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INFLUENCE OF AGRICULTURAL ANTHROPOPRESSION ON WATER QUALITY OF THE DAM RESERVOIRS

WPŁYW DZIAŁALNOŚCI ROLNICZEJ NA JAKOŚĆ WÓD W ZBIORNIKACH ZAPOROWYCH

Abstract: The research evaluated the quality of surface waters subject to agricultural anthropopressure. The authors analyzed river water feeding dam reservoirs and water in reservoirs. The research covered the catchment areas of reservoirs Kozlowa Gora, Przeczyce and Laka, located in the Upper-Silesian region (southern Poland). The dominating form of land management in the catchments is agriculture. The reservoirs were found to be often fed with running waters whose parameters suggested eutrophication, especially with regard to the concentration of nitrates (mean yearly concentration of NO_3^- > 10 mg/dm^3). Eutrophication also concerned reservoir water, which could be seen in frequent water blooming. The reaction of water in the reservoirs happened to increase up to strongly alkaline (pH_{max} > 8.5). The highest fertility of waters was that of reservoir Laka, mainly alimented from agricultural lands (77% of the catchment area) also situated within its direct catchment. This was reflected in high phosphate concentrations in the water of the reservoir (average 0.389 mg PO_4^{3-} /dm^3). The research showed that agricultural anthropopressure is a significant threat to functioning of dam reservoirs because it fosters the process of eutrophication and thus affects the quality of disposable water resources.

Keywords: land use, agricultural anthropopression, water quality, dam water reservoir, eutrophication

In multidirectional management of dam reservoirs, it is necessary to maintain high ecological values of their ecosystems, especially good quality of water. That quality depends on environmental and anthropogenic influences in the feeding areas of the catchment. Recognition of relations and influence between the catchment and the reservoir makes it possible to determine optimum forms of land management which would foster protection of collected water resources. The factor that severely restricts the use of reservoirs is eutrophication, which is the result of increased discharge of organic and

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mineral matter into water [1, 2]. The process concerns many lakes and water reservoirs all over the world which are subject to anthropopressure [3-7]. The trophic condition of reservoir water is mainly determined by phosphorus; its concentrations reaching as low as 20÷30 μg P/dm^3 are sufficient to cause algal blooms [8]. The following limit values of indexes of eutrophication of still waters have been introduced in Poland [9]: *total phosphorus* (P) - over 0.1 mg/dm^3, *total nitrogen* (TN) - over 1.5 mg/dm^3, chlorophyll *a* - over 25 μg/dm^3, transparency - below 2 m. These values are comparable to reports from researchers in other countries [10, 11]. Other important indexes of eutrophication include growth of aerophytic algae, deoxidation of the hypolimnion, reduction in biodiversity and the mentioned algal blooms. Eutrophication of lakes and water reservoirs also brings about unfavorable consequences of socioeconomic nature. That mainly results from contamination of water with organic matter, with consequent deterioration of its taste, smell and color. Use of such quality water leads to corrosion of waterpipes, clogging of filtrating devices and poor heat exchange in exchangers. Eutrophicated water bodies lose their recreational and aesthetic values and may even create a sanitary threat because of anaerobic decomposition of organic matter and toxicity of algae [12, 13].

Processes of eutrophication are typical of watercourses and reservoirs located in catchments which are used for agricultural purposes. That results from increased migration of biogenic substances and organic matter (eg from fertilizing material, or in erosion rainwash) to surface and underground water [14-18]. Farming activities should therefore be carried out in a way which would limit migration of soil nutrients outside farmlands [19, 20]. The basic European document which determines the directions of protection of water quality from farming-related contaminations is "Council Directive 91/676/EEC of 12 December 1991 concerning the protection of waters against pollution caused by nitrates from agricultural sources". Its provisions are adapted for the conditions in particular countries and taken into consideration in legal acts. They are also referred to in numerous scientific publications and guidebooks for farmers [21-23]. However, introduction of protective actions requires monitoring of water quality, which was taken up by the authors of this paper in the Upper-Silesian region - in southern Poland. The aim of the proceedings was to diagnose the water quality in selected dam reservoirs operating under agricultural anthropopressure.

Objective and methods of research

Three dam reservoirs, situated in the Upper-Silesian region, were selected for the research - Kozlowa Gora on the Brynica River, Przeczyce on the Czarna Przemsza and Laka on the Pszczynka [24]. Field observations and indoor studies (cartographic materials, ortophotographs and satellite imagery) showed that farmlands are the main serious source of environmental pollution in the catchment areas of these reservoirs. They cover at least half of the area of the catchment in the profile of land use (Fig. 1).

