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

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ABSTRACT

The aim of this paper is to present the current state and the need for development of sanitary infrastructure in the communes of Parczew District, in Lublin Voivodeship. Parczew District encompasses seven communes: Parczew, Dębowa Kłoda, Jabłoń, Milanów, Podedwórze, Siemień, and Sosnowica. The present paper uses the data from the surveys conducted in these communes in 2016. On average, 88% of the population used the water supply system in the communes surveyed, while 48% of the inhabitants were connected to a sewerage system. Parczew District had 12 collective mechanical and biological wastewater treatment plants with a capacity exceeding 5 m^3/d. The households which were not connected to the sewerage network discharged the wastewater mainly to non-return tanks. In the communes surveyed, 1,115 households had domestic wastewater treatment plants. All of them were systems with infiltration drainage, which do not ensure high efficiency of removing pollutions and may even contribute to the degradation of the groundwater quality. In order to solve the existing problems of sewage and water management in the communes of Parczew District, it is necessary to further develop the collective sewerage systems and equip the areas which have a dispersed development layout with highly efficient domestic treatment plants, such as constructed wetlands.

Keywords: sanitary infrastructure; commune; water supply system; sewerage system; wastewater treatment plant; septic tank

INTRODUCTION

After joining the European Union, Poland has undertaken to comply with the legal provisions regarding the sound management and protection of water. The changes that had to be introduced into the national law and the need to adjust this law to the requirements of the Water Framework Directive 2000/60/EC of 23 October 2000, as well as the Council Directive 91/271/EEC of 21 May 1991 concerning urban wastewater treatment, prompted local government bodies to take actions aimed at developing the water and sewerage infrastructure [Jóźwiakowski and Pytka 2010]. For this reason, in recent years there has been a significant increase in the investments into building water supply and sewage removal systems in urban and rural areas. This increase has been connected not only with the requirements of environmental protection, but above all with the better possibilities of financing the investments with the EU funds. In addition to the ecological and economic effects, the development of the technical and sanitary infrastructure brings many benefits of a social and economic nature, as it contributes to improving the living conditions of the inhabitants and the development of entrepreneurship.

The statistical data show that the length of the water supply and sewerage systems as well as the number of water supply and sewage disposal facilities in Poland have significantly grown in the recent years. The length of the water sup-

ply system increased from 245,600 km in 2005 to 301,000 km in 2016. In rural areas, the increase was from 190,700 km to 233,200 km, and the number of households connected to the system grew by 25.3%. In the period of 2005–2016, the length of the sewerage network increased by 73,900 km (92.2%), reaching 154,000 km in 2016. In rural areas, the length of the sewerage network increased by 53,600 km (146%). The increase was larger than in cities, where 20,300 km of new pipelines were laid (an increase by 46.8%) [GUS 2017a].

In 2016, almost 91.9% of the total population used the water supply network (a 5.8% increase compared to 2005). In urban areas, over 95.5% of inhabitants had access to a water supply system (an increase of 1.2% compared to 2005). In rural areas, the proportion of people using the water supply network in 2016 was 85%. As far as the sewerage systems are concerned, in the period of 2005–2016, the percentage of people having access to a sanitation network increased from 59.2% to 70.2% (an 11.0% increase). In cities, 90.0% of the population used the sewage system (a 5.2% increase), whereas in rural areas, the proportion was 40.3% (a 21.5% increase) [GUS 2017a].

In 2016, there were 3,319 collective sewage treatment plants in Poland, including 763 facilities located in cities and towns, and 2,556 in the countryside [GUS 2017b]. In villages with dispersed housing, wastewater was discharged into non-return tanks or domestic wastewater treatment plants. In 2016, there were 2,333,000 such facilities, out of which about 91% were non-return tanks, and about 9% were domestic wastewater treatment plants. For several years now, a systematic decrease in the number of non-return tanks has been observed, while the number of domestic sewage treatment plants has been on the increase. In 2016, the number of non-return tanks was 2,117,000, whereas the number of domestic wastewater treatment plants amounted to 217,000 [GUS 2017a].

