Teka Kom. Ochr. Kszt. Środ. Przyr. – OL PAN, 2013, 10, 462–468

PHYSICOCHEMICAL PROPERTIES OF WATER RETAINED IN MIDFIELD BOG POOLS[1]

Danuta Urban[*], Antoni Grzywna[**]

*Institute of Soil Science and Environmental Engineering and Management
University of Life Sciences in Lublin, Leszczyńskiego str. 7, 20-069 Lublin, danuta.urban@up.lublin.pl
**Department of Environmental Engineering and Geodesy, University of Life Sciences in Lublin
Leszczyńskiego str. 7, 20-069 Lublin, antoni.grzywna@up.lublin.pl

Summary. The current paper presents the results of examination of the quantity and quality of surface water. The investigations were conducted on 6 midfield peatbogs undergoing the phase of secondary accumulation of water and matter. The study was carried out in 2011–2012 and consisted in collecting 4–8 samples from the ponds. The water bodies have a surface area of a few to several dozen hectares and are located primarily in the Łęczna-Włodawa Lakeland. Measurements of the water depth performed twice a year revealed that the depth of the surface water retained in the midfield bog pools did not exceed 20 cm; only in some peat pits did it exceed 50 cm. The investigations indicate that lower water levels often increase the concentration of biogens released from organic soils. In a majority of cases, the examined waters were characterised by a very high content of iron, phosphates, ammonia, and nitrites. Therefore, they were classified as class IV quality with poor chemical status. The water quality indicators analysed exhibited high variability, which in many cases was higher than 100%.

Key words: midfield peatbogs, water quality, water depth, Łęczna-Włodawa Lakeland

INTRODUCTION

Poland's accession to the European Union implies compliance with many laws implemented in the European Community, including these regulating soil and water conservation. A comprehensive approach to water protection is proposed by the Water Framework Directive [2000/60/WE], whose major objective is to ensure high water quality by 2015. In Poland, water protection has crucial importance, since our country has poor water resources (the 23rd place among 27 countries) [Zieliński and Słota 1996].

[1] The study was conducted in part under the research project N N305 410338

Peatbogs, in which human activity has led to a decrease in the water level through intensive agriculture, constitute natural water retention reservoirs. In the recent years, secondary water accumulation has been reported from many mid-field peatbogs of the Lublin Province. Given their contribution to conservation of biodiversity, they are designed to be ecologically usable lands [Kondratiuk *et al*. 1995, Radwan and Kornijów 1999, Kiryluk 2003].

The aim of the study was to characterise the water relations in peatbogs by measurements of the depth of midfield peat ponds and assessment of the quality of retained water.

MATERIAL AND METHODS

6 midfield peatbogs were selected for the investigations (Radzic, Jelino, Albertów, Nadrybie, Ostrówek Podyski, Uroczysko Jezioro). The study was carried out in 2011–2012 and consisted in collecting 4–8 water samples from the peat ponds (Tab. 1). The objects have a surface area of a few to several dozen hectares. In terms of physical geography, they are located in the Łęczna-Włodawa Lakeland, a mezoregion of Polesie, and in the Dorohusk Depression (Uroczysko Jezioro), which is a part of the Volhynian Polesie region [Kondracki 2002]. In terms ofadministration , they are located in the Lublin Province.

Table 1. Water depth in bog pools and peat pits

Number and name of the object (number of samples)	Number of the site	Location of the site	Date of measurement			
			25.05. 2011	25.09. 2011	05.06. 2012	10.10. 2012
			Depth of the reservoir, cm			
1 Albertów (8)	1	Ditch in the north	20	10	10	10
	2	Ditch in the east	20	10	10	10
2 Radzic (8)	3	Ditch along a road	20	10	15	10
	4	Peat pit	20	5	10	5
3 Jelino (10)	5	Eriophoro-Sphagnetum	55	40	45	35
	6	Northern part	35	30	30	20
	7	Ditch in the north	20	15	10	5
4 Nadrybie (8)	8	Ditch	15	10	10	5
	9	Peat pit	15	10	10	5
5 Uroczysko Jezioro (10)	10	Peat pit	15	0	5	0
	11	Peat pit with *Stratiotes aloides*	40	20	30	15
	12	Ditch along a dyke	15	10	10	5
6 Ostrówek Podyski (14)	13	Eriophoro-Sphagnetum	0	0	-5	-5
	14	Peat pit – floating bog	0	0	0	0
	15	Ditch in the north	15	10	15	10
	16	Overgrowing peat pit	60	50	50	40

Object 1 Albertów („Bagno Wytrzeszczone") – the village of Albertów, Puchaczów County. Designed ecological land, transitional mire and fen; area: 7.10 ha. Peatland communities from the *Scheuchzerio-Caricetea nigrae* and *Oxycocco-Sphagnetea* classes, rush communities from the *Phragmitetea* class, aquatic plant communities from the *Potametea* class, and scrub communities from the *Alnetea glutinosae* class [Urban and Wójcikowska-Kapusta 2003].

