MIDDLE POMERANIAN SCIENTIFIC SOCIETY OF THE ENVIRONMENT PROTECTION
ŚRODKOWO-POMORSKIE TOWARZYSTWO NAUKOWE OCHRONY ŚRODOWISKA
Annual Set The Environment Protection
Rocznik Ochrona Środowiska
Volume/Tom 20. Year/Rok 2018 ISSN 1506-218X 184-202

Analysis of Water Quality of the Stobrawa River at the Location of the Walce Small Retention Reservoir

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1. Introduction

Small water reservoirs have several economic, hydropower, natural and recreational functions, and improve the water balance. Most of them are constructed for the purpose of storing water in periods of its excess and discharging it during droughts (Grzywna et al. 2016, Jurik et al. 2015, Wiatkowski et al. 2010). In addition, they help to reduce the risk of flooding. As in the upper and central river Odra within the territory of Poland the possibility of construction of large retention reservoirs is limited due to location conditions and costs, building small retention reservoirs appears to be a viable solution (Wiatkowski 2009, Wiatkowski et al. 2010). When planning the construction of a retention reservoir, one should consider not only the amount of water that will be retained in it, but also its quality (Cymes & Glińska-Lewczuk 2016, Mosiej & Bus 2015, Kanownik et al. 2013, Przybyła et al. 2015, Slaughter & Mantel 2018, Wiatkowski et al. 2015, 2018, Yunussova & Mosiej 2016). Frequently, the use of a reservoir and even its very existence is threatened by the inflowing contaminants (Bartoszek et al. 2017, Pütz & Benndorf 1998, Wiatkowski & Paul 2009). In many cases the water retained in a reservoir undergoes degradation, loses its utility values, and blooms appear frequently. The quality of water supplying a reservoir depends mainly on the methods of water and sewage management within the catchment. Here, the phosphorus and nitrogen compounds have a significant impact on water quality in a reservoir (Dąbrowska et al. 2016, Koszelnik 2014, Pütz & Benndorf 1998, Wiatkowski & Paul 2009). For this reason, it is important to monitor the catchment areas of rivers on which the construction of water reservoirs is planned. As follows from the Development Strategy for the Opolskie Province until 2020, the irregularly distributed hydrographic network of the Province and its insufficient retention capacities (also for the needs of agriculture), require a series of intervention activities, including an extension of natural and artificial retention capacities (Strategy 2012).

The purpose of this study is to analyze the water quality of the Stobrawa river and to determine the possibility of its retention in the planned Walce reservoir. For the purpose of the study, an analysis of the quality of water in the Stobrawa river was conducted in the area of the future reservoir's basin. The quality of water of the Stobrawa river was evaluated in terms of physicochemical indicators. The paper presents a preliminary evaluation of the quality of water and an estimate of eutrophication of the waters being analyzed. An analysis of the catchment area of the Walce reservoir in the aspect of matter supply to the reservoir was also performed.

2. Material and method

Characterization of the Walce reservoir and its catchment area

The Walce reservoir will be located at kilometer 82.683 of the Stobrawa river (a right-hand tributary of the Odra river). It will be situated administratively in the Opolskie Province (South of Poland), in the Oleski District (Fig. 1). The reservoir will be situated in the upper, spring part of the Stobrawa river catchment, upstream from the town of Olesno. The average annual precipitation for Olesno, from the multi-year period of 1971-2000, is 650 mm, and the mean air temperature is about 8°C.

The primary role of the Walce reservoir will be water storage for agricultural purposes. The waters from the reservoir can be effectively used for irrigation (Assessment 1997). The stored water can also be used for various other purposes, e.g.: recreation, leisure, firefighting, angling, etc., hence the importance of the quality of water in the reservoir. No flood reserve capacity is planned.

