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ASSESSMENT OF THE IMPACT OF THE LAYING HENS FARM ON SELECTED WATER QUALITY PARAMETERS

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Abstract. The aim of this paper is to analyze the impact of a large-scale farm on surface water and bottom sediments in the zone of its direct impact and to assess the extent of surface water degradation under pressure of the company. The research was carried out in areas adjacent to the laying hens farm located in Żylice in the south of Wielkopolska in the commune of Rawicz. This paper analyzes the selected physical and chemical parameters of waters and bottom sediments in selected monitoring points located in several water bodies (rivers, ponds, reservoir). The scope of work covered three seasons – 2011, 2014 and 2015. Concentration of magnesium and calcium at points located on watercourses exceeded the established standards. The concentration of sodium in the studied period allowed to classify waters up to class I. The analysis showed that the farm has a negative impact on the quality of water in its surroundings. The statistical analysis showed a correlation between the distance from the industrial farm and some analyzed parameters. As the distance from the farm increased, total nitrogen, total phosphorus, potassium, magnesium in water and potassium in bottom sediment decreased.

Key words: laying hens farm, large-scale animal production, agricultural pollution, surface water quality

INTRODUCTION

The quality of water is closely related to its circulation in the environment. In agricultural areas, water quality depends primarily on the physico-chemical and biological properties of soils and the economic impact of people [Borowiec and Pieńkowski, 1993, Koc et al. 2003]. The agriculture is currently one of the most important sources of pollution and it contributes to the eutrophication of surface waters [Moss 2008]. The consequence of its dynamic development is the increase in the number of farms with high livestock density, but also management of large areas. Large-scale farms, particularly those covered by Council Directive 96/61/EC (IPPC), are particularly dangerous for the environment. This kind of farms may, however, be the source of other chemical, physical, biological and bacteriological pollutants [Grochowicz and Korytkowski 1999, Holvoet et al. 2015, Kay et al. 2012, Kenneth 2006, Romanowska-Słomka and Mirosławski 2009, Trawińska 2004]. In total, 164 different substances, which more than 30 are particularly detrimental and harmful to health, enter the atmosphere. In 2008, the large-scale farms were recognized by the Helsinki Commission (HELCOM) as a point source of agricultural pollution (the so-called Baltic Hot Spots). In Poland there are 831 farms with livestock of large-scale, 697 of which are poultry farms. The largest number of these installations is located in the territories of Wielkopolska, Mazowieckie, Zachodniopomorskie, Kujawsko-Pomorskie and Lodz [List of installations... 2014]. Among the most important problems associated with

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the operation of this type of installation are water and air pollution, odor and noise emissions, as well as landscape transformation. The installations for intensive livestock also have a significant impact on local communities, including human health. Large-scale livestock farms expanded rapidly in the last few decades. People living close to livestock farms are exposed to air pollutants that may affect the airways, such as fine dust and ammonia. Residents are exposed to potentially harmful bacteria and viruses, as well.

The concentrations of calcium, potassium and sodium in water depend primarily on the outflow in catchments and sedimentation processes. The reason for the high concentrations of these nutrients in surface waters is their run off from soils. The reason for the intensification of this phenomenon should be seen in improper agricultural practices, but also in the acidification of precipitation and soils [Kajak 2001]. The use of fertilizers, which is an indispensable element in production, can additionally increase the share of the agricultural economy in the phenomenon of water pollution [Koc 2004].

The aim of the study is to analyze the impact of a large-scale farm located in Żylice on surface water and bottom sediments in the zone of its direct impact and the assessment of the extent of surface water degradation under the pressure of the company. The paper presents a working hypothesis that industrial animal husbandry affects the deterioration of some physico-chemical parameters of surface waters in the zone of direct impact.

MATERIAL AND METHODS

The research was conducted in areas adjacent to a large-scale farm, specializing in intensive laying hens, located in Żylice (51°63′ N; 16°83′ E) in the south of Wielkopolska (Fig. 1). On the area of 35 hectares there are 27 livestock buildings with an area of 79 122 m^2, in which over 6.1 million animals were kept [Environmental interview 2015, Lamperska 2012, Łuczak et al. 2012, Łuczak and Sternal 2010]. The farm is subject to the Directive IPPC (96/61/EC). In 2011, 2014 and 2015 samples of water for chemical analyzes were collected at selected monitoring points (Fig. 2). In total, 96 water samples and 8 sediment samples were analyzed. Water was taken four times a year: in spring, summer, autumn and winter at nine points (six points are located on rivers, one on pond and one on reservoir). The information about monitoring points and their distance from the farm is presented in Table 1. In 2015 and 2016 in summer season bottom sediment for physico-chemical analyzes were collected in the above mentioned points.

