

The Condition of the Sanitary Infrastructure in the Ryki 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 Ryki District located in the Lublin Voivodeship. The Ryki District encompasses 1 urban Commune – Dęblin, 1 urban-rural Commune – Ryki and 4 rural communes: Kłoczew, Nowodwór, Stężyca and Ułęż. The paper is based on the data from the surveys conducted in all the afore-mentioned communes in 2016. In the whole district on average 71.3% of the population used the water supply network, while 42% of the inhabitants were able to discharge wastewater to the sewage system. Within the area of the Ryki District, 5 collective wastewater treatment plants with a capacity exceeding 5 m³/d functioned in 2016. The households which were not connected to the sewage network discharged wastewater mainly to non-return tanks. About 440 household sewage treatment plants were found in the surveyed communes. The overwhelming majority of such small objects in the discussed district were activated sludge systems (92%). The research carried out in 2016 proved a strong need to develop the current state of the sanitary infrastructure in the Ryki District. A particular emphasis should be placed on the wastewater management by connecting the inhabitants of urban areas to a joint sewage disposal system. Ecological awareness must be raised so as to encourage people to invest in household wastewater treatment plants, which should be used in the areas with scattered development.

Keywords: district, septic tanks, household wastewater treatment plants, collective wastewater treatment plants, water supply network, sewage system

INTRODUCTION

After the accession to the European Union, Poland undertook to comply with the legal provisions on the rational management of water resources and their protection. The changes that occurred in the national law concerning water management have prompted local government units to take action in the field of development of water and sewage infrastructure [Jóźwiakowski et al. 2012]. This contributed to the growth of investments in the area of urban and rural sewerage. Apart from the ecological and economic effects, the development of technical and sanitary infrastructure brings many social and economic

benefits, as they contribute to the improvement of living conditions of the inhabitants and the development of entrepreneurship.

The statistical data from recent years indicate a significant increase not only in the length of the water and sewage system but also the number of facilities used for water supply and wastewater disposal in Poland. In recent years, the length of the water supply network has increased from 245.6 thousand km in 2005 to 301 thousand km in 2016. It was observed that the length of water supply network increased by 146% in rural areas and by about 47% in cities [CSO 2016]. The number of people using sewerage network and the number of wastewater treatment plants is still

increasing. In urban areas, characterized by huge population, the majority of sewage is treated in collective facilities that are joined for the whole cities or communes. However, in rural areas, often characterized by dispersed settlement, people generally use septic tanks and different household wastewater treatment plants.

Although the general state of sanitary infrastructure in Poland has improved over the recent years, the disproportions in equipping cities and villages with water supply and sewage systems still exist, especially in rural areas.

The aim of this study was to assess the state and needs of the development of sanitary infrastructure in the Ryki District. The basis of the study were 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 2016]. Questionnaires were sent to all the communes of the Ryki District, but sometimes no feedback was received. Then, the data from CSO was used [2016]. The researchers wanted to investigate, among others, the length of the water supply network and the sewage system as well as number of people with an access to them, number and types of collective and household wastewater treatment plants but also the number of non-effluent tanks (septic tanks) functioning in each commune. The obtained data was analyzed and the results were presented in tabular and graphical forms.

THE CHARACTERISTICS OF THE RYKI DISTRICT

The Ryki District is located in the north-western part of the Lublin Voivodeship in Poland (Fig. 1). The Ryki District borders with the following districts: the Łuków District – to the north-east, the Lubartów District – to the east, the Puławy District – to the west and the Garwolin District (Masovian Voivodeship) – to the north-west. The area of the Ryki District is 615.5 km², so it is one of the smallest districts in the Lublin Voivodeship (2.5% of the voivodeship area). Within the discussed district there are both 4 rural communes – Stężyca, Ułęż, Nowodwór and Kłoczew, 1 urban commune – Dęblin and 1 urban-rural commune – Ryki, which is the official seat of the Ryki District (Fig. 2). It is also the largest commune in the whole district (26% of

the district area), whereas the urban Dęblin Commune constitutes only 6% of the Ryki District area (Table 1).