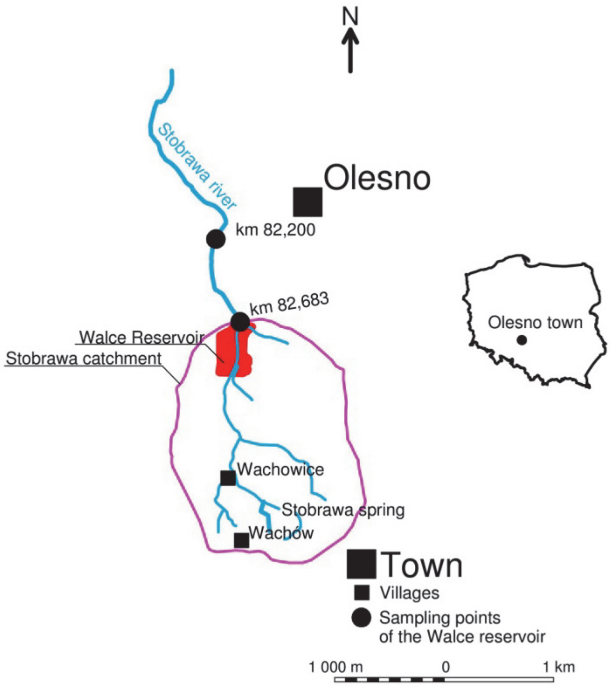

Fig. 1. Location of the planned Walce reservoir with a dam on the Stobrawa river and the sampling points for hydrochemical measurements
Rys. 1. Lokalizacja projektowanego zbiornika Walce wraz zaporą na rzece Stobrawie oraz z punktami do pomiarów hydrochemicznych

The main elements of the Walce reservoir are the dam and the weir structure. The catchment surface area at the profile of the reservoir dam the is 5.6 km^2 and the longitudinal slope of the catchment area is about 17.1%. The catchment area of the Walce reservoir is under agricultural use. Arable lands and forests account for 81.9% and 10.4% of its area, respectively. Urbanized areas constitute about 6%. The Normal Pool Level in the reservoir is 243 m a.s.l. The capacity of the reservoir is 0.215 million m^3 and its surface area is 9.5 ha. The average flow rate SSQ in the Stobrawa at the dam section is 0.032 m$^3 \cdot$s^{-1}. The damming height will be 6.7 m and the average depth of the reservoir will be about 2.2 m. In terms of topography, the area in which the reservoir will be constructed is diversified. Narrow valleys of water courses are surrounded with hilly areas. The basin of the reservoir is characterized by large lateral slopes. Land elevation differences approach 20 m. Sand formations cover the entire area. The area of the projected dam of the reservoir and its vicinity is covered with alluvial sand formations. Those are mainly sands (particle size distribution from silt sands to fine and medium sands). The ground water table is situated at the depth of about 3.5 m and deeper on the slopes. The topographic, geological-water and natural conditions in the planned location of the reservoir are good (Assessment 1997). Most of the area to be covered by the reservoir is occupied by agricultural lands under extensive use – with a large number of trees and bushes. The adaptation work will require the trees and bushes to be rooted up. The planned location of the reservoir is outside of any nature protection areas. Prior to the construction of the reservoir, the drainage and sewage system in the catchment of the reservoir will have to be improved, including in the village Wachowice situated upstream from the reservoir. The Province Inspectorate for Environmental Protection in Opole deals with the monitoring of the quality of surface waters in the Opolskie Province. The last study of the quality of the Stobrawa river (at the Stare Olesno profile, km 74,000) was carried out in 2004 as part of the regional monitoring. At present, in the Olesno commune, the quality of surface waters is not being monitored. According to the classification of the uniform parts of surface waters (UPSW), the analyzed profile of the river should be classified as "Stobrawa from sources to Kluczbork Stream" with the European code PLRW60001713231. It has the status of a heavily changed water body with ecological potential good and below good, but with poor assessment of status (National Water and Environmental Program 2010, Ordinance of the Council 2016). The nearest measuring point of the mentioned UPSW is located only at the Czaple Stare profile, km 45.000 of the Stobrawa river (Results of the surface water analysis from 2015).

The analysis of water quality of the Stobrawa river in the vicinity of the basin of the planned reservoir was conducted in two measurement periods. The first period lasted from November 2006 to October 2007 (water was sampled at kilometer 82.200, once a month), and the second from April 2011 to February 2012 (water was sampled at kilometer 82.683, once every two months). The following physicochemical indicators were analyzed: PO_4^{3-} (orthophosphates), P_{tot}, NO_3^-, NO_2^-, NH^{4+}, BOD_5, dissolved oxygen, water temperature, reaction and electrolytic conductivity. The temperature was investigated in situ and the remaining water quality indicators were tested in the laboratory of the Department of Land Surface Protection at the University of Opole in accordance with Polish standards. Water samples were collected from the stream of the Stobrawa river, from the subsurface layer. Estimation of eutrophication of the analyzed water was made on the basis of the Ordinance of the Minister of the Environment (2002), using the Vollenweider criterion (1976). Evaluation of the catchment of the Walce reservoir with regard to matter supply to the reservoir was conducted on the basis of the Bajkiewicz-Grabowska criterion (2002).

