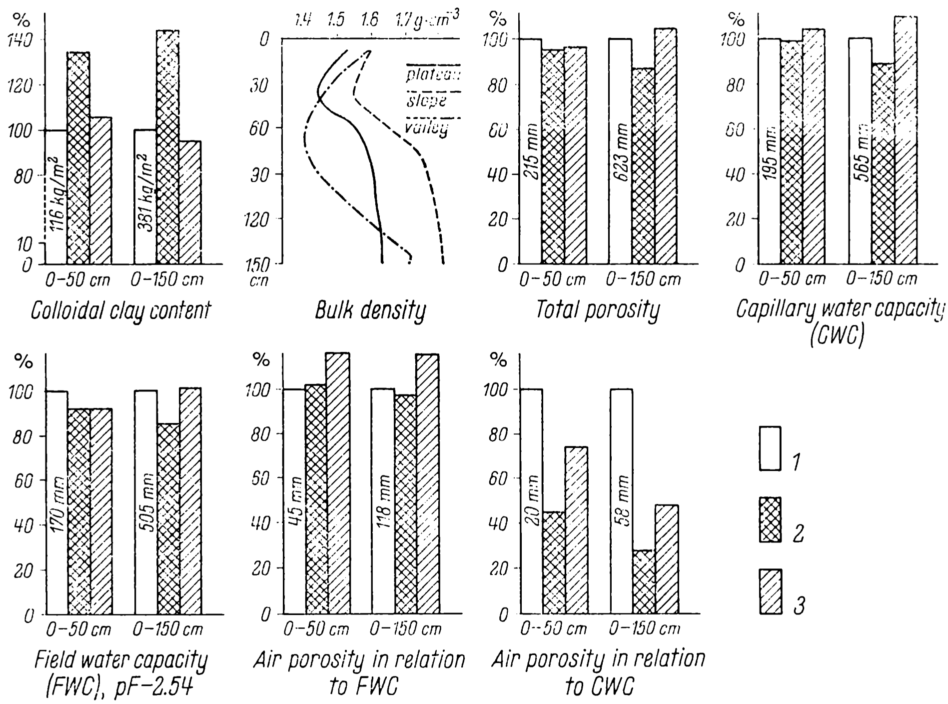

Fig. 4. Some physical properties of soils in the toposequence 4 explanation — as in Fig. 1

character. It was confirmed by many authors, investigating the effect of the soil solid phase condensation degree on physical properties of soils and the growth, development and yields of crops [1, 2, 5, 6, 9, 12]. At the same time these investigations suggest the possibility of an improvement of physical conditions of eroded soils as well as of an increase of their productivity by means of an appropriate agronomy [10, 14].

CONCLUSIONS

The investigations allow to draw the following conclusions :

1. Current state of physical properties of soils on eroded areas is forming under the effect of typologic soil processes, erosion degree of the given area, and particularly of the agronomy measures on the soil, responsible for the condensation of its solid phase.

2. Most favourable arrangement of water-air relations in grey forest soils of the Głubczyce Plateau is at the bulk density of about 1.3 g • cm^{-3} in the A_p horizon and suggests the necessity of application of appropriate agronomy measures leading to an improvement of conditions of the growth, development and yields of crops.

REFERENCES

[1] Domżał H., Słowińska-Jurkiewicz A.: Pressure effect on the structure of pores and the water capacity of soil. Rocz. glebozn., 26, 1975, 1, 49-60.

[2] Domżał H.: Soil conditions effect on the content of strongly bounded water and the retention of productive and useful water. Rocz. glebozn. 30, 1979, 3, 47-72.

[3] Feuerlein W.: Zum Einfluss des Schlepperrads auf den Acker. Landbauforsch. Völkenröde 1961, 3, 69-71.

[4] Gordienko W. P.: Stroenie yushnykh karbonatnykh chernozemov v zavisimosti ot ikh plotnosti. Pochv. 1976, 2, 69-74.

[5] Kowaliński S., Drozd J., Licznar M.: Changes of physical properties of soils due to intensified compaction by agricultural tools and machines (in print).

[6] Kowaliński S., Drozd J., Licznar M.: Reaction of maize to change of physical properties of the soil caused by densification of the solid phase (in print).

[7] Licznar M.: Properties and genesis of some chernozems of the Głubczyce Plateau. Rocz. glebozn. 27, 1976, 4, 107-148.

[8] Licznar M., Kowaliński S.: Composition of humus compounds in the eroded soils. Humus et Planta, VII, Brno, 20-24 August 1979.

[9] Onishchenko V. G., Michurin B. N.: Vlianie uplotnenia na vodnye svojstva pochvy. Pochv. 1971, 5, 42-46.

[10] Orlik T.: Technico-natural conditions and possibilities of an increase of the agricultural production on eroded soils on loess on an example of the Experiment Station Elizówka. Rozprawa habil., Wydawn. AR Lublin, 1976.

[11] Oświecimski A., Kowaliński S.: Water erosion of soils of Lower and Opole Silesia against the natural indices. Wiad. IMUZ 4, 1964, 3, 23-50.

[12] Smierzchalski L.: Soil condensation effect on yielding of some cereal and root crops. Międz. Konf. Nauk. „Współczesne kierunki w uprawie roli" PAN Warsaw—Olsztyn—Puławy, July 1972, 23-38.

[13] Turski R., Domżał H., Hodara J.: Soil deformation as a function of load, its duration and initial state of soil. Rocz. glebozn. 30, 1979, 2, 185-197.

[14] Ukalski J.: Attempt of water retention increase in soil on slope at the tillage executed with modified typical ploughs. Zesz. probl. Post. Nauk ro 1977, 193, 251-264.

M. LICZNAR, S. KOWALIŃSKI, J. DROZD

ZMIANY NIEKTÓRYCH WŁAŚCIWOŚCI FIZYCZNYCH GLEB PŁASKOWYŻU GŁUBCZYCKIEGO POD WPŁYWEM EROZJI WODNEJ

Instytut Chemii Rolniczej, Gleboznawstwa i Mikrobiologii AR we Wrocławiu

Streszczenie

Celem pracy było poznanie wpływu erozji, która w powiązaniu z procesami typologicznymi, a zwłaszcza lessiważem i brunatnieniem zachodzącym w rejonie występowania szarych gleb leśnych na Płaskowyżu Głubczyckim, powoduje zmiany

ilościowe niektórych składników masy glebowej w obrębie gleb zlokalizowanych w różnych częściach skłonu.

Przeprowadzone badania wykazały, że erozja, aczkolwiek powoduje pewne zmiany we właściwościach fizycznych, to aktualny stan ich w terenach erodowanych poszczególnych toposekwencji zależy przede wszystkim od stanu agrotechnicznego gleby decydującego o stopniu zagęszczenia w nich fazy stałej.

Stwierdzony najbardziej korzystny układ stosunków wodno-powietrznych w szarych glebach leśnych, kształtujący się przy gęstości objętościowej ok. 1.3 g • cm^{-3} w poziomie A_p, wskazuje ponadto na konieczność stosowania odpowiednich zabiegów agrotechnicznych sprzyjających poprawie warunków wzrostu rozwoju i plonowania roślin.

Dr Michał Licznar
Instytut Chemii Rolniczej, Gleboznawstwa i Mikrobiologii AR
Wrocław, ul. Grunwaldzka 53