The measured chemical parameters of the water and bottom sediment quality and methods of their determination are summarized in Table 2.

The correlation matrix was used to identify the potential relationship between the land use structure and the water quality in the analyzed waters used the correlation matrix (Statistica Soft 12.5). For this purpose, buffer zones (direct impact) of 500 m in length and 200 m in width were designated for each measuring point. Then, the share of particular forms of land use, which is used in the correlation was calculated in these zones. The relationships between farm distances and physical and chemical parameters of water were also analyzed using the Principal Component Analysis (PCA) (Statistica Soft 12.5). The raster map of the Hydrographical Division of Poland 2010 and land-use map the Corine Land Cover 2000 [http://mapa.kzgw.gov.pl/] are used to determine the structure of land use in buffer zones.

The characteristics of the research area

The research area is located in the Rawicz commune, Wielkopolska province (Fig. 1). The analyzed area includes a large-scale farm and areas adjacent to it (Fig. 2). Żylice, in which the

Table 1. Distances of the water monitoring points from a large-scale farm

The name of point	Acronym	Distance (m)*
Żylicka Struga (I)	ZS1	580
Żylicka Struga (II)	ZS2	415
Żylicka Struga (III)	ZS3	1 650
Żylicka Struga (IV)	ZS4	2 210
Nowa Pijawka (Zakrzewski Rów)	NP	1140
Stara Pijawka (I)	SP1	615
Stara Pijawka (II)	SP2	1 160
Reservoir	R	2 490
Pond	P1	955

* the distance from the central point of the farm

Table 2. A table of summarizing methods for determining individual chemical parameters

L.p.	Parameter	Method	Unit
Water			
1	potassium	flame photometry	mg K·dm^{-3}
2	magnesium	complexometric titration	mg Mg·dm^{-3}
3	calcium	complexometric titration	mg Ca·dm^{-3}
4	sodium	flame photometry	mg Na·dm^{-3}
Bottom sediment			
5	total nitrogen	distillation method (Kjeldahl)	%
6	total phosphorus	colorimetric (Egner method)	mg P·100 g b.s.
7	potassium	flame photometry (Egner method)	mg K·100 g b.s.

b.s. – bottom sediment

company is located, is about 3 km north-west from Rawicz. The farm is located in an nitrate vulnerable zone – the Orla catchment area [Regulation... 2012].

There are three quaternary aquifers in the area. The level of groundwater is related to the sandy sediments of the Masłówka and Pijawka Valley as well as to the sandy clayey parts on the Upland. It lies at a depth of 1.1–2.1 m. There are four wells within the Żylice farm. Waters derived from them are derived from tertiary (Miocene) and quaternary (Pleistocene) formations [Łuczak et al. 2010]. The results of the monitoring carried out by the Voivodship Environmental Protection Inspectorate in Poznan for nitrate vulnerable zone (NVZ) in 2014 showed that the average annual nitrate value of groundwater in the analyzed area is in the range of 40–50 mg $NO_3 \cdot dm^{-3}$, which indicates the waters at risk of nitrate pollution [Results ... 2015].

Fig. 1. Location of the research area against the background of the Wielkopolska province

The analyzed watercourses are located within three sub-catchments with the total area of 2178.1 ha. The length of water flowing in their area is 50.76 km. All are the tributaries of Masłówa (Orla tributary), which leads through the waters at the section of 1316 meters in the studied area. The Stara Pijawka flows through Żylice. Its length in the area is 5733 m. The Nowa Pijawka runs to the south of the border of the farm. There is also an artificial barrier reservoir for recreation and fishing. Its area is about 1.65 hectares. The rivers in the Rawicz municipality have a snow-rainy power supply. The precipitation deficiency and low retention capacity of the area affect small outflows [Study ... 2015].

