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The Condition of the Sanitary Infrastructure in the Bialski District in Poland and the Need for its Development

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ABSTRACT

The aim of this paper was to present the current state and the need for development of the sanitary infrastructure in the communes of the Bialski District located in the Lublin Voivodeship. The Bialski District encompasses 2 urban communes: Miedzyrzec Podlaski and Terespol and 17 rural communes: Biała Podlaska, Drelów, Janów Podlaski, Kodeń, Konstantynów, Leśna Podlaska, Łomazy, Międzyrzec Podlaski, Piszcząc, Rokitno, Rossosz, Sławatycze, Sosnówka, Terespol, Tuczna, Wisznice and Zalesie. The present paper uses the data from the surveys conducted in these communes in 2016. On average, 79.2% of the population used the water supply system in the surveyed communes, while 39.4% of the inhabitants had the possibility of discharging wastewater to the sewerage system. In the area of the communes, there were 20 collective, mechanical and biological wastewater treatment plants with a capacity exceeding 5 m^3/d. The households which were not connected to the wastewater network, discharged wastewater mainly to non-return tanks. In the surveyed communes, there were 4437 household wastewater treatment plants. Most of them (above 80%) were the systems with infiltration drainage, which do not ensure high efficiency of pollutants removal and may even contribute to the degradation of the groundwater quality. In order to solve the existing problems of wastewater and water management occurring in the communes where the Bialski District is located, it is necessary to further develop collective wastewater systems and equip the areas characterized by dispersed housing with highly efficient household treatment plants, e.g. constructed wetlands.

Keywords: district, septic tanks, household wastewater treatment plants, collective wastewater treatment plants, water supply network, sewerage systems

INTRODUCTION

Water is one of the most important resources on Earth. It determines both the human health and the standard of living of the population. During the last 20 years, the volume of water intake in particular sectors of the Polish economy has not changed significantly: 70% of water has been used by the industry, 20% by municipal management, 10% for irrigation in agriculture and forestry and filling and replenishing fish ponds [CSO 2019]. For the industrial purposes, mainly surface water has been used. Groundwater, which is characterized by much better quality than surface water, has been used mainly as a source of drinking water for the population.

The social and economic transformations in Poland, the increase in the ecological awareness and greater care for the state of the environment, as well as greater availability of new technological solutions contributed to an increase in the length of both the water supply network and the sewerage system in recent years [CSO 2019].

The aim of the study was to present the current state of the sanitary infrastructure in the communes of the Bialski District, which is part of the Lublin Voivodeship. The results of a survey conducted in 2016 by the Department of Environmental Engineering and Geodesy of the University of Life Sciences in Lublin and the data from the Statistical Office in Lublin [CSO 2017] were used in the paper. The method employed in the

research was a diagnostic survey and the research technique was a questionnaire. The questionnaire was sent to the offices of 19 communes located in the Bialski District. Feedback was received from 17 communes, whereas some of them did not contain all the answers. When no feedback was available from some communes, if possible, the data from the CSO was used [2016].

The research, involved a questionnaire consisting of 10 closed questions concerning the water and wastewater infrastructure existing in each given commune. The questions included in the questionnaire concerned: the length of the water supply network and sewerage system, the number of people using the water supply and sewerage system, as well as the number and types of collective and domestic wastewater treatment plants. The information concerning the number of functioning non-effluent tanks (septic tanks) and the needs of the commune in terms of water and sewerage infrastructure development was collected as well. The obtained information was analysed and the results were presented in a tabular and graphical form.

CHARACTERISTICS OF THE RESEARCH AREA

The Bialski District is located in the north-eastern part of the Lublin Voivodeship. It is the largest district of the voivodeship. Its area is about 2755 km², which is about 11% of the voivodeship area (Fig. 1). In 2016, 112.5 thousand people lived here, and the average population density was 40 people/km² [Statistical Office in Lublin 2019].

