The analysis of some physical properties of drained peat-moorsh soil layers

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Abstract: *The analysis of some physical properties of drained peat-moorsh soil layers.* The paper presents the results of measurements of some physical properties for 14 drained fen peat-moorsh layers (degree of decomposition, bulk density, particle density, porosity and saturated moisture content). The soil samples were taken from north--east, central and east part of Poland. These areas were drained in order to use as a grassland and meadows. The article presents obtained data of selected physical properties from several drained peatlands in Poland and shows the comparison of established results with relevant data published in literature.

Key words: peat, drainage, moorsh, physical properties

INTRODUCTION

Most of lowland fen peat soils in Poland and Europe were drained in 19th and 20th century in order to use as grasslands, meadows and even sometimes as arable lands. The decreasing of groundwater level and moisture content were the main reasons to start unsuitable processes in these soils like mineralisation and degradation of basic physical and chemical properties. With drainage and aeration the organic soil matter goes to the irreversible moorsh forming process.

The basic physical soil properties are often describe by bulk density, particle density, porosity, saturated moisture content and in case of drained organic soils degree of decomposition. Values of bulk density as high as 0.2 to 0.4 Mg·m^{-3} have been reported for fen peat for Central Europe (Okruszko 1993). Average values of particle density of peat soils is around 1.45 Mg·m^{-3}. Such parameter is rather weakly compared with bulk density. The highest values of particle density are observed for woody peats (Okruszko 1971, 1993). Peat soils are as one of the highest porous material. Total porosity of the undecomposed peat can reach even value of 97% and decrease for decompose and highly decomposed to level of 85–80%. In the literature there are some published results of changing of basic physical properties due to drainage and mineralization processes (Okruszko 1971; Gawlik 1992; Piaścik and Łachacz 1997; Brandyk and Szatyłowicz 2002; Ilnicki and Zeitz 2003).

The aim of this paper is to analyse of some basic physical properties of several drained peat and moorsh soil layers from Poland and comparison of obtained data with other published results in the literature.

MATERIAL AND METHODS

The peat-moorsh soils used in this study were taken from three following sites in Poland: north-east part Biebrza River valley – Podlaskie Voivodeship, central part – Mazovia Voivodeship and east part – Lubelskie Voivodeship. All of these peatlands areas were drainaged in 20th century and used as a grasslands and meadows. The undisturbed soil samples were taken in four replication from each characteristic 14 layers in analysed 6 soil profiles. The presented data were shown according to peat group starting from alder peat to moss peat (Table 1). The values of bulk density and saturated moisture content were determined used by gravimetric method (Brandyk and Szatyłowicz 2002; Brandyk et al.

TABLE 1. Location of analysed peat-moorsh soil layers

No of site	Community Voivodeship	GPS position	Name of site	Depth of sampling [cm]	Peat group	Peat species
1	Rajgród Podlaskie	N:53° 40' 39.3" E:22° 37' 39.5"	Bełda	30–40	alder	alder-swamp forest
2	Góra Kalwaria Mazowieckie	N:52° 2' 19.4" E:21° 6' 11.4"	Solec	35–45		alder-swamp forest
3	Rajgród Podlaskie	N:53° 40' 13.2" E:22° 34' 31.7	Miecze	50–60	reed	reed
4	Rajgród Podlaskie	N:53° 36' 57.8" E:22° 36' 32.7"	Sołki	50–60		reed
5	Skórzec Mazowieckie	N:52° 5' 0.2" E:22° 4' 32.6"	Dąbrówka Stany Suchodół	60–70		reed
6	Warszawa Mazowieckie	N:52° 7' 21.8" E:21° 6' 49.1"	Powsin	30–45	sedge	sedge-reed
7	Warszawa Mazowieckie	N:52° 7' 21.8" E:21° 6' 49.1"	Powsin	45–55		sedge-reed
8	Serniki Lubelskie	N:51° 26' 24.4" E:22° 48' 56.3"	Brzostówka	45–55		sedge-reed
9	Skórzec Mazowieckie	N:52° 4' 48.0" E:22° 5' 11.8"	Dąbrówka Stany Zapulec	45–55		sedge-reed
10	Skórzec Mazowieckie	N:52° 5' 0.2" E:22° 4' 32.6"	Dąbrówka Stany Suchodół	45–55		sedge
11	Grajewo Podlaskie	N:53° 37' 59.1" E:22° 34' 56.1"	Łamane Grądy	50–60	moss	sedge-moss
12	Serniki Lubelskie	N:51° 26' 24.4" E:22° 48' 56.3"	Brzostówka	15–25	moorsh	humic moorsh
13	Skórzec Mazowieckie	N:52° 4' 48.0" E:22° 5' 11.8"	Dąbrówka Stany Zapulec	20–30		humic moorsh
14	Góra Kalwaria Mazowieckie	N:52° 2' 19.4" E:21° 6' 11.4"	Solec	10–20		humic moorsh