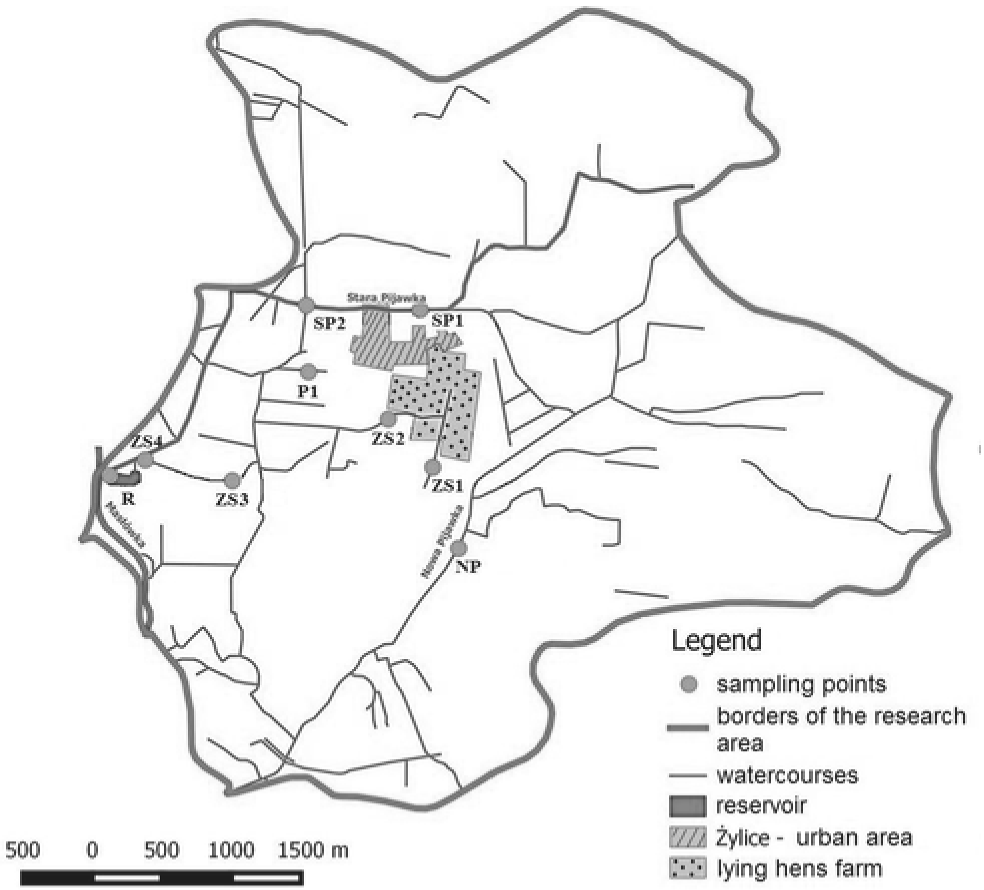


Fig. 2. Location of the water and bottom sediment monitoring points

The research area is 21.9 km^2. Most part of the area is occupied by agricultural land (75.5%). The urbanized zones (consisting of the villages of Żylice, Izbice, part of the Łaszczyn village and the north-western outskirts of the Rawicz town) occupy 13.3% (Table 3, Fig. 3).

The characteristics of the farm

In the 70s of the 20th century, an agricultural production company built a farm of 50 000 hens in Żylice. Since 1990 the hens have been owned by the poultry farm. Today it is Europe's largest producer of consumer eggs. The company runs intensive rearing of laying hens in battery cages in a non-bedding system. In the analyzed farm, the animals are watered with tap water. Its daily consumption is within the limits of 0.2–0.3 dm^3 per hen. Water consumption by poultry is about 2380 m^3/day.

Non-bedding system of maintenance poultry causes the accumulation of faeces. One hen per day has an average of 180 g of manure with a humidity of 70 to 80%. It is removed by the

Table 3. The comparison of average annual physical parameters during the research period