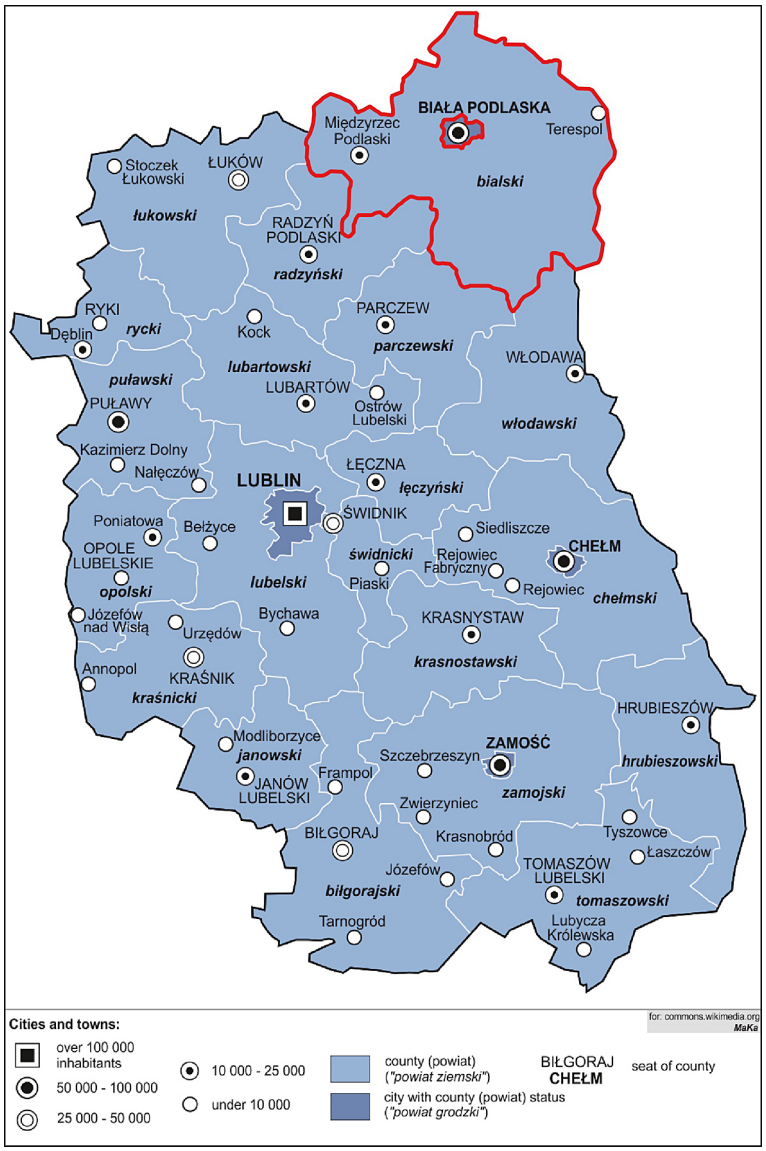

Fig. 1. Location of the Bialski District in the Lublin Voivodeship [http1]

The eastern and northern border of the district is marked by the largest river in the region – the Bug River. It is also the border between Poland and Belarus.

The Bialski District consists of 2 urban communes: Miedzyrzec Podlaski and Terespol and 17 rural communes: Biała Podlaska, Drelów, Janów Podlaski, Kodeń, Konstantynów, Leśna Podlaska, Łomazy, Międzyrzec Podlaski, Piszcząc, Rokitno, Rossosz, Sławatycze, Sosnówka, Terespol, Tuczna, Wisznice and Zalesie (Fig. 2). The administrative seat of the Bialski District is the city of Biala Podlaska, which is a separate unit – a city with district rights.

The largest commune of the district – Biała Podlaska has an area of 325 km² (about 12% of the district area), while the smallest is the urban commune of Terespol with an area of 10 km², which is 0.4% of the district area (Table 1).

The District Office in Biała Podlaska [2020] states that about 20% of the district population live in towns and 80% live in rural areas. The most populated communes (outside the cities) are among others: Terespol, Konstantynów, Leśna Podlaska and Piszczac, the least people live in the following communes: Rossosz, Sławatycze and Sosnówka.