2003). The particle density of analysed peat and moorsh layers were done using picnometr method (Maciak and Liwski 1996). Based on bulk density and particle density the porosity of soil samples was calculated. The degree of decompositions, peat group and species and type of moorsh were estimated using microscopic method proposed by Okruszko (1971) and Maciak and Liwski (1996). The peat soil classification presented in Table 1 was prepared using Tołpa et al. (1967) proposition.

RESULTS AND DISCUSSION

The obtained results of analysed physical properties are presented in Table 2.

The lowest degree of decomposition (30%) was observed for reed and moss peats and the highest (70%) for reed and sedge peats (Fig. 1). Generally the rising of degree of decomposition (the rate of degradation and mineralisation) causes the increasing of bulk density and decreasing of porosity and saturated moisture content. In case of moorsh

TABLE 2. Characteristics of some physical properties of analysed peat-moorsh soil layers

| No of site	Name of site	Depth of sampling	Bulk density	Particle density	Porosity	Saturated volumetric moisture content	Degree of decomposition
		[cm]	[Mg·m^{-3}]	[Mg·m^{-3}]	[%]	[vol. %]	[%]
1	Bełda	30–40	0.30	1.83	83.73	82.77	50
2	Solec	35–45	0.25	1.59	81.91	81.91	65
3	Miecze	50–60	0.19	1.56	87.95	87.84	30
4	Sołki	50–60	0.14	1.52	90.83	90.92	35
5	Dąbrówka Stany Suchodół	60–70	0.20	1.61	87.74	86.87	70
6	Powsin	30–45	0.22	1.70	87.35	87.13	35
7	Powsin	45–55	0.13	1.57	91.62	90.80	35
8	Brzostówka	45–55	0.12	1.51	91.74	92.31	40
9	Dąbrówka Stany Zapulec	45–55	0.17	1.60	89.49	88.05	50
10	Dąbrówka Stany Suchodół	45–55	0.22	1.64	86.47	84.05	70
11	Łamane Grądy	50–60	0.18	1.64	88.97	88.68	30
12	Brzostówka	15–25	0.15	1.50	90.07	89.41	Z_2[a]
13	Dąbrówka Stany Zapulec	20–30	0.20	1.68	88.15	86.02	Z_2
14	Solec	10–20	0.40	1.78	77.56	75.96	Z_2

[a]Z_2 – humic moorsh.
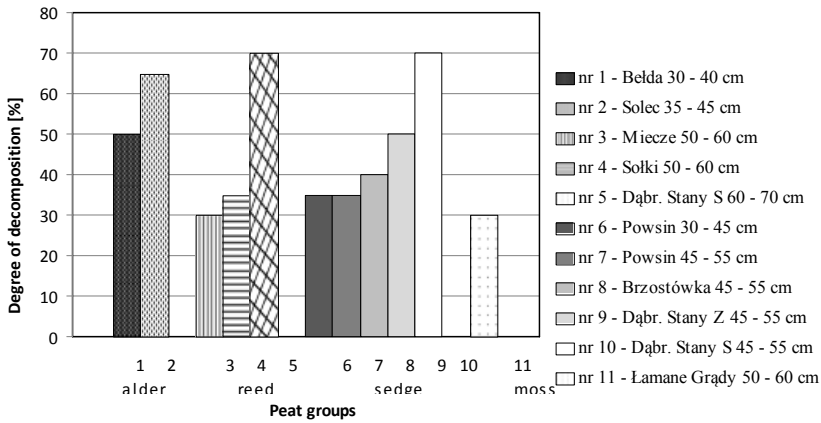
FIGURE 1. The degree of decomposition for analysed fen peat groups