No	Point	Period	Potassium*	Magnesium	Calcium	Sodium*
			mg K·dm^{-3}	mg Mg·dm^{-3}	mg Ca·dm^{-3}	mg Na·dm^{-3}
1	ZS1	2011	11.5[2]	39.4[3]	241.1[3]	n.d.
		2014	7.8[1]	16.6[3]	157.7[3]	17.5[1]
		2015	16.4[3]	15.6[3]	97.2[3]	22.9[1]
2	ZS2	2011	17.9[3]	18.6[3]	116.4[3]	n.d.
		2014	9.4[1]	15.8[3]	121.4[3]	55.6[1]
		2015	9.3[1]	21.4[3]	103.0[3]	35.5[1]
3	ZS3	2011	20.8[3]	17.8[3]	135.8[3]	n.d.
		2014	8.3[1]	16.6[3]	120.0[3]	50.9[1]
		2015	12.5[3]	32.9[3]	140.1[3]	28.0[1]
4	ZS4	2011	29.1[3]	19.3[3]	136.3[3]	n.d.
		2014	9.0[1]	14.0[3]	119.7[3]	50.1[1]
		2015	14.4[3]	32.9[3]	140.2[3]	27.4[1]
5	NP	2011	15.2[3]	14.8[3]	134.6[3]	n.d.
		2014	9.5[1]	14.2[3]	114.1[3]	19.6[1]
		2015	11.9[2]	31.2[3]	98.7[3]	15.9[1]
6	SP1	2011	12.0[2]	21.2[3]	131.6[3]	n.d.
		2014	21.5[3]	14.5[3]	135.2[3]	28.9[1]
		2015	11.3[2]	41.6[3]	154.4[3]	23.2[1]
7	SP2	2011	20.5[3]	22.7[3]	160.2[3]	n.d.
		2014	15.7[3]	13.3[3]	137.7[3]	29.9[1]
		2015	11.4[2]	32.9[3]	163.0[3]	29.6[1]
8	R	2011	4.8[1]	19.9[4]	112.1[4]	n.d.
		2014	6.0[1]	7.8[4]	97.7[4]	22.6[1]
		2015	3.5[1]	22.9[4]	105.1[4]	18.8[1]
9	P1	2011	9.2[1]	15.9[4]	118.4[4]	n.d.
		2014	2.7[1]	26.0[4]	159.6[4]	22.4[1]
		2015	1.3[1]	31.6[4]	156.6[4]	17.0[1]

[1] – I class; [2] – second class; [3] – not meeting the requirements for 1st and 2nd class, [4] – lack of norm, n.d. – no data
*Potassium and sodium according to 1991 standard

tape system from the bottom of the battery it and then passed on to the receivers. The farm also has an egg processing center specializing in punching, filtering, cooling, pasteurizing, packaging, storage and reprocessing. The installation is designed to process 3 million eggs per day [Lamperska 2012].

