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PHYSICO-WATER PROPERTIES OF ORGANIC SOILS DRIED BY GROUNDWATER INTAKE IN WIERZCHOWISKA

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A b s t r a c t. Water properties of hydrogenic soil objects are differentiated according to the kind, amount of water supply and human ingerention, e.g., groundwater intake. This leads to irreversible metamorphosis of this soils and their degradation. The aim of this paper was to estimate the influence of intensive drainage by groundwater intake activity on the changes of the more important physico-water parameters of peat soils in Stawek-Stoki valley.

K e y w o r d s: organic soils, retention and conductivity properties, shrinking and swelling

INTRODUCTION

The increasingly tense water balance forces city authorities to look for new water supply resources. Serious contamination of surface water results in the situation when the unique solution is obtaining ground water from new water intakes. However, the real analyses of consequences of such investments are done very rarely. The example of that can be a ground water intake 'Wierzchowiska' for the town of Świdnik. The construction and usage of this intake together with the incorrect infrastructure of the land's melioration, made very unfavourable changes of the natural environment on of the neighbourhood territory. Now the water laws make the influence prognosis of future investments obligatory for investors [13]. It can be done in two ways - by long-term and expensive land surrvey or using the mathematic modelling method, based on parameters relatively easy to reach. Relatively low costs, quick results and the possibility of simulation of phenomena, which can be absent during traditional research [6,7], make cause the increase in the number of adherents to this method. This method needs however, in its initial stage, the parametrization of the environment in question. In this paper a few results of that work are presented, on the example of peat meadows, situated directly at the zone of the water intake 'Wierzchowiska'. The research has been done with the intention of optimisation of the land reclamation process on that territory, by using in the decision process methods of numeric modelling.

METHODS

The following properties of investigated soil were analysed: shrinking, swelling, critical moisture, water retention and water conductivity [10]. In this paper the morphological description of the research area is omitted. Additionally, to achieve the final aim of the study, the estimation of degradation degree of the soil present in the valley was necessary.

Measurements were taken for undisturbed samples, taken into PVC cylinders of 143 mm diameter and 2, 4, 8 and 30 cm height, as well as in to steel cylinders of 50 mm diameter and 5 cm height. The samples were taken by vertical or horizontal pushing of the cylinders into the chosen layers of soil profile.

The following methods were used during measurement: the method and formulae of Segebert [11] and Loveday [3] for irreversible shrinking and water retention ability estimation, methods of dried monoliths accepted by Institute of Land Reclamation and Grassland Farming (ILRGF) [9] for determining water conductivity value, the Wind [12] method for the water permeability in saturated zone.

The measurements took place from May to November 1994 in the ILRGF and Lublin Technical University laboratories [1].

OBJECT OF THE RESEARCH

The water intake 'Wierzchowiska' is situated in the valley of two rivers - Stawek and Stoki, on the agriculturally used peat meadows. Before the intake started its activity, the site around had relatively rich water resources. To this day exist the remnants of the so-called 'water holes' and land melioration prepared only for dehydration.

When the water intake began to function the essential changes of water relations in the depression funnel zone and the neighbouring territory occurred. The river Stoki dried up completely on 3.5 km of its course. The intensive dehydration of soil in the valley caused the degradation of the surface layers of soil, the proof of which is micropolygonal relief of the surface of the meadow, a lot of craks, even to 1.5 m depth. The break of water contact necessitated changes in the crops cultivated in the meadows. In this situation their owners forced the local authorities to undertake a decision about recultivation of the degraded territory.

The example soil profile was as follows: 0-10 cm - turf layer saturated by dark brownish decay (Z3), 10-30 cm - peat decay (Z1), derived from slightly decomposed, fine-fibrous muscus peat of brown-brownish colour, 30-60 cm - black-brownish peat, humid, in strong decomposition (R3), 60-125 cm - the fibro-amorphous structure peat (R3) with silting increasing with depth, 125-150 cm - completely decomposed, black, amorphous peat, with high content of mineral silt increasing with depth, 150 cm - clayey silt.