layer (Z_2 humic moorsh) there is large gape between basic physical properties: the highest values of bulk density and particle density was observed for Solec site (10–20 cm) and the lowest values of these parameters for Brzostówka site (15–25 cm).

The relationship between bulk density and particle density was presented on Figure 2. The average values of bulk density 0.1–0.25 Mg·m^{-3} corespondent to values of bulk density in the range 1.5–1.7 Mg·m^{-3}. The highest values of

bulk density (0.3–0.4 Mg·m^{-3}) and particle density (around 1.8 Mg·m^{-3}) were observed for moorsh layers.

The measured in the laboratory saturated moisture content and calculated porosity values (using bulk density and particle density) were presented on Figure 3. The values of these parameters should be very similar (porosity equals saturation moisture content, no air in saturation soil samples). The lowest values of considered parameters are for moorsh and alder peats layers (Fig. 3).
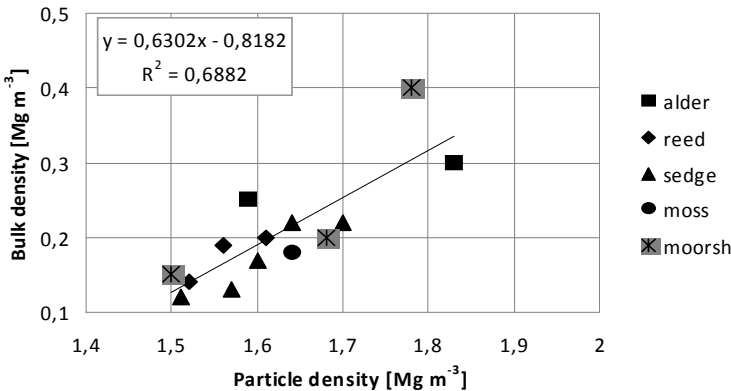

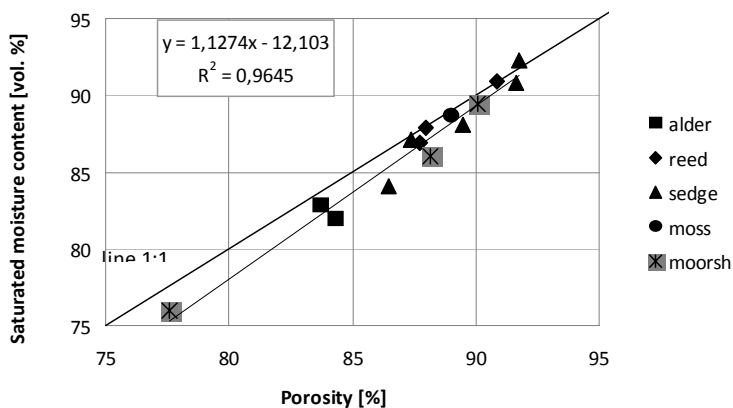FIGURE 2. The relationship between bulk density and particle density for analysed soil layers

FIGURE 3. The comparison between saturated moisture content and porosity for considered soil layers

The bulk density has large influence on porosity and moisture content values. High values of bulk density causes the decreasing of porosity (moisture content). In case of analysed peat and moorsh soil layers the strong linear relationship between these parameters is presented (Fig. 4). Increasing the bulk density values from 0.1 $Mg \cdot m^{-3}$ to 0.4 $Mg \cdot m^{-3}$ causes decreasing the porosity from around 92 to around 77%.

The next physical parameter – degree of decomposition decreasing also the saturated moisture content (porosity) values of all analysed peat layers (Fig. 5).

The comparison of obtained data (porosity and bulk density) with relevant results presented in literature was presented on Figure 6. The similar and very closed to the author's relationship are the linear equations proposed by Zawadzki (1970) and Okruszko (1971).