The Bialski District is characterized by a negative natural growth, increasing in recent years, and a negative balance of migration [The District Office in Biala Podlaska 2020]. There are 340 villages in the district, with agriculture as the main economic activity. In the total area of the district, the agricultural land occupies 67.1%, forests and forest land 28.3% while the remaining land and wasteland 4.5%. The main crops cultivated in the district are cereals, potatoes, vegetables and fruits. The livestock production is dominated by cattle and pig farming. Due to the agricultural character of the area and the lack of industrial plants polluting the environment, the individual farms located here produce healthy, high-quality food. Therefore, the agri-food processing and light, wood and metal industries, as well as the production of building materials develop well in the district. The border location on the axis of important transcontinental transport routes has contributed to the development of transport companies. Horse breeding in the stud farm in Janów Podlaski is also of particular importance. There is the Podlasie Bug River Gorge Landscape Park, 8 nature reserves and 282 monuments of living and inanimate nature [The District Office in Biala Podlaska 2020].

Fig. 2. The communes in the Bialski District [http2]

Table 1. Characteristics of the communes in the Bialski District [own research and CSO 2016]

Name of the commune	Area [km^2]	Population [people]	Population density [people/km^2]	Share of the commune area in relation to the district [%]
Biała Podlaska	325	14000	43	11.8
Drelów	228	5593	25	8.3
Janów Podlaski	136	5408	40	4.9
Kodeń	151	3756	25	5.5
Konstantynów	87	4247	49	3.2
Leśna Podlaska	98	4363	45	3.6
Łomazy	199	5228	26	7.2
Międzyrzec Podlaski	262	10531	40	9.5
Międzyrzec Podlaski (urban)	21	17301	824	0.8
Piszcząc	170	7504	44	6.2
Rokitno	141	3142	22	5.1
Rossosz	76	2331	31	2.8
Sławatycze	72	2372	35	2.6
Sosnówka	148	2600	18	5.4
Terespol	141	6743	48	5.1
Terespol (urban)	10	5830	583	0.4
Tuczna	170	3309	19	6.2
Wisznice	173	5130	30	6.3
Zalesie	147	4535	31	5.3

RESULTS AND DISCUSSION

A characteristic feature of the Polish water and wastewater management is the noticeable, but too slow, development of the sewerage system (Table 2). The persisting difference between the length of the water supply network and the sewerage system is even more visible when comparing cities with rural areas.

According to the data of the Statistical Office in Lublin [2017], the total length of the water supply network in all the communes of Bialski District in 2016 was over 1950 km (Table 3), which constituted about 9.2% of the length of the water supply network of the entire Lublin Voivodeship. However, it was not distributed evenly [Statistical Office in Lublin 2017].

The longest water supply network was 197 km in the Biała Podlaska Commune. The shortest water supply network was in the Rossosz Commune – 17.5 km. However, the length of the water supply network should not be a determinant for the evaluation of the drinking water supply for the population, because it depends on many factors, such as: the size of the commune, the settlement method which is dominant in a given area and the housing density. Such a large disproportion between the length of the water supply network proves a very spatially diverse settlement network. The commune with the longest water supply network is at the same time the largest commune of the Bialski District.

Among the analyzed communes, the highest level of water supply was in the Międzyrzec Podlaski commune – 99.2% of the population used the water supply network (Fig. 3). It is characterized by the second longest water supply network in the district – 179.3 km and one of the largest areas – 262 km^2. The lowest percentage of the population using the water supply system was in the Łomazy Commune – 24% of population. With quite a large area of this commune – 199 km^2, in 2016 it was inhabited by half of the population of the Międzyrzec Commune, while the length of the water supply network amounted to 153.61 km and was one of the greatest in the district. Such data prove dispersed population in centres of the commune.