These data show that after the Poland's accession to the European Union, the increase in water and sewerage infrastructure investments in towns and villages was much larger than in the early 1990s [Jóźwiakowski and Pytka 2010]. Nevertheless, there are still great disproportions among Polish cities and villages regarding the access to water supply and sewage removal systems. These disparities are most prominent in rural areas.

The aim of the present study was to evaluate the state of the development pertaining to the sanitary infrastructure and the need for expanding this infrastructure in Parczew District (county), which constitutes one of the 24 districts of Lublin Voivodeship. The analyses were carried out using the official statistical data and the results of surveys conducted in 2016 in seven communes of Parczew District by the employees of the Department of Environmental Engineering and Geodesy of the University of Life Sciences in Lublin. The surveys identified the percentage of the population having access to public water supply and sanitation systems and the number of non-return tanks as well as collective and domestic wastewater treatment plants.

CHARACTERISTICS OF THE PARCZEW DISTRICT

Parczew District is located in the north-eastern part of Lublin Voivodeship and occupies an area of 952 km^2, i.e. 3.8% of the area of the province (Figure 1). The district is inhabited by 36,147 people, who constitute 1.7% of the province's population. It borders with the districts of Lubartów, Radzyń, Biała Podlaska, Włodawa, and Łęczna. The following communes belong to Parczew District: Parczew, Milanów, Jabłoń, Podedwórze, Siemień, Dębowa Kłoda, andi Sosnowica (Figure 2) [SYNERGIA. Advisory Office, 2013]. The largest area is occupied by Dębowa Kłoda Commune, whereas the smallest by Podedwórze (Table 1). The population density in the county varies over a very wide range from 16 people/km^2 in the communes of Podedwórze and Sosnowica to 101 people/km^2 in Parczew Commune (Table 1).

In terms of the physical-and-geographical units, Parczew District extends over the area of three regions of the Western Polesie macroregion: Równina Parczewska (the Parczew Plain, north-eastern part of the district), Pojezierze Łęczyńsko-Włodawskie (the Łęczna-Włodawa Lake District, southern part of the district) and Garb Włodawski (the Włodawa Elevation, between the Parczew Plain and the Łęczna-Włodawa Lake District) [SYNERGY. Advisory Office, 2013].

Parczew District is a typically agricultural area, which, at the same time, uses its landscape and natural resources to create a welcoming environment for tourism and leisure activities. The agricultural land constitutes about 67% of the total area of the district; about 26% of the district