For presentation's sake, in this paper only results of 3 out of 7 soil pits have been presented, where 1st and 2nd were found in the strongly degraded zone with micropolygonal relief, 500 and 300 m from the Stoki river. The 3rd soil pit was situated 150 m from the place where the two rivers meet, on the nondegraded meadow, where craks in the soil profile were not observed.

RESULTS

Retention properties

The retention properties were examined in 2 ways: by determining the course of water binding forces in soil (pF curve) and the estimation of critical moisture points the transgression of which causes irreversible limitation of water retention ability by consecutive processes of sample saturation and dehydration.

The results of the examination of water binding forces in soil are presented in Fig. 1. Additionally, a comparison of values from the charts was made - the values of total porosity and water capacity at pF 2.0 and 2.7 for examined layers (Table 1).

Comparing the presented charts of pF curves and values comprised in Table 1 it can be said that despite the fact that the samples were taken in places characterised by various degrees of deformation of surface, there is no essential differences between strip pits. It can lead us to a conclusion about poorly advanced degradation process in peat soil in the examined valley. But the changes in the shape of pF curves, especially in the subturfed layer are clearly visible. The characteristic humps disappear. Curves in its course are more skew, especially in final sections, where its course is close-up to the characteristics of mineral soil. The porosity and comprised water capacity reach their maximum values for layers situated below 25 cm.

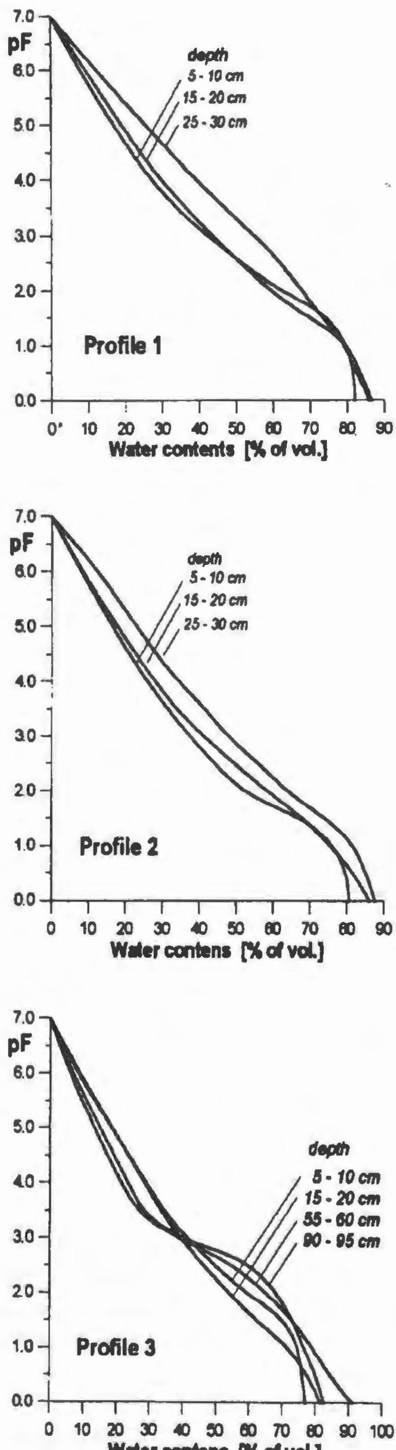

Fig. 1. The pF curves of the peat soil profiles.