In 2016, above 57 thousand people lived in the discussed district; the average value of population density was 93 people/km² [CSO 2016]. According to the collected data in 2016, the most people lived in the Ryki Commune (about 37%) and the Ułęż Commune had the least inhabitants (about 6% of the whole district population). When it comes to the share of people living in rural and urban areas, it was observed that in 2016 about 54% of the district inhabitants lived in the countryside and 46% – in towns. The Ryki District is marked not only by a negative natural growth, but also a negative net migration rate [CSO 2016]. The land utilization in the discussed district is quite diverse and the largest part of the area is occupied by arable farming (above 50%) forests (above 21%) and grassland (above 13%) [Waste management plan for the Ryki District for the years 2010–2013 with an outlook until 2017]. Generally, the Ryki District is poorly industrialized, the most of people work in the agricultural sector. In 2016, about 5.5 thousand farms existed in the district, most of which were quite small (2–10 ha). It is estimated that about 70% of the farm produce is allocated for the market and the remaining part for own purposes. The specialization of agricultural production is oriented to the needs of agri-food processing plants. Among the crops, a significant area is occupied by strawberries, raspberries, currants and cherry orchards. A special kind of agricultural production in the district are fish farms, which are located, among others in: Jagodne (the Kłoczew Commune) – about 220 ha, Sobieszyn – 205 ha, Ułęż – about 77 ha and in Ryki – 283 ha (<http> 3). The Ryki District is characterized by a quite small share of areas with nature protection – about 11%. There are 3 areas of Natura 2000 site, 7 ecological grounds, 64 monuments of living and inanimate nature [Environmental Protection Programme for the Ryki District for the years 2010–2013 with an outlook until 2017].

RESULTS AND DISCUSSION

Water supply network and sewage system

Polish water and wastewater management is still in the development phase. The length of water supply system and sewage network is still

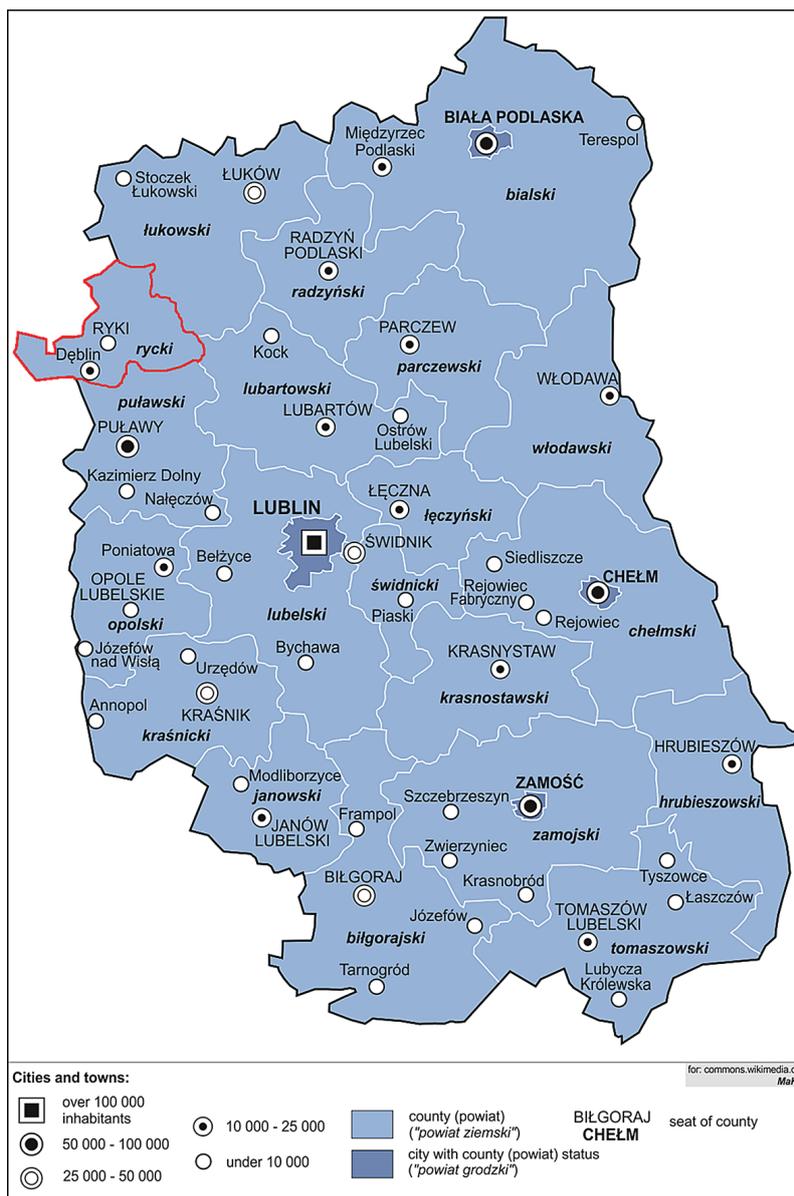


Fig. 1. Location of the Ryki District in the Lublin Voivodeship [http 1]