Object 2 Radzic near Radzic and Zezulin, Ludwin County. Fen with numerous peat excavation pits and drainage ditches; area: 3.5 ha. Meadow communities from the *Molinio-Arrhenatheretea* class, rush communities from the *Phragmitetea* class, aquatic plant communities from the *Lemnetea minoris* class, and scrub communities from the *Alnetea glutinosae* class.

Object 3 Jelino in the Zagłębocze village, Sosnowica County. Natura 2000 site. Transitional mire and raised bog with numerous peat excavation pits; area: 8.9 ha. Peatland communities from the *Scheuchzerio-Caricetea nigrae* class, rush communities from the *Phragmitetea* class, aquatic plant communities from the *Potametea* class, and scrub communities from the *Alnetea glutinosae* class.

Object 4 Nadrybie near Nadrybie Dwór, Puchaczów County. Fen with an area of 1.7 ha with meadow communities from the *Molinio-Arrhenatheretea* class, rush communities from the *Phragmitetea* class, and aquatic plant communities from the *Lemnetea minoris* class.

Object 5 Uroczysko Jezioro near Dorohucza, Trawniki County. Protection zone of the Nadwieprzański Landscape Park; designed nature reserve. Fen with numerous peat excavation pits; area: 47.0 ha. Meadow communities from the *Molinio-Arrhenatheretea* class, rush communities from the *Phragmitetea* class, aquatic plant communities from the *Lemnetea minoris* class, and scrub communities from the *Alnetea glutinosae* class [Łuczycka-Popiel and Urban 1995].

Object 6 Ostrówek Podyski in the Cyców village, Cyców County. Natura 2000 site. Transitional mire and raised bog with peat excavation pits; area: 44.0 ha. Peatland communities from the *Oxycocco-Sphagnetea* class, rush communities from the *Phragmitetea* class, quatic plant communities from the *Potametea* class, and forest communities from the *Vaccinio-Piceetea* class.

The physicochemical analyses of water were performed using widely-used methods:

– pH reaction, conductivity (S) – with and a multi-parameter meter Multi 340i;

– CODCr, total nitrogen (N_{tot}), ammonia (NH_4), nitrites (NO_2), and phosphates (PO_4) – with an MPM 2010 WTW photometer;

– nitrates (NO_3), iron ions (Fe), sulphates (SO_4), and chlorines (Cl) – with a Slandi photometer LF 300.

The study results were statistically analysed in the Excel program and the minimum (N), maximum (W), and mean (x) values as well as the variability coefficient (v) were calculated. The classification of water quality was based on the Regulation of the Minister of the Environment of February 11, 2004 [Journal of Laws No. 32 item 284] on classification of the status of surface and ground waters, methods for monitoring, interpretation of results and presentation of the water status. The Regulation of the Minister of the Environment of November 9 2011 [Journal of Laws No. 257 item 1545] was not applicable, as it takes into account only nitrogen and total phosphorus for water reservoirs; therefore, the analysis of the results obtained would have been incomplete.

RESULTS

The measurements of water depth carried out twice a year showed that due to dry May and September the depth of surface water retained in midfield bog pools did not exceed 20 cm (Tab. 1). Only in some peat pits did it exceed 50 cm, although peat pits that were dry or covered with a thick cover of *Sphagnum palustre* were also found. The physicochemical properties of surface water stagnating in peatbogs exhibited a markedly higher variability than those in peat pits.