3. Results

Water quality

Table 1 presents the water quality characteristics of the Stobrawa river in the profile of the planned Walce reservoir in two measurement periods. Fig. 2 presents the changes in the content of phosphates and total phosphorus. Fig. 3 presents the changes in the content of nitrates, nitrites and ammonia over the study period.

The comparison of the Stobrawa river water quality testing results from the second measurement period (2011-2012) with those from the first measurement period presented in (Wiatkowski et al. 2012) reveals an improvement in water quality. An analysis of the results shows that the highest mean value corresponds to higher values of spread and deviation from the mean, which indicates a greater variation of results (Tab. 1).

In the case of phosphates (Fig. 2), the analysis of the two measurement periods showed that the lowest concentrations of these compounds occurred in November 2006 (0.17 mg $PO_4^{3-}\cdot dm^{-3}$) and in April 2011 (0.08 mg $PO_4^{3-}\cdot dm^{-3}$), while the highest were recorded in September 2007 (2.22 mg $PO_4^{3-}\cdot dm^{-3}$) and in August 2011 (0.14 mg $PO_4^{3-}\cdot dm^{-3}$).

The concentration of total phosphorus in the waters of the Stobrawa river in the first measurement period varied from 0.06 (November 2006) to 9.76 mg $P\cdot dm^{-3}$ (June 2007), and in the second period - from 0.12 (December 2011) to 0.35 mg $P\cdot dm^{-3}$ (April 2011) (Tab. 1, Fig. 2).

Tabela 1. Water quality indicators of the Stobrawa river in the profile of the planned Walce reservoir in two measurement periods
Tabela 1. Wskaźniki jakości wody rzeki Stobrawy w przekroju planowanego zbiornika Walce w dwóch okresach badawczych

Parameter	First measurement period Sept. 2006 – Oct. 2007 <u>minimum – mean – maximum</u> standard deviation	Second measurement period June 2011 – Feb. 2012 <u>minimum – mean – maximum</u> standard deviation
Phosphates [mg $PO_4^{3-}\cdot dm^{-3}$]	<u>0.17 – 0.91 – 2.22</u> 0.57	<u>0.08 – 0.10 – 0.14</u> 0.02
Phosphorus [mg $P\cdot dm^{-3}$]	<u>0.06 – 1.93 – 9.76</u> 2.60	<u>0.12 – 0.18 – 0.35</u> 0.09
Nitrates [mg $NO_3^{-}\cdot dm^{-3}$]	<u>0.35 – 8.45 – 26</u> 7.88	<u>1.67 – 2.06 – 2.23</u> 0.21
Nitrites [mg $NO_2^{-}\cdot dm^{-3}$]	<u>0.04 – 0.10 – 0.23</u> 0.06	<u>0.05 – 0.08 – 0.11</u> 0.02
Ammonia [mg $NH_4^{+}\cdot dm^{-3}$]	<u>0.27 – 2.14 – 3.2</u> 0.83	<u>0.0 – 0.40 – 0.73</u> 0.28
BOD_5 [mg $O_2\cdot dm^{-3}$]	<u>1.20 – 6.19 – 24.0</u> 6.05	<u>0.2 – 2.33 – 4.46</u> 1.54
DO [mg $O_2\cdot dm^{-3}$]	<u>0.0 – 5.79 – 10.1</u> 3.76	<u>6.88 – 9.28 – 11.54</u> 1.85
Temperature [°C]	<u>0.6 – 8.7 – 15.3</u> 4.75	<u>1.9 – 9.63 – 16.5</u> 5.86
Reaction [pH]	<u>6.7 – 7.14 – 7.80</u> 0.30	<u>6.96 – 7.78 – 8.8</u> 0.88
Electrolytic conductivity [$\mu s\cdot cm^{-1}$]	<u>331 – 462 – 805</u> 133	<u>250 – 295 – 353</u> 41