Reservoir Kozlowa Gora was built in 1935-1939. Its maximum area is 587 ha and total volume 15.3 mln m^3. The catchment area of the reservoir takes 206.14 km^2. Agrarian land covers 48.6% and forested land 43.8% of this area. Urban areas are located in the central and lower parts of the catchment over the total area of 10.99 km^2. Reservoir Przeczyce has been in use since 1963. It covers the area of 470 ha, and its basin can retain up to 20.7 mln m^3 of water. The reservoir is alimented with water flowing from the area of

296.25 km^2, almost half of which (49.5%) is occupied by land of agricultural use. Forested land of the catchment covers 40.1%, and urban area 27.64 km^2, which is 9.3% of the catchment. Reservoir Laka (maximum area - 350 ha; total volume - 11.2 mln m^3) is one of the younger water bodies of the Upper-Silesian region - it was put into service in 1986. Its catchment (157.92 km^2) is typically agricultural. Farming activities use 121.7 km^2 (77.1% of the catchment area). Urban landscape is scattered and covers 12.41 km^2. Only 12.7% of the catchment area is covered by forested land.

The mentioned reservoirs function in a lake district region called Upper-Silesian Anthropogenic Lake District [25]. Its area includes a few thousand water reservoirs of various origins and sizes, which are highly important with regard to improvement of disposable water reserves. It is therefore justifiable to recognize the threats facing retained waters and take up protective actions.

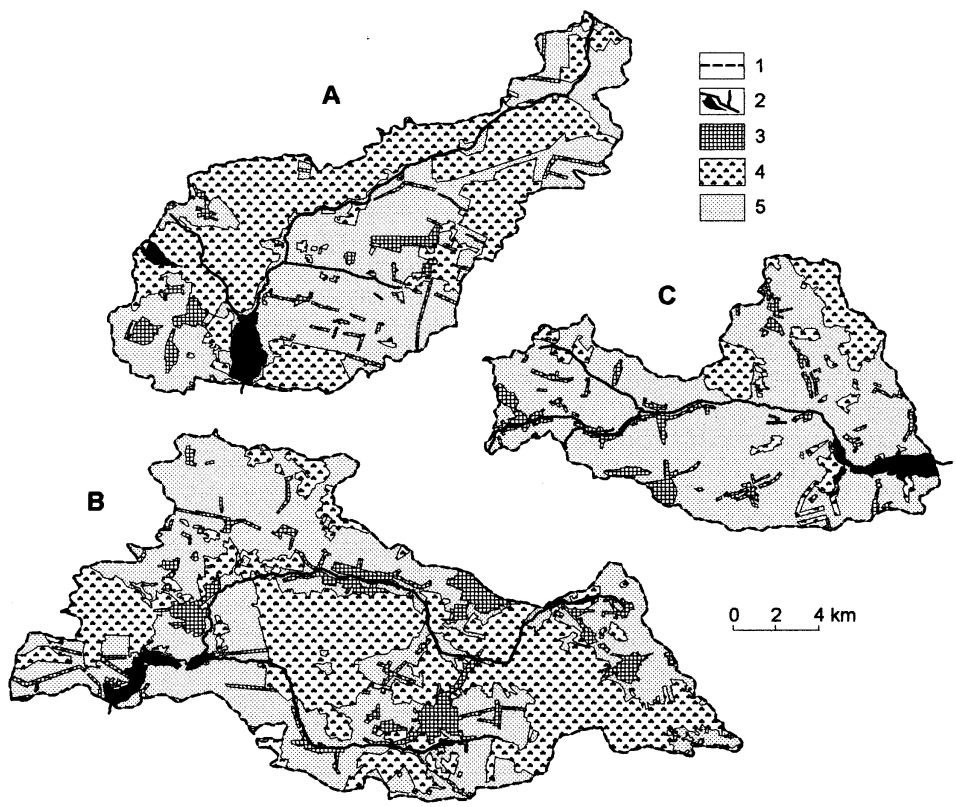

Fig. 1. Land use of the catchment area of the selected dam water reservoirs in the Upper-Silesian Region (A - Kozlowa Gora, B - Przeczyce, C - Laka): 1 - catchment boundaries, 2 - surface waters, 3 - urbanised areas, 4 - forestlands, 5 - farmlands. Source: made by the authors