Table 2. Length of the water supply network and the sewerage system (in thousand km) in Poland in 2000–2018 [CSO 2019]

Length of the	2000	2005	2010	2015	2017	2018
Water supply network	211.9	245.6	272.9	297.9	303.9	307.7
Sewerage system	51.1	80.1	107.5	149.7	156.9	160.7

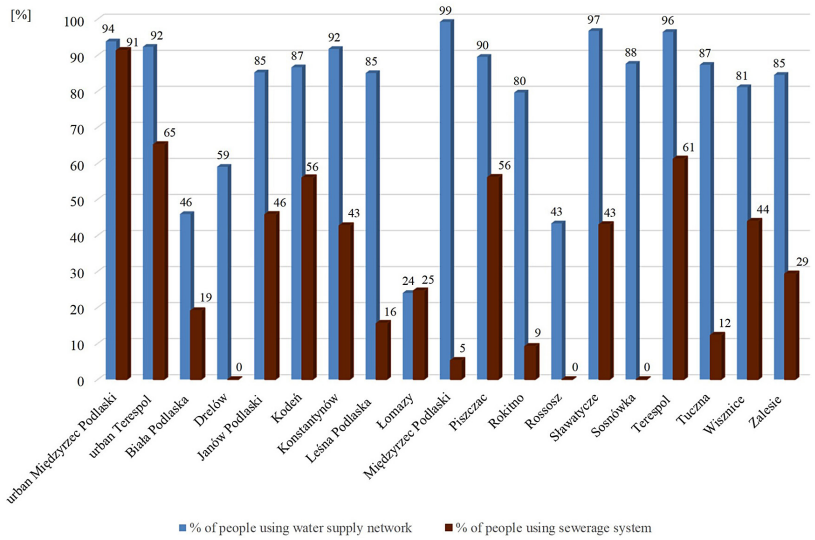

Fig. 3. The level of the water supply network and the sewerage system in the communes of Bialski District in 2016

The Surveys carried out in the neighbouring districts show that in Radzyń District, the total length of the water supply network in 2016 was over 880 km and was used by 90% of the district population [Bogusz et al. 2020]. In turn, in the Parczew District, the total length of water supply system was 630 km and on average was used by 88% of the population of the district [Micek et al. 2018]. Despite the fact that in 2016 the water supply network on the territory of Bialski District was used on average by about 79.2% of the population, the analysis of the collected survey data allows us to assess the condition of the water supply infrastructure in the discussed district as unsatisfactory.

On the basis of the analysis of the data from the survey on the length of the sewerage network in each commune of the Bialski District, it was found that in 2016, it did not exist in the communes of Drelów and Rossosz, whereas in the commune of Sosnówka the sewerage system was still under construction, and in the remaining 16 communes it was already partly in operation. The total length of the sewerage system in the Bialski District in 2016 was 497.5 km, which constituted 7.7% of the length of the wastewater network of the entire Lublin Voivodeship [Statistical Office in Lublin 2017]. The longest sewerage network – 98.8 km was found in the commune of Piszczac. Its length constituted almost 20% of the length of the network in the whole district. The results of the survey showed that the number of people using the sewerage system varied greatly and ranged from 15806 people in the urban commune of Międzyrzec Podlaski to 406 people in the Tuczna Commune.

In order to be able to compare individual communes, the average length of the network per each inhabitant using the sewerage system was calculated. According to the National Municipal Wastewater Treatment Programme [KPOŚK 2017], the unit length of the sewerage network should not exceed about 8 m per capita [Heidrich, Stańko 2008; AKPOŚK 2017]. In the case of the Bialski District communes, only three meet these requirements: the urban commune of Międzyrzec Podlaski – 3.9 m/M, Łomazy – 6.6 m/M and Rokitno – 3.5 m/M. However, in the case of the latter, it should be noted that this is the shortest existing sewerage network in the district with a length of 1 km. In three other communes, a unitary length of the sewerage network was slightly exceeded, as it was 8.0 in the commune of Kodeń, 8.4 – Konstantynów and 8.7 in Janów Podlaski Commune. The other communes were characterized by a unitary length of the sewerage network which was many times greater than the advised value, i.e: from 9.06 in the commune of Terespol to 39.8 in the Tuczna Commune.