Table 1. The values of total porosity and water capacity at pF 2.0 and 2.7 for examined layers

No. of soil pit	Layer (cm)	Total porosity	Water capacity	
			pF 2.0	pF 2.7
		% v.v.		
1	5-10	82.0	63	50
	15-20	86.8	60	47
	25-30	85.0	69	61
2	5-10	80.0	53	42
	15-20	86.0	59	47
	25-30	86.8	65	53
3	5-10	77.0	62	49
	15-20	81.5	55	43
	25-30	85.8	58	47
	55-60	91.0	67	53
	90-95	82.5	69	59

Beside the course of pF curves the water retention ability were examined, during consecutive processes of saturation and dehydration. The obtained results show that water absorption ability (W1) in the examined peats depends on their dehydration degree. The final formulae of that dependence, regression lines, are shown in Fig. 2. The critical moisture points return from which to the start value of moisture content were impossible are comprised in Table 2.

Generally, the samples from the surface layer (0-30 cm) are less sensitive for consecutive deeper dehydration cycle, than samples from deeper layer (30-60 cm). It is interesting that samples from surface layer, independently from dehydration degree, return to moisture higher than field water capacity (Fig. 2B). Additionally, for the 1st soil profile the lack of dependence of water retention ability on the samples dehydration degree is clearly visible. Moisture level after saturation was higher then the value for the determined field water capacity in the whole soil profile range examined.

The results comprised in Table 2, with the morphology description of ground area and detected course of saturation function, can say about essential degradation of surface layer on the examined territory, which causes clear changes of peat soil properties, as a result of intensification of decaying process [2,5,8].

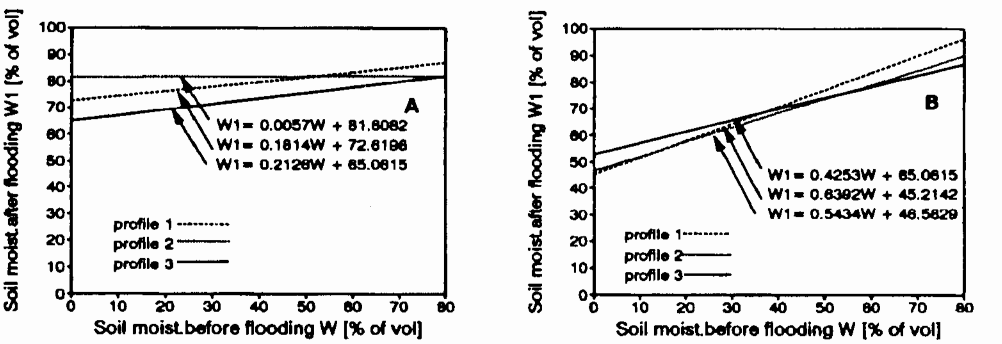

Fig. 2. Relation between soil sample moisture level after flooding (*W1*) and moisture level before flooding (*W*), for A - layer 3-30 cm, B - layer 30-60 cm.

Table 2. The comparison of critical moisture points (% vol.) the reach of which causes return to start moisture value impossible

Soil profile	Layer	
	0-30 cm	30-60 cm

Table 3. The comparison of coefficients of water conductivity *Ks* determined for full saturation and for pF 2.0 stage

Soil profile	Layer (cm)	*K* pF=2.0 (mm/day)	K_s (mm/day)
1	5-40	0.035	7926
	40-75	0.350	18043
3	5-40	0.100	12214
	40-75	0.850	16569

Water conductivity properties

The measurements of water conductivity *K* (mm/day) for full saturation and as a function of soil suction forces *h* (cm H_2O) for streap pit No. 1 and No. 3 were also carried out. The results are presented in Fig. 3, in the from of regression line. Additionally, they are given in Table 3.

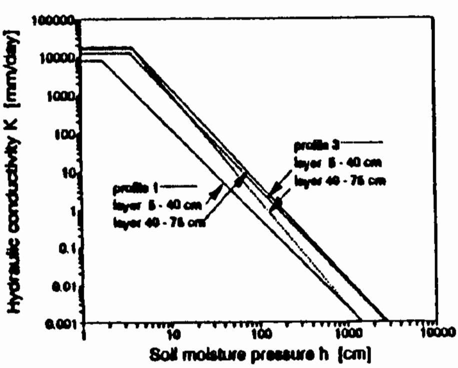

Fig. 3. Relation between hydraulic conductivity coefficient (*K*) and soil moisture pressure (*h*).