The comparison of porosity and degree of decomposition were presented on Figure 7. For low degree of decomposition (low rate of mineralization and moorshing process) the values of porosity were very similar with increasing of degree of decomposition, the values of
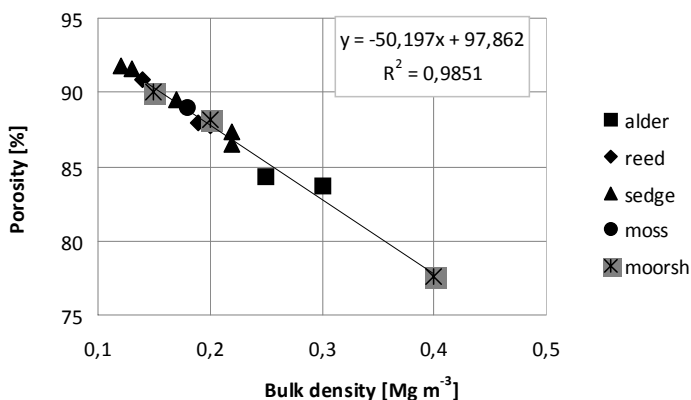

FIGURE 4. The relationships between porosity and bulk density for peat-moorsh layers
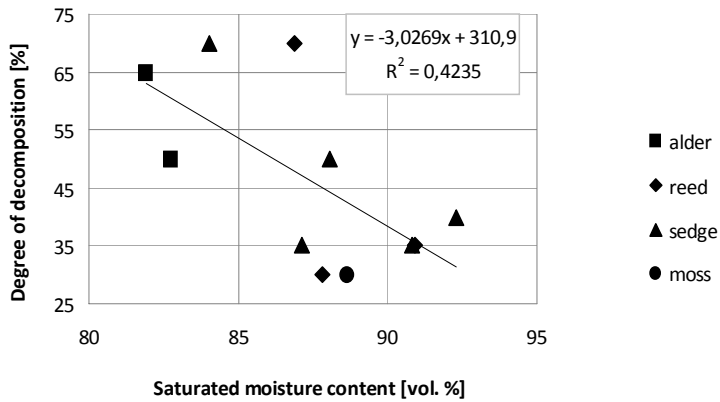
FIGURE 5. The characteristic of degree of decomposition and saturated moisture content for analysed soil layers
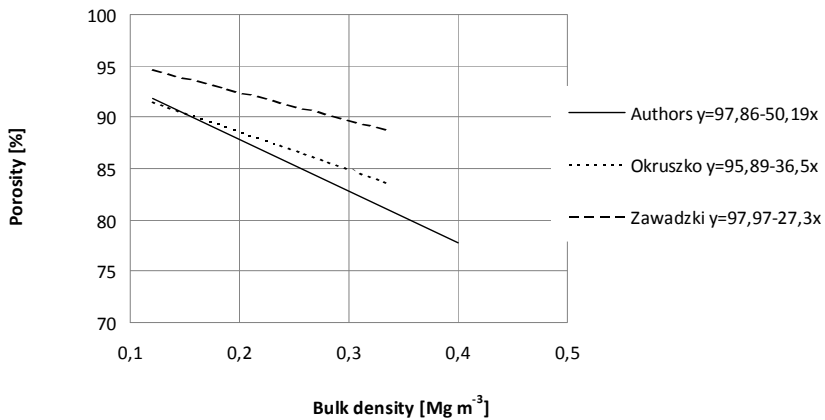