Fig. 2. Communes of the Ryki District [http 2]

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

Commune	Area [km ²]	Inhabitants [people]	Population density [people/km ²]	Share of the commune area in relation to the district area [%]
Dęblin	38.3	16526	431	6.2
Ryki	161.8	20918	129	26.3
Kłoczew	143.2	7457	52	23.3
Nowodwór	71.7	4304	60	11.6
Stężyca	116.8	5342	46	19.0
Ułęż	83.6	3376	40	13.6

growing but definitely too slowly. Over the recent years, a huge disproportion in the rate of these two systems extension has been observed, also in the Ryki District described in this paper, which is depicted in Figure 3.

While comparing the length of the elements of the sanitary infrastructure in 2016 in individual communes of the Ryki District (Table 2) it can be noticed that the longest water supply network was observed in the Kłoczew Commune, while the shortest in the Ułęż Commune. On the other hand, the urban Ryki Commune had the longest sewage system, while the Ułęż Commune had the shortest one. Totally, in 2016 the length of the water supply network in the whole Ryki District amounted to about 710 km, while the length of the sewage system was about 130 km.

However, only on the basis of the length of these two systems, it cannot be stated which commune is the one with the poorest state of the sanitary infrastructure. This is determined by many different factors, such as the size of the discussed territorial unit or the housing density [Jóźwiakowska and Marzec 2020]. Another very important indicator is the percentage of people with an access to the water supply network and to the sewage system (Table 3).

On the basis of the data presented in the Table 3 it can be stated that in 2016 the Stężyca Commune had the smallest level of water supply, because only 9.8% of its inhabitants were connected to water pipe. The opposite was the Ułęż Commune, where all the inhabitants had an access to the water supply network. In 2016, the commune with the smallest level of wastewater management was the Kłoczew Commune, because only 1.5% its inhabitants had an access to the sewage system. On the other hand nearly 90% of the inhabitants of the Dęblin Commune had an access to the sewage system and in 2016 this was the prime commune according to the sewage system in the whole Ryki District. Totally, in 2016 the percentage of the inhabitants of the Ryki District who were connected to the water supply network amounted to above 71% and to the sewage system – about 42%.

Another aspect that is very important while comparing the state of the sanitary infrastructure in different territorial units is the indicator expressing the length of the water supply network or the sewage system per one inhabitant using the discussed system. Thus, Table 4 shows the calculated indicators.

It was calculated that the communes with the longest water supply network per one inhabitant were the communes of Stężyca and

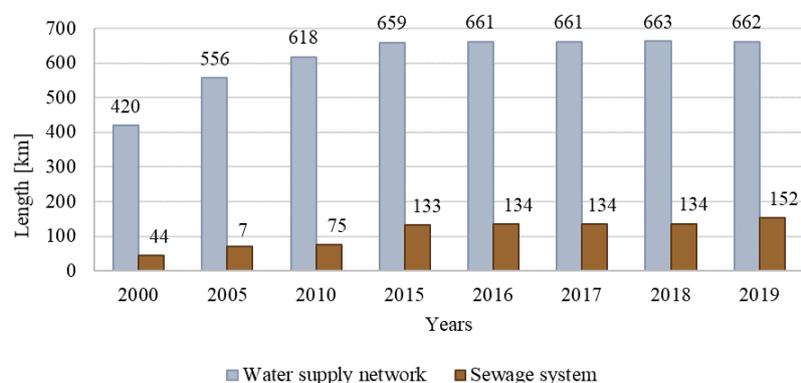
**Fig. 3.** The length of the water supply network and the sewage system in the Ryki District over the years 2000–2019 [CSO 2019]

Table 2. The length of the water supply network and the sewage system in the communes of the Ryki District in 2016 [own research and CSO 2016]

Length of the system [km]	Dęblin	Ryki	Kłoczew	Nowodwór	Stężycza	Ułęż	whole district
Water supply network	59.2	218.0	165.9	126.3	89.9	50.6	709.8
Sewage system	59.7	35.7	6.4	4.1	21.3	2.8	130.0

Table 3. Share of the inhabitants of the analyzed communes with an access to the water supply network and sewage system in 2016 [own research and CSO 2016]

Inhabitants of the communes with an access to the system [%]	Dęblin	Ryki	Kłoczew	Nowodwór	Stężycza	Ułęż	whole district
Water supply network	86.7	98.3	19.7	23.5	9.8	100.0	71.0
Sewage system	89.6	40.2	1.5	8.7	10.6	2.4	42.0