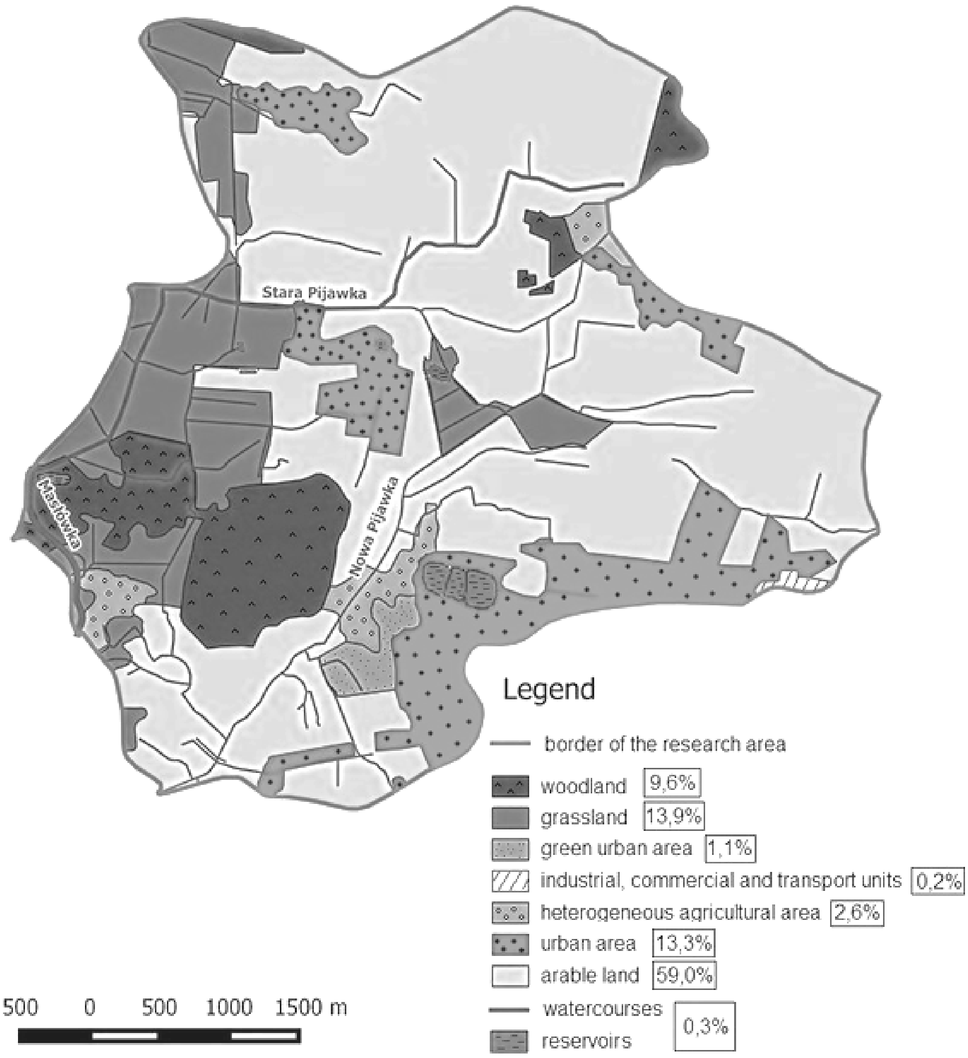


Fig. 3. The land pattern of the research area

RESULTS

The mean annual results of the analyzed chemical parameters in the analyzed period were presented in Table 3. The exceedances of standards in the watercourse of the analyzed waters were e very frequent in the analyzed nutrients. In the case of potassium, 37% of the results obtained were not in the standard for Class II. In 2014, the lowest concentrations of this element were recorded in most cases. The same trend also applies to magnesium. The highest potassium concentrations were recorded in points ZS4 and SP1. All average annual concentrations of mag-

Table 4. Physical and chemical parameters of bottom sediment in the monitoring points

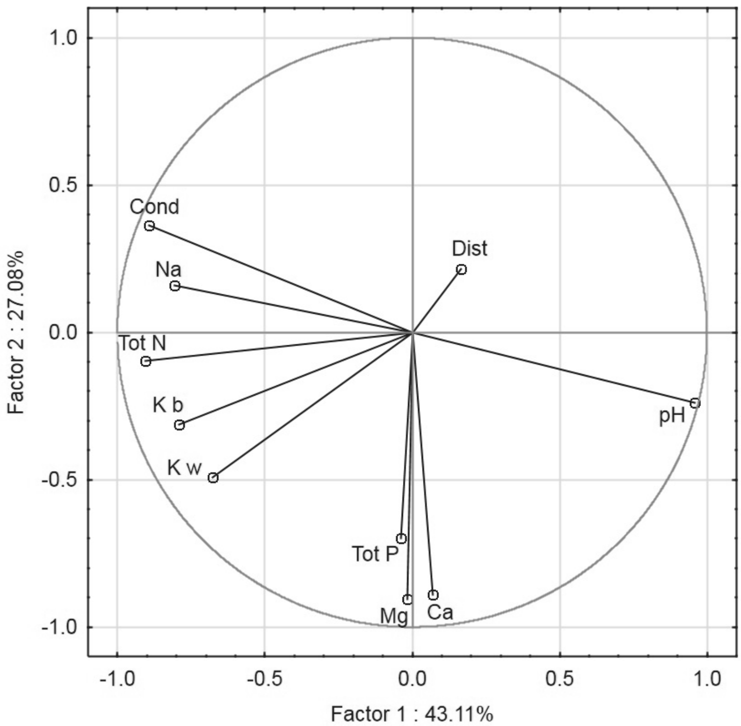
Point	pH	Conductivity ($mS \cdot cm^{-1}$)	Total nitrogen (%)	Total phosphorus (mg P·100 g DM)	Total potassium (mg K·100 g DM)
ZS1	7.1	1.04	0.9	2.7	22.5
ZS2	4.5	3.24	0.9	1.9	15.6
ZS3	4.6	2.58	1.7	2.2	43.5
ZS4	6.1	1.49	0.9	3.5	16.8
NP	6.4	1.54	0.4	0.3	21.3
SP1	6.9	0.50	0.7	7.0	30.4
SP2	7.2	0.49	0.1	7.6	10.5
R	8.0	0.12	0.0	2.2	1.3
P1	7.8	0.21	0.0	0.5	0.3

DM – dry matter

Table 5. Matrix of coefficients of correlation between variables (the coefficients of correlation are significant with p <0.05)

