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FLUCTUATIONS OF DEPTH OF LAND DRAINAGE IN UHNIN GRASLAND IN YEARS 2011–2012[1]

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Summary. The paper presents an analysis of fluctuations in the water level of ground and surface water drainage on site Piwonia-Uhnin sectional Uhnin. The ditches are 1–1.2 m in depth and overgrown with willow. The water in the ditches stagnates at a very low level, and in some of them it dries out completely. The present differentiation of the level of groundwater table on the studied area was identified on the basis of static hydrometric measurements performed in 9 piezometric wells by means of a hydrogeological whistle and on 7 water-level gauges using a measuring rod. Surface water levels in drainage ditches during the study period were subject to minor changes, mainly due to lack of water flow. In the trenches 2, 3 and 4 of filling was 35–55 cm, while in the trenches 1, 5 and 6 of the filling was 5–25 cm. Adverse weather conditions and the system current state of drainage facilities dryness caused by the free outflow of water. For this reason, built dikes ground water outflow. However, the excessive drying we have on mineral soils (sections 7–9) where there are deep ditches and drainage depth exceeds the maximum standard dry h_3. It should also be noted that at the end of the winter semester, depth to the water table is less than the minimum standard dry h_1.

Key words: depth of drainage, level of the groundwater, melioration object, grassland

INTRODUCTION

The comprehensive approach to the protection of waters is regulated by the Framework Water Directive, the primary objective of which is the achievement of good quality of waters by the year 2015. In Poland the protection of waters assumes a special significance as we are among those countries that are poor in water [Zieliński and Słota 1996]. Water deficit limits the possibility of economic development and enforces careful analysis of threats to the amount and quality

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of available water [Mioduszewski 1999]. The areas belonging to the first category needs to be water retention northern part of Lublin (Polesie Lubelskie). In terms of water resources situation in the Lublin province, where resources are per 1360 $m^3 \cdot year^{-1}$ is very negative. Renewable water resources per capita are 1580 $m^3 \cdot year^{-1}$ with a European average of 4560 $m^3 \cdot year^{-1}$. Availability of water in a specific quantity and quality and at the right time satisfying the needs is an essential element of sustainable economic development. In addition to differences in rainfall patterns over the country, we have to deal with the variability between years and seasons [Harasimiuk *et al.* 1998].

Drainage is one of the primary factors that cause the degradation of a habitat [Jurczuk 2000]. Identification of its intensity and effects, and of the possibility of preventive actions, permits the implementation of activities aimed at sustainable development of meliorated areas [Kowalik 2001].

Aim of this study is to analyze the changes in the depth of the water table and water levels on the object surface drainage Piwonia-Uhnin. The water level in cross-hygrometric is one of the basic characteristics of water. The paper references the depth of the water table to the characteristic values of the standards dry soil.

MATERIAL AND METHODS

The study was conducted on the hydrometric transect Uhnin, with a length of 770 m, situated on the melioration object Piwonia-Uhnin, during the period of vegetation of grasslands (April–October) in the years 2011–2012, with frequency of every 30 days. Previous work [Grzywna 2012] presents the results of hydrological studies in the same section in 2006–2009 under the conditions of free drainage of water. In 2010, in order to reduce the drying of soils in ditches and earth dikes were built. The analyzed section is located in the municipality of Dębowa Kłoda for Zaklęsłość Sosnowicka [Kondracki 2002]. Meteorological data were obtained from the meteorological station of the University of Life Sciences in Lublin, located in Sosnowica distance of 10 km.

The Zaklęsłość Sosnowicka is characterised by the occurrence of an apparent abundance of surface waters accumulated in lakes, and by shallow levels of groundwater table (4–7 m). In the years 1954–1961 the Wieprz-Krzna Canal was constructed, which created an interconnection for numerous meliorated peatlands and also involved the conversion of 6 lakes into retention reservoirs. In the course of the melioration works, grasslands were subjected to full tillage management and the drainage ditches were deepened. In spite of the far-reaching human intervention, however, the region is still characterised by very high landscape values and for that reason it has been included in here designated a Natura 2000 site and Biosphere Reserve UNESCO [Chmielewski 2009].

Dehydration of the middle section of the bottom of the valley Piwonia made in 1960–1963 As a result of hydro produced several drainage facilities, and one of them is the object Piwonia-Uhnin an area of 676 hectares of agricultural land.