Nowodwór and in 2016, it was above 172 meters per inhabitant [m/I] and above 124 m/I, respectively. This may be explained by the fact that the rural communes of Stężycza and Nowodwór are characterized by dispersed settlement, so in order to connect the inhabitants to the water supply network the length of the pipes must be quite long, so as to reach all the houses. On the other hand, the Dęblin Commune had the smallest indicator – only 4.1 m/I. This phenomenon probably stems from the fact that concentrated settlement dominates in the urban commune, many people live in multifamily buildings, so one pipe can provide water for many inhabitants, thus the length of the water supply network per capita is relatively small. As previously explained, quite similar results were obtained in the case of the sewage system, so the highest value was observed in the Kłoczew Commune – 56.6 m/I and the smallest in the Dęblin Commune – 4.0 m/I. The obtained values can be compared to some recommendations which state that the unit length of the sewage system should not exceed about 8 m per capita [Heidrich and Stańko 2008; AKPOŚK 2017]. When it comes to the communes of the Ryki District, only two meet the requirements, i.e. the urban Dęblin Commune (4.0 m/I) and the urban-rural Ryki Commune (4.1 m/I). All the others commune are characterized by a sewage system which unitary length of the

sewage network is many times greater than the advised value, i.e. from 11.0 m/I in the Nowodwór Commune up to 56.6 m/I in the Kłoczew Commune.

In order to assess the state of the water supply and sewage system independently, the Ryki District was compared with some other districts, also located in the Lublin Voivodeship (Fig. 4). The water supply network occurred to be the poorest in the Ryki District and in 2016 only 71% of this district inhabitants had connection to water, while the situation was better in other districts: 79% of the population in the Biała Podlaska District [Józwiakowska and Marzec 2020], 88% in Parczew [Micek et al. 2018] and 90% in Radzyń [Bogusz et al. 2020]. Although in 2016, the Radzyń District was characterized by the highest percentage of the inhabitants with connection to the water supply network, this district had also the least people (35%) with an access to the sewage system. In other districts of the discussed group, the situation was a bit better – in the Biała Podlaska District, joint sewage disposal was used by 39% of the inhabitants, 42% in Ryki and 48% in Parczew. Huge disproportions can be observed in the rate of the development of the water supply network and the sewage system and it seems to be the characteristic feature of the sanitary infrastructure in the rural areas in the Lublin Voivodeship [Józwiakowska and Marzec 2020].

Table 4. Average length of the water supply network and sewage system per one inhabitant in the communes of the Ryki District in 2016 [own research and CSO 2019]

Length of the system per one inhabitant [m/I]	Dęblin	Ryki	Kłoczew	Nowodwór	Stężycza	Ułęż
Water supply network	4.1	10.6	112.7	124.9	172.2	15.0
Sewage system	4.0	4.3	56.6	11.0	37.5	34.1

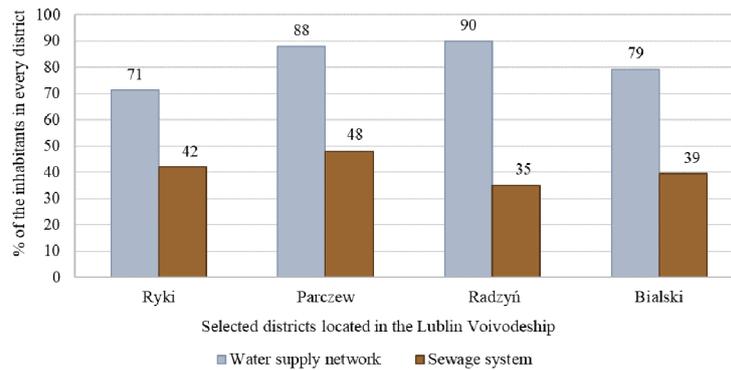


Fig. 4. Percentage of inhabitants with connection to water supply and sewage system in selected districts in the Lublin Voivodeship

Collective wastewater treatment plants and joint sewage disposal

Another important aspect of the state of the sanitary infrastructure of the Ryki District that must be discussed corresponds to wastewater treatment plants. According to the data collected in 2016, there were 5 collective wastewater treatment plants with a capacity greater than 5 m³/d (Table 5).