	Water quality parameters				Bottom sediment quality parameters				
	K	Mg	Ca	Na	pH	Cond	N	P	K
Arable land	0.070	0.220	0.231	-0.309	-0.020	0.116	0.013	-0.058	0.172
Urban area	0.023	-0.408	-0.333	0.596*	-0.584*	0.686*	0.178	-0.176	-0.053
Railway line	0.021	-0.431	-0.381	0.617*	-0.593*	0.689*	0.160	-0.177	-0.066
Woodland	-0.148	-0.350	-0.372	0.224	-0.259	0.179	0.407	-0.181	0.328
Roads	-0.403	-0.889*	-0.855*	-0.096	0.040	0.034	-0.183	-0.416	-0.239
Grassland	0.073	0.265	0.246	-0.036	0.461	-0.524	-0.502	0.334	-0.530
Surface water	0.454	0.024	-0.029	0.369	-0.114	0.084	0.179	0.056	-0.033

nesium and calcium in points located on the analyzed watercourses exceeded the established standards. The highest magnesium concentrations were recorded at points ZS1 and SP1 and the highest calcium concentrations were recorded at ZS1 and SP2. High calcium concentration was also recorded in the pond (P1). In the Regulation of 2016, the standard for concentrations of magnesium and calcium for water reservoirs and natural water bodies has not been established. However the concentration values were similar to those obtained on watercourses. In the case of sodium, two years – 2014 and 2015 were tested. In most of the points, no significant fluctuations of this nutrient were observed except for ZS2, ZS3 and ZS4. However, at these points in 2015 almost half of the sodium concentrations were recorded. This can result from the fact that this year, a sewage treatment plant was started at the analyzed farm. All the points where the decrease in the concentration of this nutrient was noted are on one watercourse, below the point it discharges the sewage through the farm. Despite the fluctuation, all the obtained results fall in the first class [Regulation… 1991].



Dist – distance from the farm, Cond –conductivity, pH – acidity, Tot N – total nitrogen in bottom sediments, Tot P – total phosphorus in bottom sediments, Na – sodium, Mg – magnesium, Ca – calcium, K b – potassium in bottom sediments, K w – potassium in water

Fig. 4. The analysis of main components for tested parameters

The reaction of the sediments was characterized by very high variability in the range of 4.5–8.0 (Tabela 4). The lowest pH was observed on the watercourses at the point ZS2 and ZS3. The highest pH, in turn, occurred in the water reservoir (R) and was almost twice as high as that observed at ZS2 and ZS3. The high variability also applies to the conductivity of sediments. The lowest conductivity occurred in the water reservoir (R), and the highest in points ZS2 and ZS3, where the gradient between them was significant. When it comes to macroelements of NPK in sediments, significant fluctuations were also observed. The highest concentrations of nitrogen, but also potassium were recorded in sediments at point ZS3. In turn, the highest concentrations of phosphorus were observed at points located on the Stara Pijawka watercourse (SP1 and SP2) (Tabela 4).

The calculated coefficients of correlation between land use structure and the values of physical and chemical parameters of waters in the studied seasons are presented in Table 5. A positive correlation was observed between the developed areas, railway line and conductivity of bottom sediment and concentrations of sodium in water. A negative correlation was observed between the pH of bottom sediments and urbanized areas and the railway line. A strong negative correlation was also observed between the roads and concentrations of magnesium and calcium in water.

The analysis by means of PCA for the results showed a correlation between the distance from the industrial farm and some analyzed parameters (Fig. 4). As the distance from the farm increased, total nitrogen, total phosphorus, potassium, magnesium in water and potassium in bottom sediment decreased.

DISCUSSION

The pressure of the analyzed large-scale farm on the surface waters in its immediate vicinity could be attributed to three aspects – the emission of various substances into the atmosphere and their deposition, the discharge of raw sewage directly into the watercourses and the sale of manure to the farmers and their application to the surrounding fields. During the study, the deposition of fine organic particles (manure, feathers, dust) was observed at point ZS2. There were also discharges of water waste from the farm. In addition, local farmers bought large quantities of manure to create a reserve. This manure was very often stored for several years in one place. Some of the prisms were overgrown with grass, and some were simply blurred by the high water levels in the floodplain of the Masłówka river.

As reported by Sidoruk and Skwierawski [2006], the use of the catchment affects the concentrations of some nutrients in water. The research has shown that 22 times more Ca^{2+} and about 14 times more Na^{+}, K^{+} and Mg^{2+} inflow from the agricultural catchment than from the forest or boggy catchment. The meteorological conditions, especially the intensity of atmospheric precipitation and spring thaw, are the decisive factors about in the amount of leached from agricultural areas. According to the authors, the largest amounts of calcium flow from agricultural areas. This is also confirmed by the results of these studies. The concentrations of this element in all analyzed points were excessive. Nevertheless, Ca^{2+} concentrations in the analyzed years were much higher than those obtained in the studies of Sidoruka and Skwierawski [2006] in agricultural inflows. The average difference was 56 mg $Ca{\cdot}dm^{-3}$, and the maximum reached even 161 mg $Ca{\cdot}dm^{-3}$. This may indicate an additional source of pollution, except for run-off from arable fields, for example, discharge sewage. It is also worth noting that farmers in this region used large amounts of bird manure as a fertilizer [Kupiec 2008]. A chicken dung can contain up to 5 times more calcium than other manures [Wrześniowski et al. 1996]. Differences are also visible in the case of magnesium and potassium. The amounts of these nutrients are much higher in chicken droppings, while on farms they are even higher than on individual farms [Bednarek et al. 2010, Bullanday Scott et al. 2017, Grabowski 2009, Won et al. 2018]. This is reflected in the results concerning the quality of water surrounding the analyzed object. All the results of magnesium concentration measurements and approx. 37% of potassium concentration results indicated excessive values.