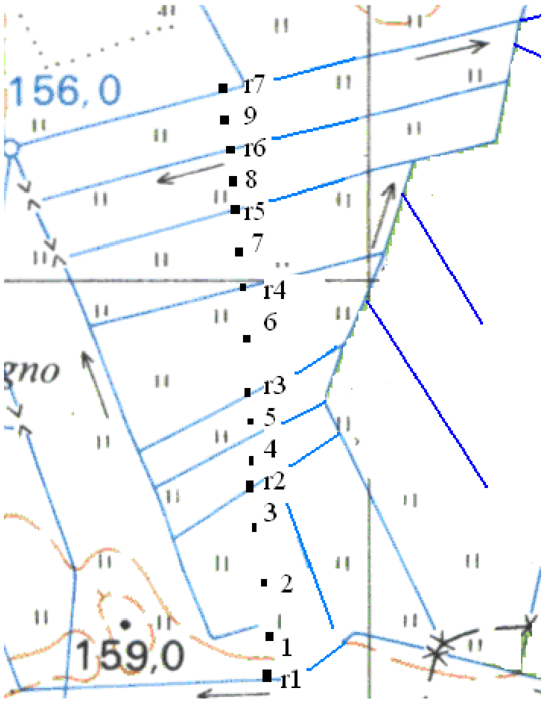

Fig. 1. Location of test points on the object Uhnin

The realisation of the research task was based on analysis of cartographic materials and hydrological studies. The present differentiation of the level of groundwater table on the studied area was identified on the basis of static hydrometric measurements performed in 9 piezometric wells by means of a hydrogeological whistle and on 7 water-level gauges using a measuring rod (Fig. 1). Based on the conducted soil soundings that were the criterion for the determination of Moisture-Soil Predictive Complexes, the drainage norms were identified [Szuniewicz *et al.* 1991].

The results obtained permitted the determination of the mean value ($\bar{x}$), minimum value (N) and maximum value (M), as well as the standard deviation (S) and coefficient of variation (v) of the depth of drainage. For comparative purposes, the terrain ordinates (T) and groundwater table ordinates (W) (m a.s.l.) in the analysed transect were calculated on the basis of levelling data.

RESULTS

Selected for the analysis was a hydrometric transect in the vicinity of the State Farm Uhnin, studied in 1974 by IMUZ in the hypsometric and soil aspects. The transect is situated in a system of melioration ditches regulating soil moisture over an area of 40 ha in midfield valley. The ditches are 1–1.2 m in depth and overgrown with willow. The water in the ditches stagnates at a very low level, and in some of them it dries out completely. The main water course draining the area under analysis is a drainage ditch with a depth of 2 m. Due to the lack of water flow (blocked culverts) there is no possibility of conducting irrigations, which leads to degradation of the soil [Gawlik and Szajda 2003]. At present the object is used as semi-natural single-cut grassland. The study shows that the soils on the object studied are mineral-much and muck-peat soils with varied morphological structure. In order to reduce land degradation and increase the retention of the trenches were built dykes with bags filled with sand. With the relative fields of corn directly adjacent to the facility from the north, south and west dams have a height of 0.3–0.4 m from the east is located in a pine grove forest and 500 meters to 2.5 meters deep river Piwonia.

The years of the study were characterised by varied periodic sums of precipitations. Years of research were characterized by varying rainfall totals. The first hydrological year 2010/11 was characterized by high amounts of precipitation (Tab. 1). The station Sosnowica rainfall was 653 mm and was 132 mm higher than the average of several years from 1981 to 2010. Were particularly high amount of precipitation in the summer half-year (May to October), which amounted to 486 mm, and were higher than the average of several years by 136 mm. However, the monthly rainfall distribution in each year was highly variable. Particularly high rainfall above 340 mm (more than 50% of the annual total) were recorded in June and July, which caused the flooding case of valley areas. Very low rainfall was recorded in March (less than 10 mm). In the hydrological year 2011/12 total precipitation was 521 mm and is equal to the average of several years. Precipitation was slightly different – the first half of the winter rainfall was about 22 mm lower, and the first half of the year as much more than average. In terms of average temperatures in the hydrological year 2010/11 was similar to the average, but with significant differences in each month. The lowest average air temperature was recorded in December -4.8°C at an average of several years of -1.1°C. Particularly hectic month was September when the average temperature was 15.2°C and was up by 2.3°C higher than the average (Tab. 2). In terms of average temperatures year 2011/12 was warmer than the average of 0.5°C was mainly influenced of warmer than average by 1.2°C.