After analyzing the level of the sewerage system in the communes of Bialski District, it was noticed that it was high only in the urban commune of Międzyrzec Podlaski and amounted to 91.3%. In the remaining communes, it ranged from 65.2% in the urban Terespol Commune and 61.2% in the Terespol Commune to 5.3% in the Międzyrzec Podlaski Commune. It should be noted that in 5 communes (Biała Podlaska, Leśna Podlaska, Międzyrzec Podlaski, Rokitno and Tuczna) it did not even reach 20% (Fig. 3).

Table 3. Length of the water supply network and the sewerage system and the number of water supply and the wastewater system users in Bialski District in 2016

Commune	Population [people]	Length of the water supply network [km]	Users of the water supply network [people]	Length of the sewerage system [km]	Users of the sewerage system [people]
Urban Międzyrzec Podlaski	17301	59.0	16228	62.3	15806
Urban Terespol*	5830	28.4	5381	34.5	3804
Biała Podlaska	14000	197.0	6432	33.0	2670
Drelów	5593	109.7	3300	0.0	0
Janów Podlaski	5408	94.3	4608	21.5	2480
Kodeń	3756	89.9	3252	16.8	2100
Konstantynów	4247	88.5	3893	15.2	1815
Leśna Podlaska	4363	115.7	3710	8.2	682
Łomazy	5228	153.6	1257	8.5	1286
Międzyrzec Podlaski	10531	179.3	10444	10.5	557
Piszczac	7504	146.4	6715	98.8	4211
Rokitno	3142	88.8	2500	1.0	289
Rossosz	2331	17.5	1010	0	0
Sławatycze	2372	66.5	2294	22.6	1019
Sosnówka	2600	73.2	2251	-	-
Terespol	6743	124.2	5947	55.1	4124
Tuczna	3309	104.6	2888	16.2	406
Wisznice*	5130	134.3	4159	57.8	2251
Zalesie	4535	79.3	3831	35.5	1331
TOTAL	**113923**	**1891.2**	**90100**	**497.5**	**44831**

* CSO 2016

The conducted research allowed determining that in the Bialski District 39.4% of its inhabitants used the sewerage system, on average, while in the neighbouring districts: Radzyń – 35% of the population [Bogusz et al. 2020] and in Parczew – 48% [Micek et al. 2018].

A characteristic feature of the water and wastewater management in the Lublin Voivodeship is that the development of the sewerage system does not keep up with the needs. This is due to the fact that the development of the sewerage network is strictly conditioned by the accessibility of the population to water supply, and its construction is more difficult and expensive.

From the data of the Local Government Portal [2017] concerning the water supply and wastewater system management in Poland it can be observed that in 2017, on the scale of the whole country, about 84% of the country's population used a water supply network, while only about 53% used a sewerage system. By analyzing the urban-rural relationship, it can be seen that less than a quarter of people used a sewerage system in rural areas, compared to cities [Local Government Portal 2017].

In the Bialski District, a clear difference is also observed in the access of the population to the water supply system – 79.2% and to the sewerage system – 39.4%. Poorer communes often do not have sufficient funds for independent development of sewerage infrastructure or for obtaining appropriate support [Statistical Office in Lublin 2017].

In rural communes, mainly in the areas with dispersed housing, the diversity in an access to the infrastructure is very high. While the level of water supply network is quite high, the construction of the sewerage system is economically unprofitable. The greatest disparities were found in the commune of Międzyrzec Podlaski, where the level of water supply was 99.2% but the level of sewerage system was 5.3%. A similar situation was observed in the communes where there was a water supply network, but no sewerage system: Drelów, Rossosz, Sosnówka and Rokitno. In urban communes, the difference between the percentage of the population using the water supply and the sewerage system was smaller (Fig. 3).