The research was carried out in years 1998-2007. In the research time, physicochemical analyses of reservoir waters were made using standard methods [26]. Some parameters (reaction, electrolytic conductivity, oxygen concentration and oxygen saturation) were

determined directly on the site using appropriate equipment. Macro-ionic composition of collected samples was determined in the laboratory of the Faculty of Earth Sciences of the University of Silesia. Data was also collected regarding the quality of water in rivers flowing into the researched reservoirs. The data was obtained from the archives of the *Environmental Research and Control Center* (OBiKS) in Katowice and refers to years 2005-2008. Continuous monitoring of land management in the catchments was also carried out as part of the research.

Results and discussion

Physiochemical properties of waters in main rivers feeding the researched reservoirs (determined within the inflow zones of these reservoirs) reflected the impact of agricultural anthropopressure (Table 1). The water contained excessive amounts of nitrates, that is more than the eutrophication threshold for running waters (average yearly concentration of NO_3^- > 10 mg/dm^3), but it was not considered sensitive water [9]. Relatively high were also concentrations of *total nitrogen* (TN), which were below the eutrophication level only in case of the Czarna Przemsza. *Total phosphorus* (P) was generally within 0.1÷0.2 mg/dm^3, but reached a few tenths of mg/dm^3 at maximum, which suggested periodical excessive fertilization of water. With regard to phosphorus concentrations, running waters are classified as eutrophicated when the average yearly concentration of P exceeds 0.25 mg/dm^3 [9]. Concentrations of total phosphorus did not generally exceed that level in the researched rivers - which mostly results from the ability of compounds of this element to be fixed and accumulated in the ground [27]. Waters of all rivers were characterized by high contents of nitrates(III) (over 0.1 mg NO_2^- /dm^3), which disqualified them as potable water [28]. Also, ammonia concentrations (especially in waters of the Czarna Przemsza and the Pszczynka) exceeded the level acceptable for drinking water - 0.5 mg NH_4^+ /dm^3 [28], or even for water which can be used in potable water treatment processes - 2.0 mg NH_4^+ /dm^3 [29]. The reaction of the researched waters was generally neutral and periodically alkaline. Also, heavy load of organic substances was periodically reported in the water - BOD_5 reached up to 8÷11 mg O_2/dm^3.

Particularly unfavorable parameters were those of the water in the Pszczynka (Table 1), which drains the catchment with the highest share of farmlands. Compared to the Brynica and the Czarna Przemsza, it was characterized by lower concentrations of dissolved oxygen and simultaneously, higher pollution with organic substances - expressed by high BOD_5 and *total Kjeldahl nitrogen* (TKN), as well as noticeably higher concentrations of ammonia and nitrates(III). This data reflects occurrence of conditions which are unfavorable for oxidation processes, and use of the waters may involve sanitary threats.

The research showed that the quality of water in the reservoirs is a derivative of the influence of the main feeding river, influence of the direct catchment and the processes occurring in the environment of still waters. At the same time, retaining river water in reservoirs results in changes in its quality which is reported not only in the conditions of agricultural anthropopressure, but also in quasi-natural or urban-industrial catchments [24, 25, 30, 31]. The limnic environment, characterized by periodic stagnation of water, has

limited possibilities of neutralization of contaminants flowing from the catchment, which are usually accumulated in reservoir basins.

Table 1

Physiochemical properties of river waters flowing to the dam reservoirs in the years 2005-2008