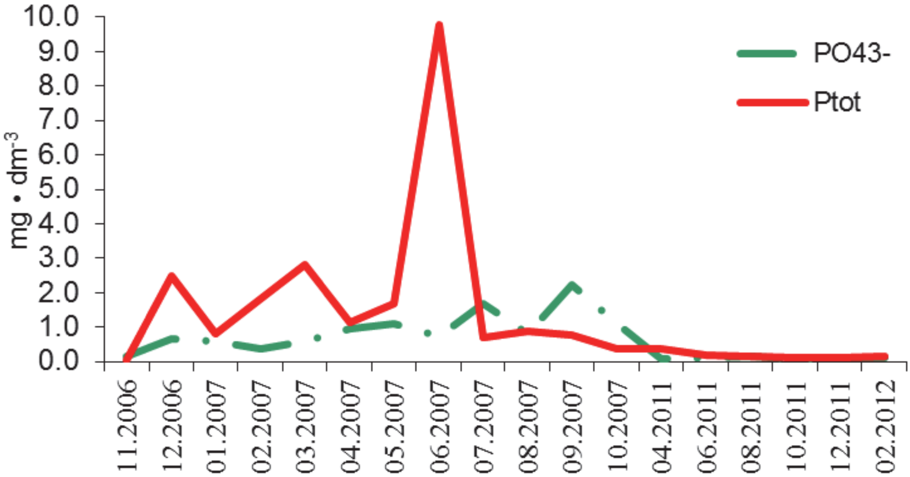

Fig. 2. Changes in the content of total phosphorus and phosphates in the Stobrawa river over the period from November 2006 to October 2007 and from April 2011 to February 2012
Rys. 2. Zmiany zawartości fosforu ogólnego i fosforanów w wodach rzeki Stobrawy w okresie od listopada 2006 do listopada 2007 i od kwietnia 2011 do lutego 2012

During the period of the study, the concentration of nitrates varied considerably (Fig. 3). The highest levels of this indicator were observed in winter periods (October 2007 – 26 mg NO_3^-·dm^{-3} and October 2011 – 2.23 mg NO_3^-·dm^{-3}). The high levels of this indicator in winter were most likely caused by the surface runoff. The lowest nitrate concentrations were recorded in summer periods (August 2007 – 0.35 mg NO_3^-·dm^{-3} and August 2011 – 1,67 mg NO_3^-·dm^{-3}), when the levels of nitrogen were regulated by plant vegetation.

The highest concentrations of nitrites were recorded in winter periods (Fig. 3). The highest content of nitrites was observed in January 2007 (0.23 mg NO_2^-·dm^{-3}) and in December 2012 (0.11 mg NO_2^-·dm^{-3}). Theappearance of that form of nitrogen in water indicates an influx of household contaminants from localities situated in the catchment area of the Stobrawa river.

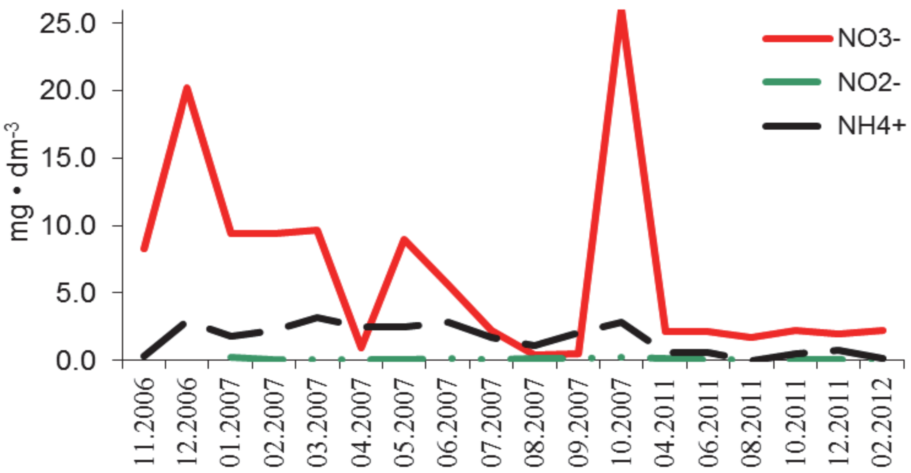

Fig. 3. Changes in the content of nitrates, nitrites and ammonia in the Stobrawa river over the period from November 2006 to October 2007 and from April 2011 to February 2012
Rys. 3. Zmiany zawartości azotanów, azotynów i amoniaku w wodach rzeki Stobrawy w okresie od listopada 2006 do października 2007 i od kwietnia 2011 do lutego 2012

The concentration of ammonia in the waters of the Stobrawa river in the first measurement period varied from 0.27 to 3.20 mg $NH_4^+ \cdot dm^{-3}$, and in the second period – from 0 to 0.73 mg $NH_4^+ \cdot dm^{-3}$ (Tab. 1).