Fig. 1. Geographical location of Parczew District

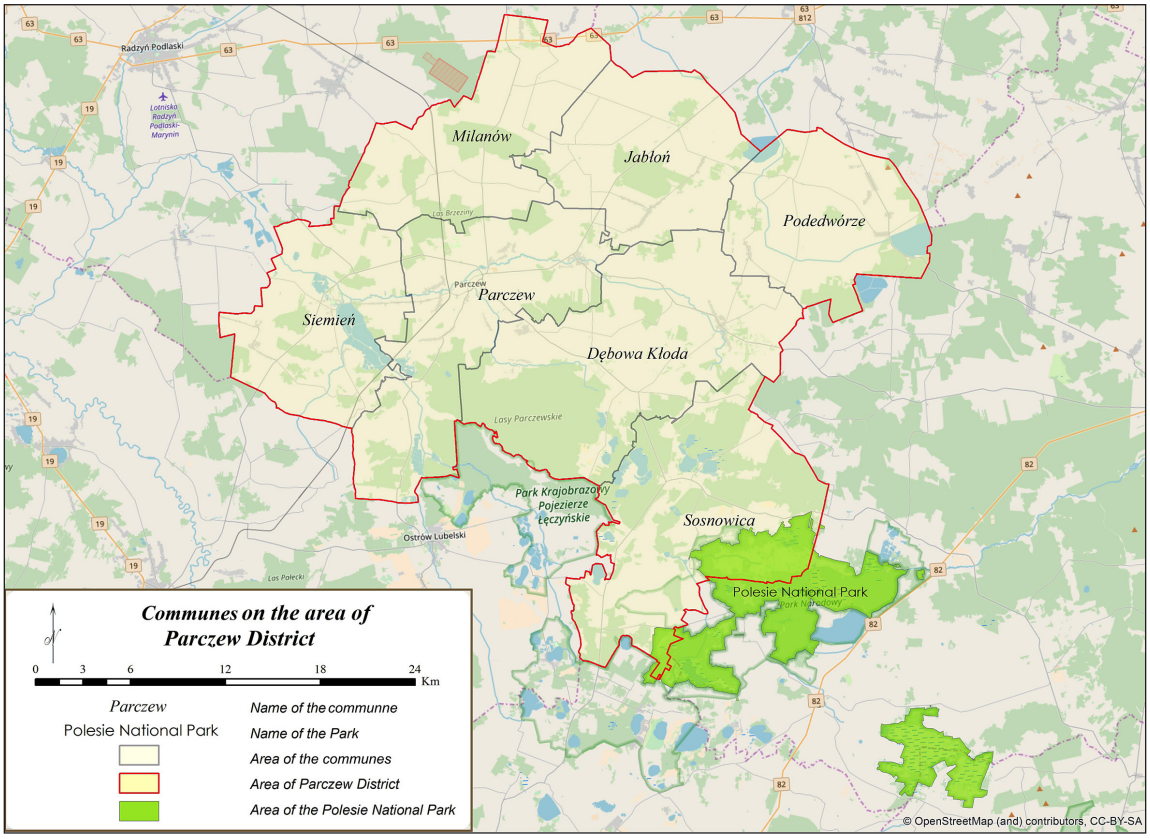

Fig. 2. The communes of Parczew District

Table 1. Characteristics of the communes of Parczew District

Name of commune	Area [km^2]	Population	Population density [people/km^2]	Proportion of district area occupied by the commune [%]
Parczew	147	14 860	101	15.42
Dębowa Kłoda	188	4009	21	19.72
Jabłoń	110	3947	36	11.54
Milanów	117	4052	35	12.27
Podedwórze	107	1749	16	11.22
Siemień	111	4802	43	11.64
Sosnowica	171	2728	16	17.94

[SYNERGY. Advisory Office, 2013]

is occupied by woodlands, which are considered to be a touristically valuable element of the landscape and ecosystem. The district's varied soil types (quality-wise) provide a basis for growing not only cereals, but, increasingly often, also herbs (chamomile, mint, valerian). The prevailing soil valuation classes are arable land (63%) and permanent grasslands (30%) [US Lublin 2017].

Parczew District boasts many highly valuable natural features. The most important of them is part of the Polesie National Park, along with the surrounding areas, covering vast stretches of meadows, forest tundra and peat bogs, a group of ponds in Siemień, retention reservoirs in the Podedwórze commune and the Parczew Forests (Lasy Parczewskie) complex. Unfortunately, many valuable boggy ecosystems and peat bogs have been destroyed as a result of large-scale water drainage interventions carried out in the recent decades [SYNERGY. Advisory Office, 2013].

Because of its landscape and natural heritage, a significant part of Parczew District has been placed under legal protection. No new investments which might pose threat to the natural environment can be made in such areas. All human interference is legally prohibited to protect the valuable natural features. The most important forms of nature conservation are the Polesie National Park, the Polesie Landscape Park, and the Polesie Area of Protected Landscape. In addition, there are six nature reserves in the district (Czarny Las, Lasy Parczewskie, Warzewo, Królowa Droga, Jezioro Obradowskie, and Torfowisko przy Jeziorze Czarnym), as well as 44 natural monuments. After the Poland's accession to the European Union, numerous parts of Parczew District have been incorporated into the Natura 2000 European network of protected areas [SYNERGIA. Advisory Office, 2013].

The clean environment and the little-changed landscape of Parczew District provide favorable conditions for the development of tourism and recreation as well as the production of healthy food. Apart from enjoying the natural assets of the district, tourists can also visit some historical buildings, including churches, manor houses and palaces as well as former Uniate Orthodox churches [http1].

In order to keep the district's natural environment, with its numerous conservation areas and tourist attractions, in good shape, it is necessary to invest in the water supply and sewage removal infrastructure [Kaczor et al. 2015; Jóźwiakowski et al. 2017a].