The data presented in the table above shows that the largest collective wastewater treatment plant was functioning in the urban Dęblin Commune and it treated 6000 m³ of sewage per day. The second largest object was located in the Ryki Commune – 3607 m³/d. Other wastewater treatment plants were projected for many times smaller capacity. The Ryki Commune was equipped with the smallest collective wastewater treatment plant and its capacity was only 12 m³/d. The Stężyca Commune did not have its own object and the sewage produced by the inhabitants of this commune was delivered to the wastewater treatment plant in Dęblin.

While comparing four different districts of the Lublin Voivodeship (Table 6) it should be emphasized that although the Ryki District had only 5 collective wastewater treatment plants,

Table 5. Collective wastewater treatment plants in the Ryki District

Commune	Capacity [m ³ /d]
Dęblin	6000
Ryki	3607
Kłoczew	140
Nowodwór	60
Stężyca	-
Ułęż	12

their total capacity was the greatest from all the other districts and amounted up to 9819 m³/d. In 2016, the Biała Podlaska District was the one with the greatest number of collective wastewater treatment plants that amounted up to 20 objects with a total capacity of more than 6805 m³/d [Jóźwiakowska and Marzec 2020].

Local systems of wastewater disposal

Rural areas are often characterized by dispersed building and on such areas it is not viable to develop joint sewage disposal systems. The National Urban Wastewater Treatment Programme (KPOŚK) states that the number of inhabitants per one kilometer of the wastewater network should exceed 120 people, so as to connect them to a collective wastewater system. Otherwise, this would enforce huge length of the network and the inhabitants would be forced to pay a lot for the sewage connection. The households that have no access to the sewage network discharge wastewater to non-return tanks or invest in own household wastewater treatment plants.

Septic tanks that hold sewage which is then delivered to the collective wastewater treatment plants are popular in rural areas and they have been used for many years. However, this solution

Table 6. The comparison of collective wastewater treatment plants in selected districts of the Lublin Voivodeship

District	Number of collective wastewater treatment plants	Total capacity [m ³ /d]
Ryki	5	9819
Parczew	12	3398
Radzyń	8	5305
Bialski	20	6805

occurs to be expensive in operation [Karolinczak et al. 2015]. Unfortunately, research shows that septic tanks are often made of old materials; this is why they do not provide full tightness and pose a serious threat to the quality of groundwater and soil environment [Nowak 2012]. On the basis of the data obtained during the conducted surveys, it was found that in 2016, 2450 septic tanks were functioning in the Ryki Commune, about 2000 in the Kłoczew Commune and 570 in the Nowodwór Commune. There is still a huge need in the discussed district to develop the ecological awareness of the inhabitants and to replace septic tanks with household wastewater treatment plants providing good effects of sewage purification [Józwiakowski et al. 2015]. The amount of septic tanks in the Parczew District also located in the Lublin Voivodeship was much smaller and above 3300 such objects were found there [Micek et al. 2018]. Even fewer septic tanks were identified in the Bialski District – only 1662 facilities [Józwiakowska and Marzec 2020].

Household wastewater treatment plants seem to be a better solution to cope with sewage in the same place where it is produced. There are many different types of such small objects but their capacity is always less than 5 m³/d [Water Law 2017 with further changes]. The type of a household wastewater treatment plant used in every situation is chosen on the basis of many factors, such as land availability, number of people in a household, technological reliability and also

an economic aspect [Mucha and Mikosz 2009, Józwiakowski et al. 2015]. There are many different types of small wastewater treatment plants, such as: settling tank with drainage system, settling tank with sand filter, container objects with activated sludge or biological bed and constructed wetlands [Pawełek and Bugajski 2017]. According to the data collected in the survey in 2016, only 3 out of 6 communes of the Ryki District recorded the number and types of household wastewater treatment plants. In the rural Kłoczew Commune, only one hybrid household wastewater treatment plant was identified, it combined the method of activated sludge and biological bed. In the Nowodwór Commune, 12 objects with drainage systems and also 221 facilities with activated sludge and 13 constructed wetland wastewater treatment plants were found. Moreover, in the Ułęż Commune, 9 drainage systems and 185 facilities with activated sludge were identified. Generally, it was shown that the activated sludge method was the most popular type of all the household wastewater treatment plants in the Ryki District. The share of selected small wastewater treatment plants in the discussed area was shown in figure 5. The overwhelming majority of the household wastewater treatment plants in the discussed district were activated sludge systems (92%). There were also some objects containing settling tank and drainage systems (4.8%).