Parameter	2005		2006		2007		2008	
	average	max	average	max	average	max	average	max
	The Brynica river (reservoir Kozlowa Gora)							
Reaction pH	7.3	7.9	7.3	7.5	7.3	7.6	7.3	7.7
Oxygen [mg O_2/dm^3]	9.8	12.7	9.1	11.5	10.1	10.9	9.0	11.0
BOD_5 [mg O_2/dm^3]	2.5	8.4	2.4	10.8	1.9	3.4	1.8	2.6
NH_4^+ [mg/dm^3]	0.31	0.81	0.15	0.45	0.13	0.23	0.08	0.16
NO_2^- [mg/dm^3]	0.16	0.91	0.09	0.23	0.08	0.26	0.09	0.29
NO_3^- [mg/dm^3]	18.0	28.0	20.1	24.0	19.0	24.0	15.4	18.6
TKN [mg/dm^3]	1.9	2.7	1.6	3.0	1.0	2.7	1.4	6.7
TN [mg/dm^3]	6.82	14.60	6.14	7.74	5.33	7.23	4.91	10.56
P [mg/dm^3]	0.21	1.10	0.13	0.24	0.09	0.19	0.08	0.18
	The Czarna Przemsza river (reservoir Przeczyce)							
Reaction pH	7.5	7.7	7.5	7.9	7.5	7.7	7.5	7.8
Oxygen [mg O_2/dm^3]	10.3	12.4	9.5	12.0	9.9	11.9	9.8	11.1
BOD_5 [mg O_2/dm^3]	2.0	3.9	1.7	2.8	2.5	6.2	2.4	8.0
NH_4^+ [mg/dm^3]	0.60	1.93	0.74	3.20	0.64	2.80	0.25	0.57
NO_2^- [mg/dm^3]	0.12	0.32	0.15	0.27	0.15	0.53	0.12	0.26
NO_3^- [mg/dm^3]	12.6	20.0	13.3	18.0	13.0	23.0	12.3	20.8
TKN [mg/dm^3]	1.6	2.7	1.5	3.6	1.3	4.4	1.7	5.3
TN [mg/dm^3]	4.46	5.91	4.59	6.16	4.31	6.91	4.48	7.98
P [mg/dm^3]	0.19	0.54	0.20	0.57	0.18	0.49	0.18	0.67
	The Pszczynka river (reservoir Laka)							
Reaction pH	7.3	7.4	7.4	7.6	7.3	7.5	7.3	7.4
Oxygen [mg O_2/dm^3]	6.7	10.5	5.8	9.2	5.8	9.9	5.5	9.4
BOD_5 [mg O_2/dm^3]	4.0	5.6	4.8	6.8	4.4	6.0	4.0	4.9
NH_4^+ [mg/dm^3]	1.62	3.76	2.35	3.71	2.65	6.85	3.77	8.04
NO_2^- [mg/dm^3]	0.33	0.82	0.48	1.14	0.45	0.78	0.31	0.55
NO_3^- [mg/dm^3]	12.3	38.3	10.4	17.8	15.5	40.9	10.7	34.6
TKN [mg/dm^3]	2.1	4.1	2.5	3.5	2.9	6.1	3.8	6.7
TN [mg/dm^3]	4.96	10.50	5.04	6.58	6.53	11.10	6.30	9.72
P [mg/dm^3]	0.17	0.29	0.20	0.34	0.18	0.29	0.26	0.43

Source: made on the base of data taken from OBiKS in Katowice

The diversity of physiochemical parameters of reservoir waters (determined in near-dam zones) corresponded with observations regarding river waters - water parameters were relatively similar in reservoirs Kozlowa Gora and Przeczyce, whereas noticeably worse in case of reservoir Laka (Table 2). The reasons for that situation were inflow of large amounts of contaminants into the latter reservoir and the agricultural use of the area of the direct catchment. Water in reservoir Laka was characterized by higher electrolytic conductivity than water in Kozlowa Gora or Przeczyce, which suggested the

presence of significant amounts of mineral substances. Among them, sodium is worth paying attention to; its high concentration (usually about 50 mg/dm^3) - exceeding the level of the geochemical background, was probably related to washing out from the fertilizing materials. That is supported by the absence of other identified sources of contamination with this element, and particularly lack of discharge of mining water into the Pszczynka river. Water in reservoir Laka also contained higher amounts of phosphates (on average 0.389 mg PO_4^{3-} /dm^3), which can be related not only to external inflow, but also to phosphates being released from bottom deposits in conditions of progressive eutrophication.