The water samples analysed exhibited an inconsiderable content of nitrogen and a low level of sulphates and chlorines (< 50 mg · dm^{-3}). In a majority of the samples, the total nitrogen content of did not exceed 5 mg · dm^{-3}, nitrite and ammonium nitrogen 1 mg · dm^{-3}, and nitrate nitrogen 0,2 mg · dm^{-3} (Tab. 2). Similarly, the content of potassium ions was very low and did not exceed 10 mg · dm^{-3} in most of the samples. Given the content of total nitrogen and its compounds, the water was classified as class II quality [Regulation 2004]. All the samples were characterised by a very high oxygen demand (COD_{Cr} > 60 mg · dm^{-3} – class V). Moreover, many samples exhibited slightly acidic reaction (pH < 6,5). The values of these indicators imply an on-going anaerobic digestion process, i.e. an element of the humification process. In most cases, the analysed waters were characterised by a high content of iron ions (> 1 mg · dm^{-3}) and phosphates (> 0,7 mg · dm^{-3}). Excessive values of these parameters categorises the water into quality class IV or even V (iron ions > 2 mg · dm^{-3}, phosphates > 1 mg · dm^{-3}). Although the analysed waters were characterised by very high COD values, they exhibited very low conductivity (< 200 μs · cm^{-1}). The electrolytic conductivity increased to 500 μs · cm^{-1} only when the depth of water bodies decreased below 5 cm. The low values of conductivity in water reservoirs below 15 cm are associated with deposition of detritus matter onto the bottom.

Compared with the spring period, the depth of the water bodies in winter was decreased by ca. 10 cm. The low atmospheric precipitation in 2012 resulted in decreased depth of the peat ponds by 7 cm on average, which partially reduced their surface area. Hence, the water quality was lowered, which was manifested by an increase in the content of total nitrogen and ammonia. In some sampling sites, the ammonia content increased several-fold and in some case it exceeded the value of 1 mg · dm^{-3} (class III).

Since bog pools are usually astatic reservoirs recharged by atmospheric precipitation, they accumulate biogenic compounds. As a result of large fluctuations in the water table level in reservoirs, nitrogen compounds contained in the

Table 2. Physicochemical properties of surface waters

Parameters	pH	S	$CHZT_{Cr}$	N	NO_2	NO_3	NH_4	PO_4	SO_4	Cl	Fe
		$\mu s \cdot cm^{-1}$	$mg \cdot dm^{-3}$	$mg \cdot dm^{-3}$	$mg \cdot dm^{-3}$	$mg \cdot dm^{-3}$	$mg \cdot dm^{-3}$	$mg \cdot dm^{-3}$	$mg \cdot dm^{-3}$	$mg \cdot dm^{-3}$	$mg \cdot dm^{-3}$
Number of object	N–W x–v	N–W x–v	N–W x–v	N–W x–v	N–W x–v	N–W x–v	N–W x–v	N–W x–v	N–W x–v	N–W x–v	N–W x–v
1	5.0–5.9 _ –8	89–108 95–9	123–156 139–10	1.9–3.3 2.8–23	0.04–0.14 0.1–49	0.02–0.50 0.2–91	0.13–0.59 0.3–78	0.1–0.4 0.3–55	0–25 12–106	1.2–17.7 11–64	0.68–1.90 1.1–47
2	4.6–7.8 _ –22	54–723 314–91	36–90 60–42	1.2–4.9 3.2–48	0.07–0.14 0.1–27	0.13–2.77 1.9–63	0.08–0.61 0.3–74	0.4–0.8 0.6–33	1–193 85–105	6.9–61.0 43–69	0.08–1.80 0.8–101
3	4.4–7.1 _ –17	32–512 140–137	88–131 114–14	1.0–3.5 2.0–48	0.03–0.21 0.1–61	0.01–0.99 0.3–120	0.05–0.53 0.2–87	0.2–1.2 0.7–63	0–5 1.7–135	1.4–66.0 19–167	0.42–2.43 0.9–91
4	4.9–7.3 _ –21	20–830 228–176	117–176 150–19	2.4–7.5 5.0–55	0.05–0.21 0.1–99	0.07–1.39 0.5–123	0.12–1.44 0.7–95	0.3–3.4 1.4–103	10–129 42–137	2.2–15.0 9–75	0.31–3.19 1.1–132
5	6.4–7.1 _ –4	120–407 275–37	56–188 121–43	2.4–6.2 3.7–40	0.01–0.40 0.1–132	0.01–0.53 0.2–111	0.08–1.84 0.5–144	0.1–2.1 0.6–121	0–169 29–240	2.1–31.3 15.6–65	0.25–1.50 1.1–45
6	4.0–6.5 _ – 19	48–230 101–61	157–295 226–20	0.8–5.9 3.2–48	0.10–0.64 0.3–64	0.04–1.11 0.3–109	0.10–1.60 0.4–137	0.4–2.0 1.1–61	0–16 5–110	4.6–23.4 8.9–72	0.56–1.79 1.2–43
Mean 1–6	4.0–7.8 _ – 19	20–830 183–108	36–295 144–44	0.8–7.5 3.2–52	0.01–0.64 0.2–100	0.01–2.77 0.5–145	0.05–1.84 0.4–122	0.1–3.34 0.8–91	0–193 24–210	1.4–66.0 15–121	0.08–3.19 1.1–68

organic matter of peatbogs are released [Radwan and Kornijów 1999]. Since there is no recharge with other sources of water, this phenomenon is impossible to eliminate [Urban and Wójcikowska-Kapusta 2003].