The development strategy update for Parczew District for the years 2014–2020 defines the following objectives and priority environmental actions:

- reduction of emissions of harmful substances and energy,
- protection of natural environment and landscape resources,
- sound management of the environment,
- increasing the civic activity and the environmental awareness of the society [SYNERGY. Advisory Office, 2013].

RESULTS AND DISCUSION

The condition of sanitary infrastructure in Parczew District was analyzed on the basis of results obtained from the surveys carried out in each commune of the district in 2016. The surveys covered the following issues: length of the water supply and sewerage network in a commune, number and capacity of collective wastewater treatment plants of over 5 m^3/d, number of domestic wastewater treatment plants by type of technological design used. The survey data were supplemented with official statistics.

WATER SUPPLY AND SEWAGE REMOVAL SYSTEMS

The status of the sanitary infrastructure depends on the length of the water and sewerage network, and, to a greater extent, on the percentage of residents who are connected to this network. In this respect, the water supply system in Parczew District is quite well developed. The total length of the water supply network in 2016 was 630 km and constituted about 2.9% of the length of the water supply network in Lublin Voivodeship. The proportion of people using the network exceeded 87% (Figure 3). The longest water supply network was that of the Siemień commune (126.7 km); it supplied water to 4,550 people, who represented approximately 95.5% of the commune's population. A similarly high percentage of the population had access to the collective water supply system in the communities of Milanów (98.3%) and Podedwórze (93.3%); however, the water supply networks in those administrative areas were substantially shorter, at 82.2 km and 60 km, respectively (Fig. 4). This was mainly due to the smaller population of these communes and a greater concentration of settlements. The second longest water supply network was that in the urban-rural Parczew Commune (100.1 km). Because of the urban character of Parczew Commune and its compact development layout, this network provided water to nearly 13,000 people, or approximately 86.4% of the commune's population. In the communes of Dębowa Kłoda and Jabłoń, the length of the water supply network in 2016 was approx. 90 km, which allowed water to be supplied to 85.3% and 86.1% of the inhabitants of these communes, respectively. In Sosnowica Commune, the length of the water supply network was 77.8 km, but it supplied water to only 60% of the inhabitants, a percentage that was very low and significantly deviated from the average for the entire district (Figure 3).

The condition (extent) of sewerage infrastructure in Parczew District was much worse than that of the water supply network. The survey showed that there was a very large disproportion between the development of the sanitation and water supply systems (Figures 3 and 4).

The total length of the sewage network in the district was 164.4 km in 2016, which constituted only 26.1% of the length of the water supply network. This meant that an average of 48.2% of the commune's population was connected to a sewage removal system. Most of the people who used the collective sewage removal systems came from the urban-rural Parczew Commune, which is inhabited by over 40% of the district's population and provides good access to sanitation services (Figure 3). In this commune, a 76.3 km long sanitation system collected the sewage from over 12,300 people (88.3% of the population of the commune). In other communes of the district, the situation was less favorable. In the communes of Siemień, Sosnowica, Dębowa Kłoda, and Jabłoń, the percentage of inhabitants discharging wastewater to the sewerage systems fluctuated within a quite narrow range from 26.8% to 32.8%. The length of the sewerage network in each of these communes was approx. 12–15 km, with the exception of Siemień Commune, in which it exceeded 32 km (Figure 4). This may indicate that Siemień has a more dispersed development pat-

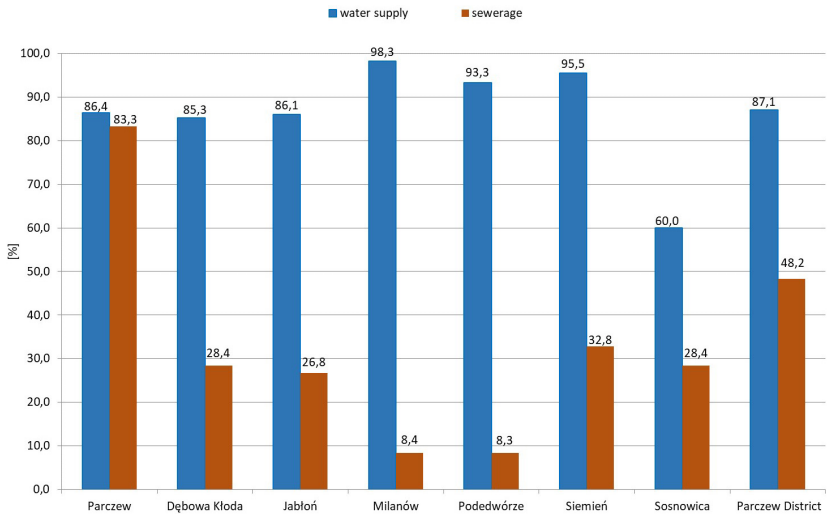

Fig. 3. Percentage of residents of Parczew District with access to the sanitary infrastructure in 2016