The level of the groundwater table was subject to notable changes in the study time and space (Tab. 3). The highest level of the groundwater table was noted at the beginning of the study, i.e. in the third decade of March 2011 year. The groundwater table was the highest at point 3, where water was found at the depth of 5 cm. The lowest level of the groundwater table was recorded at point 8, where the depth of the water table reached 88 cm. High groundwater table levels at the beginning of the vegetation period are related with the thawing of the soil and inhibited water runoff. In subsequent months the level of the groundwater table systematically lowered. The best position of the groundwater table was observed at the end of a very dry September. The maximum depth of drainage in 2011 ranged from 62 cm in point. 4 to 97 cm in point. 8.

Table 1. Monthly precipitation totals in Sosnowica

Year	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI–IV	V–X	XI–X
2010/11	52	36.6	21.7	19.8	7.4	29.9	53.7	103.2	242.4	62.9	6.8	16.5	167	486	653
2011/12	1.9	28.3	32.9	18.1	25.4	41.7	57.1	74.4	30.4	104.9	42.1	64.1	148	373	521
s	34.3	28.4	19.9	25.8	27.6	33.9	57.9	58.1	78.6	68.3	51.4	35.9	170	350	520

Table 2. Monthly average air temperatures in Sosnowica

Year	XI	XII	I	II	III	IV	V	VI	VII	VIII	IX	X	XI–IV	V–X	XI–X
2010/11	6.5	-4.8	-1.1	-4.7	2.4	9.6	14.9	17.2	18.2	18.1	15.2	7.7	1.4	15.2	8.3
2011/12	2.7	2.0	-2.0	-9.1	4.5	10	15.9	17.4	19.6	18.2	14.8	8.1	1.3	15.7	8.5
s	2.7	-1.1	-2.1	-1.5	2.0	8.7	14.3	16.2	18.5	17.2	12.9	8.1	1.5	14.5	8.0

Table 3. Characteristics depth of the groundwater table

Feature	1	2	3	4	5	6	7	8	9
h_1	25	25	25	25	25	25	25	25	25
h_3	70	70	70	60	50	50	50	50	50
T	157.11	156.86	156.63	156.53	156.62	156.79	157.00	157.04	156.78
X 2011	66	43	38	38	53	64	82	94	77
N	42	16	5	15	25	36	61	88	64
M	96	68	75	62	76	81	94	97	91
S	16.2	21.1	27.2	17.4	17.3	14.3	11.3	3.4	9.3
v	35.6	48.4	72.0	45.6	32.5	22.4	13.7	3.6	12.1
X 2012	75	44	47	48	58	66	88	98	78
N	52	10	21	29	33	45	66	80	66
M	108	78	75	65	73	88	106	110	86
S	19.1	18.8	14.2	12.2	12.8	17.1	14.9	10.5	16.1
v	22.4	42.6	30.2	21.0	22.3	22.2	14.4	8.9	7.7

Table 4. Characteristics of surface water levels, G – depth of the ditch (cm)

Feature	G	x	N	M	S	v	x	N	M	S	v
Year		2011					2012				
r1	135	5	10	2	3.0	2.3	3	8	0	4.2	3.1
r2	110	31	35	25	3.3	4.1	25	29	17	4.5	5.5
r3	110	39	43	35	1.9	2.4	33	37	30	2.4	3.0
r4	130	17	22	15	4.0	3.1	17	22	10	4.3	3.4
r5	130	7	20	3	5.2	3.9	4	13	0	5.6	4.2
r6	130	13	23	5	6.0	4.5	5	19	0	6.2	4.7
r7	180	64	70	57	5.0	4.7	60	67	54	4.0	4.3

Surface water levels in drainage ditches during the study period were subject to minor changes, mainly due to lack of water flow. The trench filling 2 and 3 was 25–45 cm, while in the trenches 4, 5 and 6 of the filling was 10–30 cm. Unlike the situation was in the trench 7, which in the past served as canal and the filling is 0.65 m Despite regulate water outflow occurred in 2012 to completely dry the ditch one bordering a field of corn.