Table 2

Water physiochemical properties of the dam reservoirs - average values 1998-2007

Parameter	Kozlowa Gora			Przeczyce			Laka		
	min.	average	max	min.	average	max	min.	average	max
Reaction pH	7.38	8.17	9.81	7.35	7.96	8.66	7.20	7.62	8.90
Conductivity [µS/cm]	274.9	364.2	410.0	418.0	462.1	521.0	476.0	588.0	719.0
Oxygen [mg O_2/dm^3]	9.6	12.4	15.1	7.4	10.5	12.3	9.0	9.6	11.9
Oxygen [%]	79.1	113.0	151.5	79.7	89.9	101.1	88.2	88.8	141.0
HCO_3^- [mg/dm^3]	92.0	141.7	179.0	174.0	209.8	397.0	134.8	152.2	162.0
Ca^{2+} [mg/dm^3]	46.0	63.3	84.0	44.0	71.9	104.0	37.1	43.1	62.0
Mg^{2+} [mg/dm^3]	1.2	20.8	36.0	9.6	25.1	39.6	7.6	10.6	12.1
Na^+ [mg/dm^3]	6.4	8.1	10.7	9.5	11.9	14.5	40.2	52.2	74.3
K^+ [mg/dm^3]	2.6	3.0	3.3	2.8	4.1	4.7	3.9	6.5	8.8
Cl^- [mg/dm^3]	16.0	27.9	64.0	17.7	27.2	38.0	41.7	89.2	94.2
SO_4^{2-} [mg/dm^3]	27.9	40.1	60.1	42.3	53.0	68.6	26.8	68.5	76.5
NO_3^- [mg/dm^3]	1.0	7.6	17.7	1.0	7.5	14.0	0.9	10.4	12.6
PO_4^{3-} [mg/dm^3]	0.004	0.062	0.141	0.006	0.075	0.197	0.079	0.389	0.421

Source: made by the authors

The studies showed that agricultural anthropopressure is characterized by loads of biogenic substances, organic compounds and some substances used in fertilizing (eg sodium, sulfur), whose concentrations in water often exceed the natural geochemical background. Hence, agricultural anthropopressure fosters eutrophication, which was remarkable in all researched reservoirs. This was particularly reflected in the maximum values of analyzed water parameters (Table 2) and algal blooms often observed during field studies. The research shows that the most intense process of eutrophication should be associated with reservoir Laka, which is subject to the strongest anthropogenic influences.

Eutrophication processes led to increased reaction of river waters while they were retained in the reservoirs. Water reaction in all the reservoirs was alkaline, or periodically strongly alkaline, which suggests intensive use of CO_2 by phytoplankton organisms. This kind of alkalization cannot be regarded as a favorable result even in the context of the described issues regarding acidification of limnic environments [32, 33]. Increased reaction resulted from water fertilization stimulated by contaminants. The growth of phytoplankton, and consequent intensive photosynthesis, also resulted in frequent supersaturation of the reservoir waters with oxygen. No significant contamination with nitrates was reported in the researched reservoirs - maximum concentrations were at over ten mg NO_3^- /dm^3. Nitrates

are very mobile substances in the environment [34] which are not subject to sorption in grounds and sediments, but are used by vegetation in production of organic matter. In this form, they create a reserve of periodically unavailable nitrogen. Relatively low concentrations of phosphates - below 0.2 mg PO_4^{3-} /dm^3 - were also detected in waters of Kozlowa Gora and Przeczyce. They do not guarantee low fertility of water in those reservoirs, though, as large amounts of phosphorus might be accumulated and kept in bottom deposits.

With regard to concentrations of macro-ions analyzed in the research, waters of all reservoirs could be classified as usable for consumption [28]. However, directly on the site, the water was frequently classified as unusable for consumption because of its color, taste or smell, that is properties which become unfavorable in eutrophic conditions. Use of these waters for production of potable water would require more detailed studies aimed at evaluation of their usability for treatment [29].

Conclusions

1. River waters in farmlands are a serious source of biogenic contaminations discharged to retaining reservoirs.
2. Agricultural anthropopressure has an impact on the process of eutrophication of water in dam reservoirs and consequently deterioration of the quality of disposable water reserves.
3. The degree of eutrophication of the reservoir waters is a derivative of distribution of farmlands within the catchment area.
4. Monitoring of parameters of river and reservoir waters subject to agricultural anthropopressure may facilitate appropriate protective measures in terms of improvement of their quality as well as renaturization of environments.

References

[1] Vollenweider R.A.: *Scientific fundamentals of the eutrophication of lakes and flowing waters with particular references to nitrogen and phosphorus as factors in eutrophication.* OECD Technical Report DAS/CSI/68.27. Paris 1968.

[2] Kajak Z.: Eutrofizacja jezior. PWN, Warszawa 1979.

[3] Lugo A., Bravo-Incla L.A., Alcocer J., Gaytan M.L., Oliva M.G., Sanchez M.R., Chavez M. and Vilaclara G.: *Effect on the planktonic community of the chemical program used to control water hyacinth (Eichhornia crassipes) in Guadalupe Dam, Mexico.* Aquat. Ecosyst. Health Manage., 1998, **1**(3-4), 333-343.