While comparing the discussed area with other districts in the same voivodeship, it was

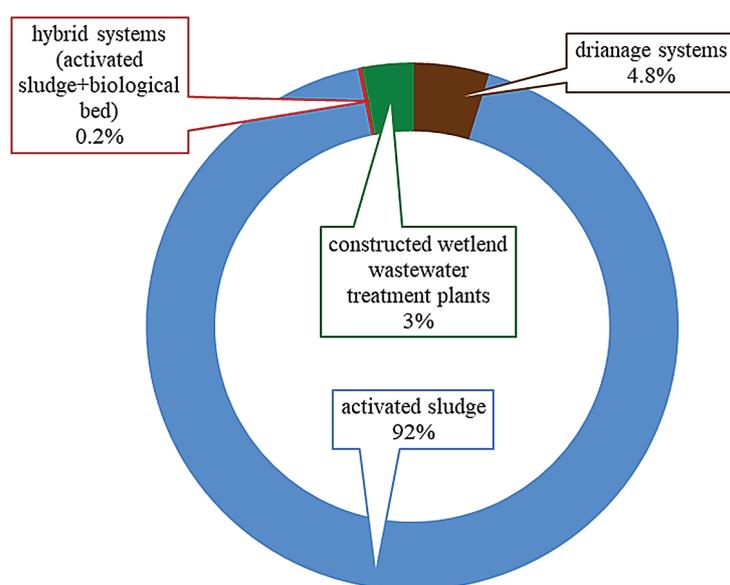


Fig. 5. Types of household wastewater treatment plants in the Ryki District

observed that for example, primarily drainage systems were found in the Biała Podlaska District – above 75% of all the small wastewater treatment plants [Józwiakowska and Marzec 2020]. The similar situation was found in the Parczew District, where in 2016 all the existing household wastewater treatment plants were the systems consisting of a settling tank and infiltration drainage [Micek et al. 2018]. However, in the Radzyń District, conventional biological wastewater treatment plants played in 2016 a significant role [Bogusz et al. 2020]. According to many authors, greater emphasis should be placed on promoting different solutions of highly-effective domestic wastewater treatment. There still seems to be a strong need to implement constructed wetland systems, which are recommended for rural areas. Such facilities are based on natural processes, provide the best effects of sewage purification and their operation is nearly costless [Dębska et al. 2015; Gajewska et al. 2015; Józwiakowski et al. 2015; Gizińska-Górna et al. 2016; Józwiakowski et al. 2017; Jucherski et al. 2017].

Acknowledgements

Publication was funded by the Polish National Agency for Academic Exchange under the International Academic Partnerships Programme from the project “Organization of the 9th International Scientific and Technical Conference entitled Environmental Engineering, Photogrammetry, Geoinformatics – Modern Technologies and Development Perspectives”.

CONCLUSIONS

1. The state of the sanitary infrastructure within the area of the Ryki District was not satisfactory in 2016 and this may exert a strong influence on the natural environment.
2. A huge disproportion between the development state of the sewage system and the water supply network was observed. In 2016, the length of the sewage network constituted only about 18% of the water supply network.
3. In the analyzed Ryki District, on average 71% of all the inhabitants were connected to water supply network and about 42% used joint sewage system. The rural Commune Ułęż was the one with the best developed water supply

network, where all the people had access to fresh water. However, the percentage of the inhabitants connected to the sewage system was the highest in the urban Dęblin Commune and amounted up to 89.6%.

4. The amount of collective wastewater treatment plants in the whole Ryki District reached 5 objects in 2016 and their total capacity was 9818 m³/d. Almost every commune had its own collective wastewater treatment plant, only the rural Commune Steżyca was connected to the huge object (capacity 6000 m³/d) located in Dęblin. In comparison with some other districts located also in the Lublin Voivodeship, the Ryki District was the one with the smallest amount of collective wastewater treatment plants.
5. On the basis of the obtained data, it was found that in 2016 above 5000 septic tanks functioned in the Ryki District. There is still a huge need in the discussed district to develop the ecological awareness of the inhabitants and to replace septic tanks with household wastewater treatment plants providing good effects of sewage purification.
6. The conducted research showed that in 2016 more than 440 household wastewater treatment plants existed in the whole Ryki District. The overwhelming majority of the household wastewater treatment plants in the discussed district were activated sludge systems (92%).
7. The research carried out in 2016 proved a strong need to develop the current state of the sanitary infrastructure in the Ryki District. A particular emphasis should be placed on the wastewater management by connecting inhabitants of urban areas to joint sewage disposal system. Ecological awareness must be raised so as to encourage people to invest in household wastewater treatment plants which should be used in the areas with scattered development.

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