As in the case of nitrite concentration, an analysis of the results of ammonia content determinations revealed that the mean levels of this element in winter periods were higher than in summer periods. Ammonia content in water is an important indicator of contamination with protein substances which, as a rule, occur at rather high concentrations in sewage. The high levels could be due to the runoff over the frozen ground cover and from household sewage. Another cause of increased levels of those compounds is the ageing and decay of macrophytes that absorb nitrogen and phosphorus compounds only in the spring and summer. Biogens are nutrients for macrophytes (Kajak 2001).

The level of BOD_5 in the waters of the Stobrawa in the first measurement period varied from 1.20 to 24 mg $O_2 \cdot dm^{-3}$ (Tab. 1), and in the second period – from 0.20 to 4.46 mg $O_2 \cdot dm^{-3}$. Higher values of BOD_5 were recorded in winter periods (the highest value was recorded in October

2007 and in December 2012). The higher the level of water contamination with easily degradable organic matter, the higher the values of BOD_5.

Oxygen content in the waters of the Stobrawa in the period of 2006-2007 varied from 0 to 10.1 mg $O_2 \cdot dm^{-3}$, and in the period of 2011-2012 from 6.9 to 11.5 mg $O_2 \cdot dm^{-3}$ (Tab. 1). Higher levels of oxygen were observed in the months with lower temperatures (January 2007, December 2012) than in summer and autumn.

Moreover, the study showed that the water temperature in the Stobrawa varied from 0.6°C to 15.3°C, from 1.9 to 16.5°C during the measurement period of 2006-2007 and 2011-2012, respectively (Tab. 1).

In the period of 2006-2007 the reaction of the waters of the Stobrawa river varied from pH 6.7 to 7.8, and in the period of 2011-2012 – from pH 6.9 to 8.8. The lowest pH values were observed in September 2007 and in December 2011, and the highest in October 2007 and in June 2011 (Tab. 1).

The electrolytic conductivity of water depends on the amount of ions dissolved in water, and also on the water temperature. The electrolytic conductivity of water of the Stobrawa ranged from 331 to 805 $\mu S \cdot cm^{-1}$, and from 250 to 353 $\mu S \cdot cm^{-1}$ in the period of 2006-2007 and 2011-2012, respectively – (Tab. 1).

Water management in the catchment area of retention reservoirs is of particular importance for their functioning, as being situated at the lowest point of their catchment such reservoirs are the recipients of the contaminants from the entire catchment area (Pütz & Benndorf 1998, Wiatkowski et al. 2010). The process of eutrophication constitutes a considerable threat to dam reservoirs. The possibility of use of water retained in a reservoir often depends on its quality, which results, from the kind of water-sewage management in place within the catchment of the reservoir (Wiatkowski & Paul 2009). Unfortunately no permanent monitoring of water quality is conducted in the catchment of the planned Walce reservoir.

Preliminary estimation of water quality of the Walce reservoir

All of the 10 water quality indicators analyzed for the Stobrawa river, are taken into account in the Polish classification of water quality status (Ordinance of the Minister of the Environment 2016). Analysis of the results of water quality of the Stobrawa revealed that the values of water temperature, electrolytic conductivity, pH, and the content of NO_3^-

(in the two measurement periods), dissolved oxygen, BOD_5, phosphates and total phosphorus (only in the second period) did not exceed the limit values pertaining to water class I. As follows from the analysis of the data, the concentrations of ammonia and nitrites (the second period) exceeded the limit values for class I, but did not exceed those for water class II. However, the concentrations of dissolved oxygen, ammonia, nitrites, BOD_5, phosphates and total phosphorus (the first measurement period) did exceed the limit values of water quality indicators pertaining to uniform areas of surface waters in natural water courses such as a river, relevant for water class II.