[4] Recknagel F., Burch M., Jablonskas G., Minney J. and Schofs S.: *Combined effects of organic pollution and eutrophication in the South Para Reservoirs, South Australia.* Water Sci. Technol., 1998, **37**(2), 113-120.

[5] Kim B., Park J.H., Hwang G., Jun M.S. and Choi K.: *Eutrophication of reservoirs in South Korea.* Limnology, 2001, **2**(3), 223-229.

[6] Håkanson L., Blenckner T., Brynh A.C. and Hellström S.: *The influence of calcium on the chlorophyll-phosphorus relationship and lake Secchi depths.* Hydrobiologia, 2005, **537**(1-3), 111-123.

[7] Petrucio M.M., Barbosa F.A.R. and Furtado A.L.S.: *Bacterioplankton and phytoplankton production in seven lakes in the Middle Rio Doce basin, south-east Brazil.* Limnologica, 2006, **36**(3), 192-203.

[8] Kajak Z.: *Eutrofizacja nizinnych zbiorników zaporowych*. [in:] Procesy biologiczne w ochronie i rekultywacji nizinnych zbiorników zaporowych. Bibl. Monit. Środow. PIOŚ, WIOŚ, ZES UŁ, Łódź 1995, 33-41.

[9] Rozporządzenie Ministra Środowiska z dnia 23 grudnia 2002 r. w sprawie kryteriów wyznaczania wód wrażliwych na zanieczyszczenie związkami azotu ze źródeł rolniczych. DzU 2002, Nr 241, poz. 2093.
[10] Carlson R.: *A trophic state index for lakes.* Limnol. Oceanogr., 1977, **22**(1), 61-69.
[11] Vollenweider R.A. and Kerekes J.J.: Eutrophication of waters - monitoring, assessment and control. OECD, Paris 1982.
[12] Maršálek B. and Bláha L.: *Comparison of 17 biotests for detection of cyanobacterial toxicity.* Environ. Toxicol., 2004, **19**, 310-317.
[13] Pawlik-Skowrońska B., Skowroński T., Pirszel J. and Adamczyk A.: *Relationship between cyanobacterial bloom composition and anatoxin-*a *and microcystin occurrence in the eutrophic dam reservoir (SE Poland).* Polish J. Ecol., 2004, **52**(4), 479-490.
[14] Hill A.R. and McCague W.P.: *Nitrate concentrations in streams near Alliston, Ontario, as influenced by nitrogen fertilization of adjacent fields.* J. Soil Water Conservat., 1974, **29**(5), 217-220.
[15] Mrkvička J. and Velich J.: *Leaching of nitrogen and of other nutrients at different levels of long-term fertilization of grassland.* Zesz. Nauk. Akad. Roln. w Krakowie, 1989, **229**, 245-259.
[16] Sapek B.: *Farm as a source of soil, water and air pollution with nitrogen, phosphorus and potassium.* Bibliot. Fragm. Agron., 1998, **3**, 124-144.
[17] Sapek A. and Sapek B.: *Assumed non-point water pollution based on the nitrogen budget in Polish Agriculture.* Water Sci. Technol., 1993, **28**(3-5), 483-488.
[18] Sapek A. and Sapek B.: *Strategia gospodarowania azotem i fosforem w rolnictwie w aspekcie ochrony wód Morza Bałtyckiego.* Zesz. Eduk. IMUZ, 2005, **10**, 27-38.
[19] Pedersen C.A.: *Practical measures to reduce nutrient losses from arable land.* Annual Crops - Proc. no. 300. The Fertilizer Society, London 1990.
[20] Bogdewicz J.: *System zaleceń nawożenia fosforem na Białorusi.* Zesz. Eduk. IMUZ, 2002, **7**, 73-83.
[21] Schulz D.: *Potencjalne możliwości zmniejszenia emisji azotu z rolnictwa do środowiska. Program ograniczenia emisji azotu w Niemieckiej Republice Federalnej.* Zesz. Eduk. IMUZ, 2002, **7**, 37-46.
[22] Zwykła Dobra Praktyka Rolnicza. Ministerstwo Rolnictwa i Rozwoju Wsi, Fundacja Programów Pomocy dla Rolnictwa, Warszawa 2003.
[23] Svedinger I.: *Wdrażanie Dyrektywy Azotanowej w Szwecji.* Zeszyty Edukacyjne IMUZ, 2005, **10**, 92-96.
[24] Jaguś A. and Rzętała M.: Znaczenie zbiorników wodnych w kształtowaniu krajobrazu (na przykładzie kaskady jezior Pogorii). WNoMiŚ ATH, WNoZ UŚ, Bielsko-Biała - Sosnowiec 2008.
[25] Rzętała M.: Funkcjonowanie zbiorników wodnych oraz przebieg procesów limnicznych w warunkach zróżnicowanej antropopresji na przykładzie regionu górnośląskiego. Wyd. Uniwersytetu Śląskiego, Katowice 2008.
[26] Hermanowicz W., Dojlido J., Dożańska W., Koziorowski B. and Zerbe J.: Fizyczno-chemiczne badanie wody i ścieków. Arkady, Warszawa 1999.
[27] Steineck S., Jakobsson C. and Carlson G.: *Fosfor - stosowanie, wykorzystanie przez rośliny uprawne i nagromadzenie w glebach użytków rolnych.* Zesz. Eduk. IMUZ, 2002, **7**, 25-36.
[28] Rozporządzenie Ministra Zdrowia z dnia 29 marca 2007 r. w sprawie jakości wody przeznaczonej do spożycia przez ludzi. DzU 2007, Nr 61, poz. 417.
[29] Rozporządzenie Ministra Środowiska z dnia 27 listopada 2002 r. w sprawie wymagań, jakim powinny odpowiadać wody powierzchniowe wykorzystywane do zaopatrzenia ludności w wodę przeznaczoną do spożycia. DzU 2002, Nr 204, poz. 1728.
[30] Jaguś A. and Rzętała M.: *Transformacja parametrów fizykochemicznych wód płynących w zbiornikach przepływowych.* Ochr. Środow. Zasob. Natural., 2009, **38**, 115-122.
[31] Rzętała M.: *Purification of surface waters flowing in transfer reservoirs.* Series of Monographs, Polish J. Environ. Stud., 2009, **3**, 43-50.
[32] Newell A.D. and Skjelkvale B.L.: *Acidification trends in surface waters in the International Program on Acidification of Rivers and Lakes.* Water, Air, Soil Pollut., 1997, **93**, 27-57.
[33] Mannio J.: *Recovery pattern from acidification of headwater lakes in Finland.* Water, Air, Soil Pollut., 2001, **130**, 1427-1432.
[34] Sapek B.: *Wymywanie azotanów oraz zakwaszenie gleby i wód gruntowych w aspekcie działalności rolniczej.* Mat. Infor. IMUZ, 1995, **30**, 1-31.