tern, requiring a larger scale of investment to meet the needs of a specific group of residents. A similar situation was found in Milanów Commune, in which the sewerage network was not particularly shorter than in the communes mentioned above (12.6 km), yet it served only 8.4% of residents. The lowest percentage of users of collective sewage disposal systems was recorded in Podedwórze Commune (8.3%), which still seems to be a good result, taking into account that the length of the sewerage network in that commune in 2016 was only 0.5 km (Figure 4) .

The data presented above point to some unfavorable phenomena regarding the development of the sewerage network in Parczew District, including the very large disproportion between the length of this network in relation to the length of the water supply network and lower than average (for Lublin voivodeship – about 57% in 2016) percentage of population using the collective sewage disposal and treatment systems. These problems have many causes, including the environmental, social, technical and, above all, economic ones. The sewerage network is strictly dependent for its development on the existence of a water supply system. It is also characterised by a greater technical complexity and capital intensity of investment compared to the latter type of system [US in Lublin 2017]. In addition, in rural communes, especially in their peripheral parts, where the population or economic activity are not sufficiently concentrated, it is difficult to find justification for constructing sewerage systems; hence, the dominant role of scattered systems consisting of domestic sewage treatment plants or non-return tanks (cesspools). An equally important factor affecting the rate and scale of sewerage investments are the financial capacities of the individual communes and local public utility companies.

COLLECTIVE AND DOMESTIC WASTEWATER TREATMENT PLANTS

The survey conducted in 2016 shows that 12 collective wastewater treatment plants with a capacity of more than 5 $m^3 \cdot d^{-1}$ operated in Parczew District at that time. They were all biological treatment plants. The largest plant was located in the urban-rural Parczew Commune and served mainly the area of Parczew Town. The facility had been designed to treat about 2,400 m^3 of sewage per day (as of 2016). At present, the plant is undergoing a thorough modernization, the aim of which is to improve the efficiency of the wastewater treatment and reduce the consumption of the energy used in the process. Larger facilities, with a capacity of over 100 m^3/d, are located in the communes of Milanów, Jabłoń, Siemień and Sosnowica (Table 2).

The capacity of the remaining facilities did not exceed 70 m^3/d. The structure and operation of collective wastewater treatment plants are closely related to the existence of collective sewerage networks, which is why they are most often located in the settlements with the highest concentration of population, where the construction of the network is justified. The only exception includes the facilities intended for neutralization of the sewage coming from non-return tanks, which is brought to the sewage treatment plant by gully emptiers. An example of a wastewater

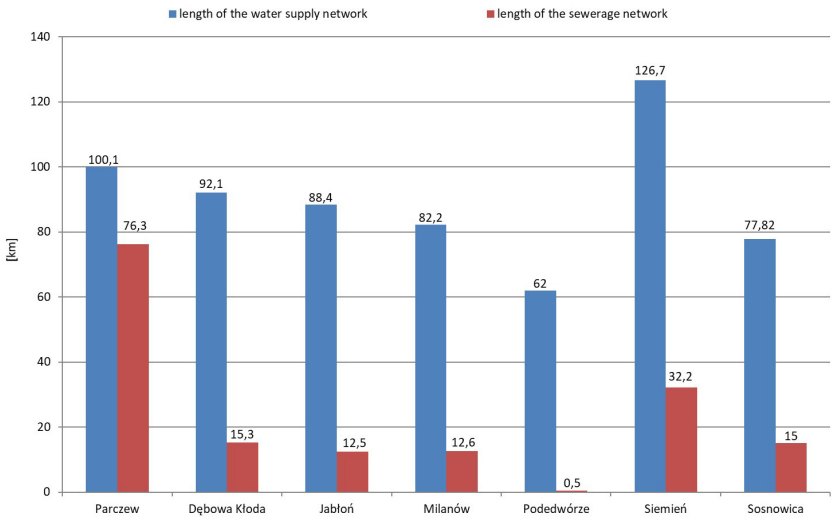

Fig. 4. The length of the water supply and sewerage network in Parczew District in 2016