In order to determine to what degree the Walce reservoir will be threatened by eutrophication, preliminary calculations were performed for the two measurement periods. By analyzing the concentration of total phosphorus from the two measurement periods and the limit value of this concentration (> 0.25 mg $P \cdot dm^{-3}$) given in the Ordinance of the Minister of the Environment (2002) it was found that the waters of the Stobrawa river should be considered eutrophic during the first period of study. The average annual concentration of total phosphorus (2.60 mg $P \cdot dm^{-3}$) exceeded the limit given in the Ordinance (2002). The calculations carried out based on the Vollenweider criterion allowed more parameters of the designed reservoir. Based on this criterion and taking into account that in the first period of research the concentration of total phosphorus in the profile of the future reservoir was 1.93 mg $P \cdot dm^{-3}$ (Tab. 1), with average flow rate of 0.032 $m^3 \cdot s^{-1}$, it was calculated that the load of phosphorus would be 1.95 mg $P \cdot year^{-1}$. The amount of phosphorus per 1 m^2 of the reservoir would be 20.5 g $P \cdot m^{-2} \cdot year^{-1}$ with the ratio of the mean depth of the reservoir – 2.2 m to the time of retention – 0.213 year. For the total phosphorus concentration recorded in the second measurement period (0.18 mg $P \cdot dm^{-3}$), it was found that the load of phosphorus per 1 m^2 of the reservoir would amount to 1.9 g $P \cdot m^{-2} \cdot year^{-1}$. Thus, given the phosphorus load for both measurement periods, and the parameters of the Walce reservoir, eutrophication will take place. According to the Vollenweider classification (Kajak 2001), the planned Walce reservoir was classified as eutrophic. According to Kajak (2001), actual loads are often several times higher than the threshold or danger levels, and may attain a dozen and more grams of phosphorus and nearly 200 g of nitrogen per 1 m^2 of the reservoir surface area. This is several hundreds times more than the permissible levels (with the mean depth of up to 5 m the allowable load for N and P should be up to 1.0 and 0.07 $g \cdot m^{-2} \cdot year$, respectively, while the danger level for N and P should be up to 2.0 and 0.13 $g \cdot m^{-2} \cdot year$, respectively).

The prevailing opinion on the quality of waters and the effect of their retention in small reservoirs is that when the waters supplying the reservoir are strongly contaminated they deteriorate the quality of water in the reservoir, and the smaller the reservoir the greater the load per unit surface area (Wiatkowski 2009, Wiatkowski and Paul 2009).

4. Evaluation of the Stobrawa catchment in terms aspect of the matter supplied to the Walce reservoir

Water reservoirs have the ability of intercepting matter migrating from their catchment areas (Wiatkowski et al. 2015). Water quality in reservoirs is largely determined by external inflows. The rate of natural eutrophication of a reservoir depends on the physical and geographical structure of the catchment that functions as a permanent supplier of various forms of matter to the reservoir (including nutrients), and on the morphometric parameters of the reservoir and its hydrological status (Pütz & Benndorf 1998, Paul & Pütz 2008, Koszelnik 2014, Wiatkowski & Paul 2009, Wiatkowski et al. 2010). The susceptibility of a reservoir to eutrophication can be estimated on the basis of the system proposed by Bajkiewicz-Grabowska (2002), that is used successfully by researchers (Wiatkowski et al. 2012). The natural physical and geographical features of the catchment allow the immediate catchment area of the reservoir to accelerate or inhibit the supply of matter (including nutrients) to the reservoir.

The effect of the catchment area on the rate of matter supply to a reservoir is estimated using assessment of each of the above characteristics in a scale from 0 to 3 points, where 0 means very weak effect on matter supply and no possibility of its reaching the reservoir, and 3 – a strong effect and rapid supply of matter to the reservoir (Bajkiewicz-Grabowska 2002). The characteristics describing the degree of catchment effect on the reservoir include e.g. the Ohle lake index and the balance type of reservoir. The strength of the impact in the immediate catchment is defined by the endorheic character of terrain, average slope of catchment, density of river network, surface formations and method of land use. Table 2 presents the evaluation of the Stobrawa catchment as a matter supplier to the Walce reservoir.