The essential difference between water conductivity coefficients for surface and deeper layers is clearly visible. It can certify to alteration of surface layers, signalized above. The values of conductivity coefficients determined for pit No. 3 are much higher then for pit No. 1, which seems to be connected, in accordance with morphology description, with much lower alteration degree than in other soil pits.

Shrinking and swelling

The results of examination of shrinking and swelling are presented in graphs. Dependence of cubic, vertical and horizontal shrinking on moisture of samples is presented in regression lines in Fig. 4.

The maximum values determined for shrinking are given in Table 4. It is visible that samples from surface layer responded less to consecutive processes of saturation and dehydration. Additionally, the considerable diversification

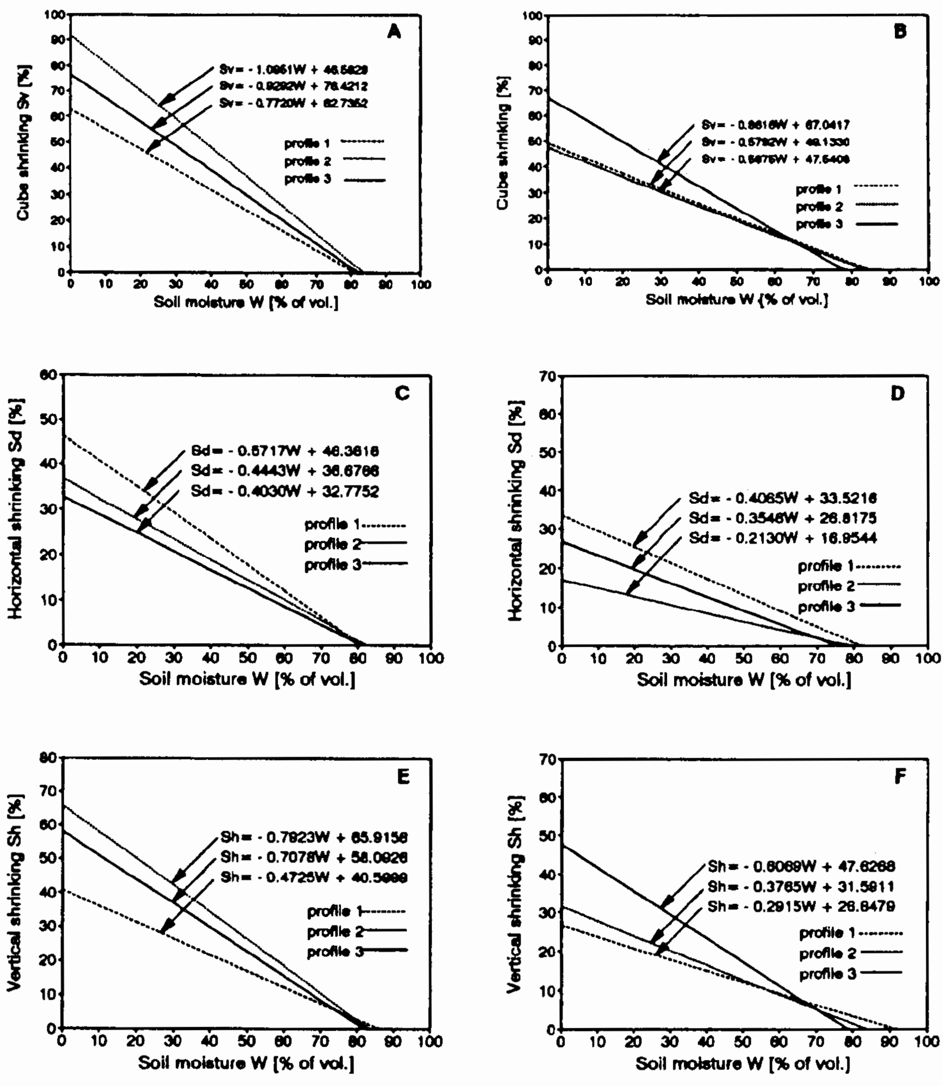

Fig. 4. Dependence of cubic shrinking (*Sv*) - A,B, horizontal shrinking (*Sd*) - C,D and E,F vertical shrinking (*Sh*) on the soil moisture level (*W*), for A,C,E - layer 0-30 cm, B,D,F - layer 30-60 cm.

between them is observed. The samples from pit No. 3 showed higher sensitivity than samples from other pits.

Among samples from deeper layer, the most sensitive to realized processes were samples from pit No. 1. The tendency of occurring higher deformation of ground surface, connected with higher shrinking, is clearly observed. However, the decisive seems to be the phenomenon of cubic and vertical shrinkage [4].

Assuming that appearance of irreversible changes starts when one, from among examined, shrinkage occurs, it can be said that irreversible structure changes will occur at the following moisture: pit No. 1 - 63 % vol., pit No. 2 - 52 % vol., streap pit No. 3 - 58 % vol. (Table 5).

It is worth noting that between surface and deeper layers differences did not ocurr. This can certify, as in the case of retention abilities, that the degradation processes in examined peats are not highly advanced.

Table 4. The comparison of shrinking maximum values of examined samples (%)

Shrinking	Layer	
	0-30 cm	30-60 cm
Cubic	48 - 68	62 - 92
Horizontal	18 - 34	32 - 47
Vertical	27 - 48	40 - 66

Table 5. The determined critical moisture points (% vol.) the transgression of which causes irreversible shrinking phenomena