CONCLUSIONS

1. The investigations conducted indicate that decreasing levels of water often leads to an increase in the concentration of biogens released from organic soils. A majority of the examined water samples exhibited a very high content of iron, phosphate, ammonia, and nitrites. Therefore, the analysed water was classified as class IV or even V, and their chemical status was determined to be poor.

2. The analysed waters are characterised by slightly acidic reaction and very high COD values resulting from decomposition of organic matter.

3. Bog pools are astatic reservoirs accumulating matter and biogens. The depth of surface water depends on atmospheric precipitation rates.

4. The analysed indicators of water quality exhibited high variability, which in many cases exceeded 100% (conductivity, nitrates, nitrites, ammonia, potassium, chlorines), or even 200% in the case of sulphates.

REFERENCES

Dyrektywa Parlamentu Europejskiego i Rady Nr 2000/60/WE z 23 października 2000 r. w sprawie ustanowienia ram dla działalności Wspólnoty w dziedzinie polityki wodnej.

Kiryluk A., 2003. Rola niektórych roślinnych zbiorowisk łąkowych w ochronie gleb przed degradacją. Zesz. Probl. Post. Nauk Roln., 493, 889–895.

Kondratiuk P., Kołos A., Grygorczuk I., 1995. Użytek ekologiczny – forma ochrony mokradeł śródpolnych, w: Mat. Konf.: Torfoznawstwo w badaniach naukowych i praktyce. Falenty, s. 103–108.

Kondracki J., 2002. Geografia regionalna Polski. Wyd. Nauk. PWN, Warszawa.

Łuczycka-Popiel A., Urban D., 1995. Zbiorowiska roślinne Uroczyska Jezioro koło Dorohuczy na Polesiu Lubelskim. Annales UMCS, sec. C, 50, 113–132.

Radwan S., Kornijów R. (red.), 1999. Problemy aktywnej ochrony ekosystemów wodnych i torfowiskowych w polskich parkach narodowych. Wyd. UMCS Lublin.

Rozporządzenie Ministra Środowiska w sprawie klasyfikacji dla prezentowania stanu wód powierzchniowych i podziemnych, sposobu prowadzenia monitoringu oraz sposobu interpretacji wyników i prezentacji stanu tych wód (Dz. U. 2004, Nr 32, poz. 284).

Urban D., Wójcikowska-Kapusta A., 2003. Wpływ zlewni na zawartość makroelementów w glebach śródpolnego torfowiska przejściowego. Acta Agrophysica, 87, 1, 339–348.

Zieliński J., Słota H., 1996. Stan i wykorzystanie zasobów wód powierzchniowych Polski. IMGW, Gospodarka Wodna i Ochrona Wód, nr 20, ss. 52.

WŁAŚCIWOŚCI FIZYKO-CHEMICZNE WODY ZALEGAJĄCEJ W ŚRÓDPOLNYCH OCZKACH TORFOWYCH

Streszczenie. W prezentowanej pracy przedstawiono wyniki badań ilości i jakości wody powierzchniowej. Do badań wytypowano 6 torfowisk śródpolnych, znajdujących się w fazie wtórnej akumulacji wody i materii. Badania przeprowadzono w 2011 roku, pobierając z oczek od 4 do 8 próbek. Obiekty te mają powierzchnię od kilku do kilkudziesięciu hektarów i położone są głównie na Pojezierzu Łęczyńsko-Włodawskim. Pomiary głębokości wody, wykonane dwukrotnie w ciągu roku, wykazały, że miąższość wody powierzchniowej zalegającej w śródpolnych oczkach torfowych nie przekraczała 20 cm, jedynie w torfiankach miejscami przekraczała 50 cm. Z przeprowadzonych badań wynika, że obniżenie poziomu wody powoduje często wzrost stężenia biogenów uwalnianych z gleb organicznych. W większości przypadków badane wody charakteryzowała bardzo wysoka zawartość żelaza, fosforanów, amoniaku i azotynów. Z tego powodu zaliczono je głównie do IV klasy czystości, a ich stan chemiczny określono jako zły. Analizowane wskaźniki jakości wody cechowały się bardzo dużą zmiennością, w wielu przypadkach przekraczającą 100%.

Słowa kluczowe: torfowiska śródpolne, jakość wody, głębokość wody, Pojezierze Łęczyńsko-Włodawskie