Table 2. Evaluation of the Stobrawa river catchment– source of supply of matter to the Walce reservoir
Tabela 2. Ocena zlewni rzeki Stobrawy – dostawcy materii do zbiornika Walce

Characteristics of the catchment area of the Walce reservoir		Bajkiewicz-Grabowska criterion (2002)	Number of points
Lake (Ohle) index – quotient of A of basin (5.3 km^2) and F of reservoir (9.5 ha at Normal Pool Level))	51	40-150	2
Type of reservoir	Throughflow	Throughflow	3
Morphometry - river network density [km · km^2] - average slope - endorheic areas (%)	 1.0 17.1 0.2	 0.5-1.0 10-20 <20	 1 2 3
Geological structure	Quaternary formations, Mainly sands and gravels	Loamy-sandy	2
Type of land use	Forests 10.4%, agricultural lands 83.4%, built-up area 6.1%, water reservoirs 0,1%	Forest-agricultural with buildings, Pasture-agricultural with buildings, Agricultural with buildings	3
Mean			2.3

Source: Bajkiewicz-Grabowska E., 2002, own work

The final rating – arithmetic mean of points awarded to the individual features – is 2.3 and qualifies the Stobrawa catchment area, from the springs to the profile of the Walce reservoir, as a catchment area with a high capacity for supplying matter to the reservoir (susceptibility group 4).

With regard to the Walce reservoir, the estimation of environmental impact (Assessment 1997) recommend that, for the safe of protection of water quality in the reservoir, actions should be taken to reduce the uncontrolled inflow of sewage from settlement units and of area contaminants. Also the study (Wiatkowski et al. 2012) presents results indicating that the waters of the Stobrawa river, in the profile of the planned Walce reservoir, are characterized by considerable contamination.

At present, it is important to analyze the quality of waters in the catchment areas of planned water reservoirs, as the supply of nutrients from point and area sources (including agricultural ones) results in anthropogenic eutrophication of waters and is the primary threat to the achievement of good status of stagnant waters in Poland and in other countries of the European Community. Therefore, some actions should be taken, e.g. a reducing the concentration of nutrients in water inflowing to a reservoir, improve in the water-sewage management, performing suitable treatments in the land use in catchment area, creating protective zones in the buffer belt around the reservoir, the so-called ecotones, and using pre-reservoirs (Jurik et al. 2015, Mosiej & Bus 2015, Paul & Pütz 2008, Pütz & Benndorf 1998, Skonieczek et al. 2013, Wiatkowski & Paul 2009, Wiatkowski et al. 2010). In addition, each time, when a decision is to be taken concerning the construction of a reservoir, a water gauge section should be created for hydrological and water quality analyses at the inflow to the reservoir (Ignatius & Rasmussen 2016).

5. Conclusions

When making the decision to construct a water reservoir one should consider the quality of water which will flow into and be retained in the reservoir. Therefore, it is extremely important to conduct monitoring studies and analyses of water quality in the catchment basins of rivers on which water reservoirs are planned.

The analysis of water of the Stobrawa river, in two measurement periods, has revealed that the values of water temperature, electrolytic conductivity, reaction, and NO_3^- (in two measurement periods), dissolved oxygen, BOD_5, phosphates and total phosphorus (the second measurement period) did not exceed the limit values for water class I. However, the concentrations of DO, NH_4^+, NO_2-, BOD_5, PO_4^{3-} and P_{tot} (the first measurement period) did exceeded the limit values of water quality indicators pertaining to uniform areas of surface waters in natural water courses such as a river, relevant for water class II.

It was found that the quality of water in the Stobrawa river in the second research period (2011-2012) was characterized by lower pollution values compared to the first period (2006-2007).

Based on the limit value of the total phosphorus concentration given in the Ordinance (2002), the waters of the Stobrawa river, in the first measurement period, were classified as eutrophic.

On the basis of the Vollenweider criterion, it was found that, in terms of eutrophication, the hydrochemical conditions in the Stobrawa river catchment for the construction of the Walce reservoir are unfavorable. Analyses for both the first and the second measurement period demonstrated that the level of contamination of water inflowing to the Walce reservoir is high, and that the inflowing water can deteriorate the quality of water retained in the reservoir. Base on the acquired data (phosphorus load), the planned Walce reservoir was classified as eutrophic.

The evaluation of the Stobrawa river catchment as a supplier of matter to the Walce reservoir showed that the catchment is prone to supplying matter to the reservoir. Therefore, by proper water management in the reservoir catchment one should be aim to reduce the concentration of nutrients in the water inflowing to the reservoir and to create protective zones in the belt around the reservoir, that would allow the land use to be limited; moreover, the creation of sections for hydrochemical tests at the inflow to the reservoir should be considered.