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Abstrakt: W badaniach oceniano jakość wód powierzchniowych w warunkach antropopresji rolniczej. Analizowano wody rzeczne zasilające zbiorniki zaporowe oraz wody w zbiornikach. Do badań wytypowano zlewnie zbiorników Kozłowa Góra, Przeczyce i Łąka, położonych w regionie górnośląskim (południowa Polska). Dominującą formą użytkowania terenu w zlewniach jest działalność rolnicza. Stwierdzono, że zbiorniki były często zasilane wodami płynącymi o parametrach wskazujących na ich eutrofizację, zwłaszcza w odniesieniu do zawartości azotanów (średnie roczne stężenie NO_3^- > 10 mg/dm^3). Proces eutrofizacji dotyczył także wód zbiornikowych, a jego przejawem były częste zakwity glonów. W zbiornikach dochodziło do wzrostu odczynu wód do silnie alkalicznego włącznie (pH_{max} > 8,5). Największą żyznością wód charakteryzował się zbiornik Łąka zasilany głównie z terenów rolniczych (77% powierzchni zlewni), położonych także w jego zlewni bezpośredniej. Odzwierciedlały to m.in. duże stężenia fosforanów w wodach tego zbiornika (średnio 0,389 mg PO_4^{3-}/dm^3). Badania wykazały, że antropopresja rolnicza stanowi zagrożenie dla funkcjonowania zbiorników zaporowych ze względu na generowanie procesu eutrofizacji i przez to pogarszanie jakości dyspozycyjnych zasobów wodnych.

Słowa kluczowe: użytkowanie terenu, antropopresja rolnicza, jakość wód, zbiornik zaporowy, eutrofizacja