FIGURE 6. The comparison of relationships between porosity and bulk density values
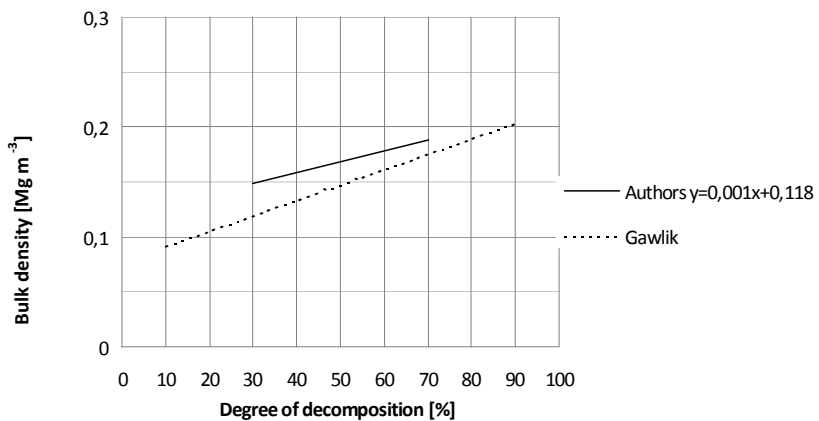

FIGURE 7. The comparison of relationships between porosity and degree of decompositions

porosity were less than values of this parameter proposed by Gawlik (1992).

The very closed data are presented in case of bulk density and degree of decomposition proposed by present research and results presented by Gawlik (1992). The difference between measured data and presented by Gawlik (1992) are at the level 5% (Fig. 8).

ty was observed. Increasing the bulk density values from 0.1 to 0.4 $Mg \cdot m^{-3}$ causes decreasing the porosity from around 92 to around 77%.

4. The performed research of selected physical properties of drained peat-moorsh soil layers are similar to relevant data published in literature.
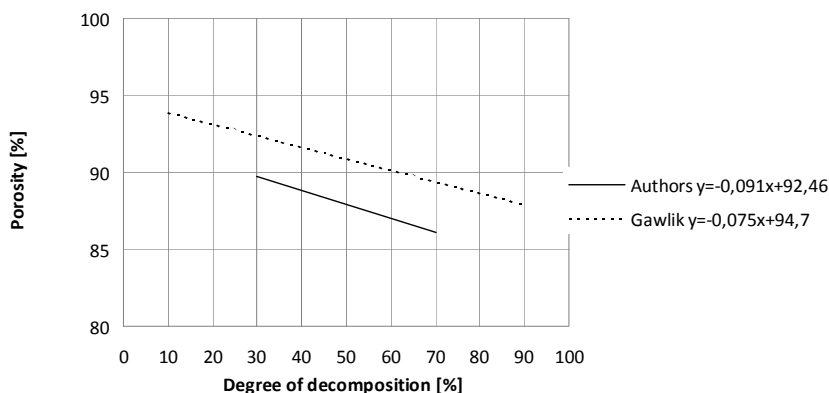

FIGURE 8. The comparison of porosity and degree of decomposition for obtained data and published in the literature

CONCLUSIONS

Based on performed research the following conclusion can be proposed:

1. The degree of decomposition of drained peat soils plays important role on some physical properties: porosity (saturated moisture content) and bulk density.

2. The average values of bulk density 0.1–0.25 $Mg \cdot m^{-3}$ corespondent to values of bulk density in the range 1.5–1.7 $Mg \cdot m^{-3}$. The highest values of bulk density (0.3–0.4 $Mg \cdot m^{-3}$) and particle density (around 1.8 $Mg \cdot m^{-3}$) were observed for moorsh layers.

3. In case of analysed peat and moorsh soil layers the strong linear relationship between porosity and bulk densi-

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Streszczenie: *Analiza wybranych właściwości fizycznych odwodnionych warstw gleb torfowo-murszowych*. Artykuł prezentuje wyniki pomiarów wybranych właściwości fizycznych dla 14 warstw odwodnionych dolinowych gleb torfowo-murszowych (stopień rozkładu, gęstość objętościowa gleby, gęstość fazy stałej, porowatość i wilgotność przy stanie pełnego nasycenia). Próbki glebowe pobrano w północno-wschodniej, centralnej i wschodniej części Polski. Tereny te odwodniono w celu rolniczego ich użytkowania jako użytki zielone i pastwiska. Praca przedstawia wyniki wybranych właściwości fizycznych dla analizowanych warstw glebowych i dokonuje porównania z wynikami podobnych badań opublikowanych w literaturze.

Słowa kluczowe: torf, mursz, właściwości fizyczne

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