As can be seen from the research, the concentrations of sodium in water were correlated with the railway line and the urbanized area. Sodium is an important element in determining the fertilizer value used to determine the suitability of wastewater for agricultural use and it has a major impact on organisms. The railway lines could have influenced the increase of concentrations of this nutrient in the immediate vicinity due to the non-adjustment of sanitary standards of toilets located in the tracks of passenger trains (lack of septic tanks). Sewage for several dozen years in Polish railway lines is dropped directly on the tracks, which caused their dispersion in the environment.

The research conducted by Sapek [2008] showed that in groundwater, sodium concentrations can be very high and reach up to 160 mg $Na{\cdot}dm^{-3}$. The high sodium concentration, on the farm in which the monitoring was located close to the municipal road, could also have been influenced by treatments related to road defrosting practice during the winter. According to the author, the main anthropogenic source of sodium is the extraction of rock salt or brine for economic or living purposes. Sodium is of conservative character in the environment, it does not emit to the atmosphere, it is practically not sorbed by the soil and bottom sediments, it does not precipitate in water. It is only absorbed to some extent by aquatic and terrestrial plants. In the analyzed watercourses, sodium could get from the farm area and from the village area due to the thawing of roads with the use of sodium chloride.

Sediments accumulating at the bottom of reservoirs and watercourses play an important role in controlling the state of the aquatic ecosystem. According to some authors, the chemical composition of bottom sediments of rivers and reservoirs is to a large extent dependent on human activity, which affects the geochemical situation prevailing in the catchment. It can be mentioned here the discharge of municipal and industrial wastewater to water reservoirs, surface run-off from agricultural fields getting into the soils from agricultural and non-agricultural activities, dust fallout and transport [Gałka 2010, Mioduszewski et al. 2004]. Although the correlation did not show a direct link between the NPK content in sediments with any category of land use in the studied region, it can be seen that concentrations of nitrogen and potassium are highest in the Żylicka Struga watercourse flowing in the immediate vicinity of the farm at ZS2 and ZS3 (Table 4). Here, the lowest pH and the highest conductivity were observed. Only the poultry farm can have a negative impact on the ZS3 point, because about 100 m down the course of the watercourse, extensively used meadows begin, and the ZS3 point is located in the forest complex. Therefore, there are no factors that could negatively affect water quality. In turn, the most phosphorus was recorded in sediments at points located on Stara Pijawka (SP1 and SP2), which were mainly influenced by intensively used arable land. According to some authors, phosphorus in the form of phosphates is absorbed by algae, bacteria and macrophytes and accumulated in their organisms throughout the growing season. One of the processes of withdrawing phosphorus from the biological cycle may be its sedimentation to bottom sediments in the form of sparingly soluble inorganic and inorganic-organic connections during the summer, as well as detritus remains after the end of the growing season. The aquatic ecosystem defends itself against excess nutrients, withdrawing a significant part of its circulation from its sedimentation to bottom sediments [Bartoszek 2007 and 2015]. Some authors confirm that the increased content of phosphorus in sediments in many cases results from the presence or inflow of organic matter into the basin [Dąbkowski and Pawłat-Zawrzykraj 2003]. The sediments collected for research from these points were mainly organic, which may have resulted from the intensively developing macrophytes, especially *Lemna minor*. The development of macrophytes, in turn, could have been stimulated by the outflow of nutrients from permeable and eroded soils intensively used for agriculture and adjacent to the watercourse.