The study conducted in the area of the catchment of the Walce reservoir provided important information on the status of purity of the waters supplying the planned reservoir.

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Analiza jakości wód rzeki Stobrawa dla lokalizacji małego zbiornika retencyjnego Walce

Streszczenie

Małe zbiorniki wodne spełniają funkcje gospodarcze, energetyczne, przyrodnicze, rekreacyjne i poprawiają bilans wodny. Budując zbiornik wodny, oprócz zagadnień ilościowych wody, należy także wziąć pod uwagę jakość wody, która będzie retencjonowana w zbiorniku. Często wykorzystaniu zbiornika, jak i jego istnieniu, mogą zagrozić zanieczyszczenia dopływające do niego głównie z wodą i rumowiskiem. Ważne są badania monitoringowe w zlewniach rzek na których zamierza się budować małe zbiorniki wodne, ponieważ w tych zlewniach najczęściej nie prowadzi się badań jakości wody. Bardzo ważnym problemem jest więc zanieczyszczenie zbiorników planowanych. Celem pracy jest analiza jakości wód rzeki Stobrawy dla określenia możliwości jej retencjonowania w planowanym, w programie małej retencji dla województwa opolskiego, małym zbiorniku wodnym o nazwie Walce. W pracy przeprowadzono analizę jakości wód rzeki Stobrawy w pobliżu czaszy przyszłego zbiornika, w dwóch okresach pomiarowych (od listopada 2006 r. do października 2007 r. oraz od kwietnia 2011 r. do lutego 2012 r.). Jakość wód rzeki Stobrawy oceniono pod względem wskaźników fizyczno-chemicznych: NO_3^-, NO_2^-, NH_4^+, Pog., PO_4^{3-}, BZT_5, tlenu rozpuszczonego, temperatury wody, odczynu i przewodności elektrolitycznej. Podstawową funkcją zbiornika ma być magazynowanie wody do celów rolniczych, przeciwpożarowych oraz rekreacji, wypoczynku i wędkarstwa, dlatego ważnym zagadnieniem jest jakość wód zbiornika. Przeprowadzone badania wykazały, że zanieczyszczenie wody rzeki Stobrawy w przekroju planowanego zbiornika Walce jest znaczne. Na podstawie uzyskanych danych zakwalifikowano projektowany zbiornik Walce do zbiorników eutroficznych. Przeprowadzona ocena zlewni rzeki Stobrawy jako dostawcy materii do zbiornika Walce wykazała, że zlewnia odznacza się dużą możliwością dostarczania materii do zbiornika.

Abstract

Small water reservoirs have economic, hydropower, natural and recreational functions, and improve the water balance. When building a water reservoir, one should consider not only the amount of water that will be retained in it, but also its quality. Frequently, the use of a reservoir and its existence can be threatened by contaminants brought into it with water and rubble. It is important to conduct monitoring in the catchment areas of rivers on which small water reservoirs are to be built, as most often no water quality analyses are conducted in such catchments. Therefore, contamination of planned water reservoirs is a very important problem. The objective of the study was to analyze the quality of water of the Stobrawa river to determine the possibility of its retention in the planned small water reservoir Walce, included in the small retention program for the Opolskie Province. For the purpose of the study, an analysis of water quality of the Stobrawa river was conducted in the vicinity of the basin of the future reservoir, in two measurement periods (from November 2006 to October 2007, and from April 2011 to February 2012). The quality of water of the Stobrawa river was evaluated in terms of the physicochemical indicators NO_3^-, NO_2^-, NH_4^+, P tot., PO_4^{3-}, BOD_5, dissolved oxygen, water temperature, reaction and electrolytic conductivity. The primary function of the reservoir is to be a water storage for agriculture, fire-fighting, as well as recreation, leisure and angling, hence the importance of water quality. The study demonstrated that the contamination of water of the Stobrawa river in the profile of the planned Walce reservoir is considerable. Based on the data obtained from the study, the planned Walce reservoir was classified as an eutrophic. The analysis of the Stobrawa river catchment, as a supplier of matter to the Walce reservoir, revealed that the catchment is characterized by a high capacity for the supply of matter to the reservoir.

Słowa kluczowe:
małe zbiorniki wodne, jakość wody, rzeka Stobrawa, zbiorniki projektowane

Keywords:
small waters reservoir, water quality, Stobrawa river, planned water reservoirs