In rural areas, where buildings are not sufficiently concentrated, there no sewerage system was built. Municipal wastewater is collected in

septic tanks and transferred to collective wastewater treatment plants. In 2016, there were 20 collective mechanical-biological wastewater treatment plants with a capacity of 5 m^3/d on the territory of the Bialski District communes. The urban commune of Międzyrzec Podlaski had a treatment plant with the largest capacity – 2000 m^3/d. This was due to its urban character – it served a very large population. On the other hand, in the Biała Podlaska Commune, there was a collective wastewater treatment plant with the smallest capacity – 30 m^3/d.

The surveys conducted in 2016 in the districts adjacent to the Bialski District show that 12 collective biological wastewater treatment plants with a capacity of more than 5 m^3/d were operating in the Parczew District [Micek et al. 2018] and on the territory of the Radzyń District there were 8 collective biological wastewater treatment plants [Bogusz et al. 2020].

According to the National Urban Wastewater Treatment Programme (KPOŚK), the use of a collective wastewater system and a wastewater treatment plant is justified when there are no less than 120 inhabitants per one kilometer of the wastewater network (excluding house drains).

Table 4. Collective wastewater treatment plants in the Bialski District

Name of the commune	Name of the wastewater treatment plant	Capacity of the treatment plant [m^3/d]
Biała Podlaska	Woroniec	30
Janów Podlaski	Janów Podlaski	400
Kodeń	Kodeń	600
	Kostomłoty	70
Konstantynów	Konstantynów	320
Leśna Podlaska	Leśna Podlaska	400
Łomazy	Łomazy	250
Międzyrzec Podlaski (urban)	Międzyrzec Podlaski	2000
Piszcząc	Dąbrowica Mała	35
	Piszcząc	360
	Trojanów	150
Rokitno	Cieleśnica	90
Sławatycze	Sławatycze	300
Terespol	Koroszczyn	500
Terespol (urban)	Terespol Wschód	600
Tuczna	Tuczna	120
Wisznice	Wisznice Kolonia	380
	Marylin	50
Zalesie	Zalesie	100
	Kijowiec	50
TOTAL		**6805**

The households which are not connected to the sewerage network discharge wastewater mainly to septic tanks, as their construction does not involve high financial outlays. However, many of them do not fulfill their role, because the requirement of keeping tightness is not maintained during construction, which results in the migration of pollutants to the ground and groundwater pollution. This is due to a low ecological awareness of the inhabitants of Bialski District and limited financial resources. The results of the survey from 2016 did not allow to determine the exact number of septic tanks existing in the Bialski District, because 13 communes did not provide any information about them. The data from 6 communes indicate the existence of 1662 such facilities, only 528 of which (almost 32%) signed an agreement with a company accountable for treating pollutants. This may indicate that a significant part of wastewater was not received to collective wastewater treatment plants, but was poured into fields, which might lead to the degradation of the groundwater quality.

In the rural areas with scattered housing, it is reasonable to invest in the construction of household wastewater treatment plants. Their number is steadily increasing every year because they are much cheaper to operate than septic tanks [Karolinczak et al. 2015]. The following technological systems can be used in household wastewater treatment plants: septic tank with drainage system, septic tank with ground filter (sand), container wastewater treatment plants with active sludge, container wastewater treatment plants with biological bed and constructed wetlands [Pawełek, Bugajski 2017].

The conducted survey shows that in 2016 there were 4437 household wastewater treatment plants of various types in the communes of the Bialski District (Table 5). Figure 4 shows the number of household wastewater treatment plants in individual communes in the Bialski District.