At this point note should be taken of the depth of groundwater table in the piezometric wells in relation to the drainage norms, as the depth of the groundwater table sold not exceed the value of the drainage norm h_3 [Szuniewicz *et al.* 1991]. Excessive lowering of the mean depth of drainage was noted at points 6–9. Such an unfavourable situation of the groundwater table was the result of drought and additionally of the draining effect of the drainage ditch cutting deep into the ground. In piezometers 1–5 the groundwater table occurred usually at optimum depths – within the range between h_1 and h_3. However, in dry years there was a rapid and excessive lowering of the groundwater table. The maximum depths of the ground water table, measured in August 2012, varied from 65 to 110 cm, notably exceeding the maximum value of the drainage norm h_3. It should be noted that at the end of March 2011 the depth of the groundwater table in the transect was less than the value of the minimum drainage norm h_1. At such a high level of the groundwater table ground water-logging appears, which renders tillage treatments impossible.

DISCUSSION

Numerous authors [Kiryluk 1997, Szafrański and Stefanek 2008, Chmielewski 2009] emphasise the high importance of the methods of management and use of catchment basins on the amounts and quality of water resources. The variations in the water level in the object studied were affected, apart from the atmospheric factors, by the deep-set drainage ditch. Analysis of the data presented shows that the lowest level of the groundwater table occurred at point 3, and the highest at point 8. Such a situation of the groundwater table is related with the effect of the system of melioration ditches which, in the spring season, may contribute to the inhibition of runoff and in the summer to the drying of the ground. The result of this is an intensive process of mucking of peat mass, disappearance of valuable plant communities, and a drop in yields [Bałaga 2007].

Unfavourable meteorological factors and the present status of structures regulating water runoff cause an excessive lowering of the groundwater table with the resultant occurrence of water deficit in the soil. Excessive drying of soil is most frequently observed in the case of mineral soils (points 7–9) and, periodically, on strongly transformed shallow peats (points 4–6) situated, in addition, within the zone of effect of the drainage ditch. At the remaining points (1–3), with deep peats and an absence of deep ditches, the depth of drainage very rarely exceeds the value of the maximum drainage norm h_3. During the early spring period it even happens that the depth of the groundwater table is lower than the value of the drainage norm h_1 [Szuniewicz *et al.* 1991].

The presented data that, despite the reduction of surface water runoff followed excessive drying of soils. Very noticeably reduced by up to 20 cm, compared to an open drain has the band would position the groundwater table. However, the average size of the drainage decreased only in the middle section (section 3–5) of 5 to 10 cm. This is certainly a large underground drainage to canal (r7) is cut into the ground to a depth of 2 m.

Recreation of the water retention capacity of catchment basins appears to be, among all other methods of improving the water balance structure, a method that is the most environment-friendly and that meets the criteria of sustainable development [Mioduszewski 1999]. However, it should be noted that the present status of management of river valleys and catchment basins preclude the complete recreation of the retention capacity of the catchment basins and limitation of the effects of extreme phenomena through human adaptation to them.

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WAHANIA GŁĘBOKOŚCI ODWODNIENIA UŻYTKÓW ZIELONYCH W UHNINIE W LATACH 2011–2012

Streszczenie. W pracy przedstawiono analizę wahań położenia zwierciadła wody gruntowej i powierzchniowej na obiekcie melioracyjnym Piwonia-Uhnin w przekroju Uhnin. Rowy melioracyjne mają głębokość 1–1,2 m i są zarośnięte wierzbą. Aktualne zróżnicowanie położenia zwierciadła wody na obszarze badań zostało rozpoznane na podstawie stacjonarnych pomiarów hydrometrycznych wykonywanych w 9 studzienkach piezometrycznych oraz na 7 wodowskazach palowych. Stany wody powierzchniowej w rowach melioracyjnych w okresie badań podlegały niewielkim zmianom, co wynika głównie z braku przepływu wody. W rowach 2, 3 i 4 napełnienie wynosiło 35–55 cm, natomiast w rowach 1, 5 i 6 – 5–25 cm. Niekorzystny układ warunków meteorologicznych i stan urządzeń odwadniających powodował przesuszenie przy swobodnym odpływie wody. Z tego powodu wybudowano groble ziemne hamujące odpływ wody. Mimo to, nadmierne przesuszenie obserwowano na glebach mineralnych (pkt. 7–9), gdzie występują głębokie rowy, a głębokość odwodnienia przekraczała wartość maksymalnej normy osuszenia h_3. Warto zauważyć także, że na koniec półrocza zimowego głębokość położenia zwierciadła wody był mniejsza niż wartość minimalnej normy osuszenia h_1.

Słowa kluczowe: głębokość odwodnienia, poziom wody, obiekt melioracyjny, użytki zielone