Soil profile	Soil layer (cm)	Cubic shrinking	Horizontal shrinking	Vertical shrinking
1	0-30	63	36	61
	30-60	63	53	63
2	0-30	52	36	52
	30-60	52	32	30
3	0-30	58	42	58
	30-60	56	46	56

CONCLUSIONS

1. The values of critical moisture indicate the following order of processes: first - structural changes, then changes in retention and conductivity properties. The appearance of craks and deformation of ground surface not always mean the irreversible changes in retention ability and structure of soil. These phenomena only occur after transgression of the respective critical moisture points.

2. In the examined zone the degradation processes in peat soils are detected, especially in surface layers. These processes, however, are not strongly advanced and there is possibility to stop then by recultivation works and water balance regulation.

3. Using executed parametrization, the solution of soil saturation model is necessary. Then, by simulation process the optimal system of irrigation can be chosen. The obtained simulation program will make possible the determination of optimal irrigation dose after realisation of land melioration works. In consequence, this will break the degradation processes and accelerate the recultivation processes.

4. The obtaining of presented parameters of soil environment took about 6 months. There is possibility to shorten the research time by breaking them when critical values are reached. The complete work, connected with creating the model of examined environment and prognosing the recultivation works, can be performed in a slightly longer term.

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WŁAŚCIWOŚCI FIZYKO-WODNE GLEB ORGANICZNYCH PRZESUSZONYCH UJĘCIEM WÓD PODZIEMNYCH W WIERZCHOWISKACH

W zależności od rodzaju i wielkości zasilania wodnego oraz dzialalności czowieka - np. ujęć wody podziemnej, różnicują się wodne wlaściwości hydrogenicznych utworów glebowych, prowadząc do ich nieodwracalnego przeobrażenia, co powoduje ich degradację. Celem artukulu byla ocena wplywu intensywnego odwodnienia na skutek eksploatacji ujęcia wód podziemnych na zmiany ważniejszych fizyko-wodnych parametrów gleb torfowych zalegających w dolinie Stawek-Stoki.

S l o w a k l u c z o w e: gleby organiczne, wlaściwości retencyjne i przewodzące, kurczliwość i pęcznienie.