Table 5. Types of household wastewater treatment plants in the Bialski District

Type of a wastewater treatment plant	Number of facilities in the district
Drainage systems	3559
Active sludge	660
Constructed wetlands	171
Hybrid systems	40
Biological beds	7
TOTAL	**4437**

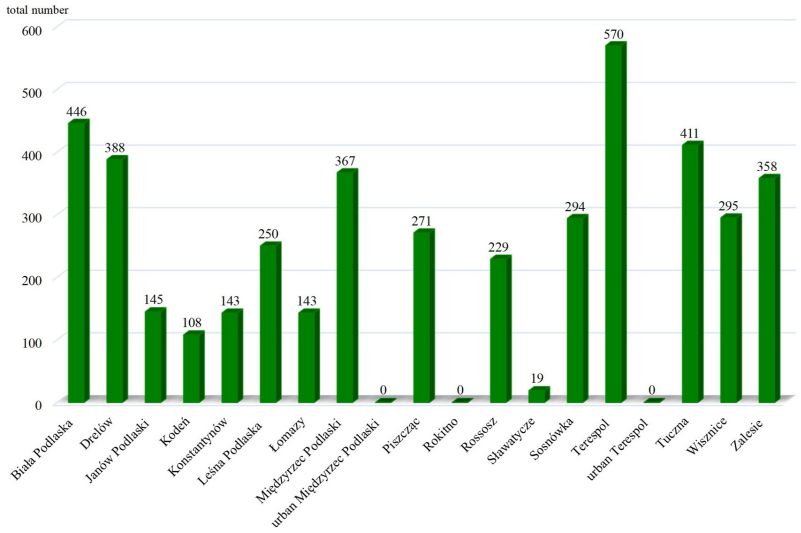

Fig. 4. The number of household wastewater treatment plants in the communes of the Bialski District in 2016

The data presented in Table 5 show that the treatment plants based on a technological system with a septic tank and drainage system constituted 80.2% of all the household facilities in the commune. They are easily accessible and affordable, which is why they are willingly bought and installed by the inhabitants of this region. However, they do not offer the possibility to control the quality of the treated wastewater, as their operation is based on discharging the mechanically treated wastewater into the ground. Such a practice may cause the groundwater quality degradation [Jucherski, Walczowski 2001; Jóźwiakowski et al. 2014; Pawełek, Bugajski 2017]. Therefore, it is necessary to promote and implement such solutions which limit the possibility of environmental pollution, ensure high effects of wastewater pollutants removal and will be characterized by high reliability of operation. Such facilities include conventional wastewater treatment methods and constructed wetlands, which are recommended by many authors [Dębska et al. 2015; Gajewska et al. 2015; Jóźwiakowski et al. 2015; Gizinska et al. 2016; Jóźwiakowski et al. 2017; Jóźwiakowski et al. 2018; Jucherski et al. 2017].

In order to solve the existing problems connected with water and wastewater management occurring in the communes within Bialski District, it is necessary to further develop not only collective water supply and sewerage systems but also municipal wastewater treatment plants, as well as to equip the areas characterized by dispersed housing with highly efficient household wastewater treatment plants, such as constructed wetlands.

CONCLUSIONS

1. The current state of the sanitary infrastructure in the communes, within the area of the Bialski District, is not satisfactory and may have a significant impact on the pollution of the natural environment.
2. A very large disproportion between the state of the water supply system and wastewater system was observed in the analyzed communes. In 2016, the length of the sewerage system constituted only 26% of the length of the water supply network.
3. In 2016, the water supply system was used by 79.2% of the district inhabitants, on average. In four communes the percentage of the population using the water supply system did not exceed 60%, in the remaining communes it was between 80 and 100%.
4. It was found that 39.4% of the population used collective wastewater disposal systems in the communes of the Bialski District, whereas three communes did not have any sewerage systems.
5. In 2016, there were 20 collective mechanical-biological wastewater treatment plants with a capacity of more than 5 m^3/d in the Bialski District communes. Their total capacity was over 6800 m^3/d.
6. In 2016, more than 4400 household wastewater treatment plants operated in the Bialski District, over 80% of which were the facilities with drainage systems.
7. In order to protect the natural environment in the Bialski District, it is necessary to undertake investment activities that will contribute to the improvement of the current state of the sanitary infrastructure. Particular attention should

be paid to the need to build and modernize the water supply networks and collective systems for wastewater collection and treatment.

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