Sharpley [1998] concluded that there is a link between large-scale poultry rearing and water quality in terms of nutrient content. According to this author, too high fertilization of farmland with farmyard manure leads to excessive concentration of some nutrients in surface waters. Ritter [2001] and Foy and O'Connor [2002], when examining point sources of pollution in agricultural areas, found that they did affect the quality of groundwater and the watercourses in their surroundings. Sobczyk [2008], while assessing the environmental impact of the large-scale poultry farm, located in Klimontów (Małopolskie province), stated that the installation was very weak on surface water. The cause-effect matrix method was used in the research. The discrepancies in the farm water impact assessments in Żylice and Klimontów may be due to different research methods, different production scales or more stringent environmental requirements on the other farm.

The influence of the scale of animal production on environmental threats is confirmed by Szymańska [2013]. When analyzing the effects of pig farming on sustainable rural development, she found that small-scale farms have the potential to balance agricultural production. On the other hand, farms engaged in intensive animal rearing have more impact on the environment. The main problem in the case of large-scale farms is the emission of nitrogen compounds, which are a threat to natural ecosystems. A good solution for the protection of surface and groundwater is an application of methods based on denitrification process. Depending on the specificity of a nitrogen pollution source, different biotechnology can be applied in the field. Around intensive farming or pasture area, the point source (e.g. storage manure), or near the coastline, denitrification barrier will be the most appropriate solution. Denitrification can be aided by increasing the organic carbon content in the soil [Bednarek et al. 2010]. Denitrification deposits also cause the reduction of other pollutants [Pietrzak and Urbaniak 2015].

CONCLUSIONS

1. Ca^{2+} concentrations in the analyzed years were significantly higher than those obtained in the studies of other authors in agricultural catchments. The average difference was 56 mg $Ca \cdot dm^{-3}$, and the maximum reached even 161 mg $Ca \cdot dm^{-3}$. This may indicate an additional source of pollution, except for run-off from arable fields, for example, discharge of sewage, but also increased doses of poultry droppings used by local farmers as a fertilizer. In this region, farmers used large amounts of poultry dung as a fertilizer. A chicken dung can contain up to 5 times more calcium than other manures.
2. All results of measurements of Mg^{2+} concentrations and about 37% of K^+ concentration results in water at the monitoring points, indicated excessive values. The amounts of these nutrients are much higher in poultry dung, while on farms they are even higher than on individual farms. Fertilization of the surrounding fields with increased doses of manure has reflection in the quality of water in the vicinity of the analyzed object.
3. Statistical analyzes showed a correlation of Na^+ concentrations in water with a railway line and an urbanized area. The railway lines could have influenced the increase of this element concentration in the immediate vicinity due to the lack of tanks without outflow. The results indicate that the highest sodium concentration occurred at points located on the watercourse flowing past the analyzed object, below the farm. One of the reasons for this condition may have been treatments related to defrosting roads in winter with the use of sodium chloride on the plant site.
4. In the case of sediments, at the points located on the watercourse flowing past the analyzed farm, the lowest pH and the highest conductivity were recorded. The concentrations of total nitrogen and potassium were also high. This may suggest the direct impact of the farm on the quality of the bottom sediments.

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OCENA WPŁYWU FERMY KUR NIOSEK NA WYBRANE PARAMETRY JAKOŚCIOWE WÓD

Synopsis. Celem pracy była analiza wpływu wielkoskalowej fermy drobiu na jakość wód oraz osadów dennych w strefie jej bezpośredniego oddziaływania oraz ocena stopnia degradacji wód powierzchniowych będących pod presją zakładu. Badania obejmowały obszar przyległy do wielkoprzemysłowej fermy kur niosek zlokalizowanej w Żylicach, w gminie Rawicz w województwie wielkopolskim. W pracy analizowano wybrane parametry fizyczno-chemiczne wody oraz osadów dennych w wytypowanych punktach monitoringowych zlokalizowanych na kilku akwenach (rzeki, oczko wodne, zbiornik zaporowy). Okres badań obejmował trzy sezony – 2011, 2014 i 2015 r. Wszystkie stężenia magnezu i wapnia w punktach zlokalizowanych na ciekach przekraczały dozwolone normy. Stężenia sodu w badanym okresie pozwoliły na zaliczenie wód do klasy I. Badania udowodniły, że ferma może oddziaływać negatywnie na wody powierzchniowe w jej otoczeniu. Analizy statystyczne wykazały korelację pomiędzy odległością od fermy a niektórymi badanymi parametrami. W miarę wzrostu odległości od fermy azot ogólny, fosfor ogólny, potas, magnez w wodzie oraz potas w osadach dennych malał.

Słowa kluczowe: fermy kur niosek, wielkotowarowa produkcja zwierzęca, zanieczyszczenie rolnictwa, jakość wód powierzchniowych

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