Table 2. Collective wastewater treatment plants with a capacity of more than 5 m^3/d in the communes of Parczew District

Name of treatment plant (commune)	Capacity [m^3/d]
Parczew (Parczew)	2400
Leitnie (Dębowa Kłoda)	70
Wyhalew (Dębowa Kłoda)	25
Uhnin (Dębowa Kłoda)	70
Jabłoń (Jabłoń)	193
Kalinka (Jabłoń)	60
Milanów (Milanów)	220
Nowe Mosty (Podedwórze)	30
Siemień (Siemień)	120
Sosnowica (Sosnowica)	120
Zienki (Sosnowica)	60
Turno (Sosnowica)	30

neutralization plant in Parczew District, is the treatment plant in the village of Leitnie (Dębowa Kłoda Commune).

According to the National Municipal Wastewater Treatment Program (NPMWW), the construction of a centralized (collective) sewerage system is justified when there are no fewer than 120 inhabitants per kilometer of sewerage network (excluding the sewer laterals). This means that the unit length of the sewerage network should not exceed about 8 m/inhab. [Heidrich and Stańko 2008; AKPOŚK 2010]. Many settlements in rural areas do not meet this criterion, and, therefore, the use of domestic sewage disposal systems is recommended for those places. The non-return tanks are the most commonly used domestic sewage disposal systems, mainly due to the low investment costs. Because many of them are inaccurately built and used beyond their useful life, they do not provide adequate tightness, with some of the contaminants migrating into the ground and groundwater. According to the survey data, in 2016, there were 3,331 operating non-return tanks in Parczew District. Unfortunately, the data cover only four of the district's seven communes. The largest numbers of tanks were recorded in the communes of Dębowa Kłoda (1,702) and Parczew (1,028).

An alternative to non-return tanks are domestic wastewater treatment plants. They are by far cheaper in use than cesspools, which is why more and more of them are built every year [Karolinczak et al. 2015]. The term 'domestic wastewater treatment plant' is not officially recognized by the existing Polish legal acts. The Polish PN-EN 12566–3:2016–10 Standard [2016] defines domestic wastewater treatment plants as the facilities that can be used to serve up to 50 inhabitants. Pursuant to the Water Law Act [2001], the limit capacity of this type of facilities is 5m^3/d, while the Construction Law [2003] sets the limit at 7.5 m^3/d. They are built as two-stage facilities, consisting of a mechanical and a biological waste removal stage [Pawęska et al. 2011].

The following technological systems can be used in domestic wastewater treatment plants [Pawełek and Bugajski 2017]:

- a septic tank with infiltration drainage,
- a septic tank with a sand filter,
- a containerized mobile wastewater treatment plant with activated sludge,
- a containerized mobile wastewater treatment plant with biological bed
- constructed wetlands

While choosing a domestic wastewater treatment plant, one should pay special attention to its reliability as well as the ecological and technical properties, and be less concerned with the economic aspects of the investment [Mucha & Mikosz 2009, Jóźwiakowski et al. 2015]. Unfortunately, in practice, the investment costs are the basic criterion for selecting a wastewater treatment technology, which means the largest number of domestic wastewater treatment plants are the cheapest structures that do not provide sufficient cleaning efficiency.

In 2016, Parczew District had 1,115 domestic sewage treatment plants. The largest numbers of domestic facilities were found in the communes of Siemień (422 plants), Podedwórze (322 plants), and Jabłoń (229 plants). In each of the remaining communes, there were fewer than fifty domestic sewage treatment plants (Figure 5).

Considering the large number of non-return tanks, a significant part of which can potentially be replaced by domestic wastewater treatment plants, the possibilities of developing this form of sewage disposal are still very large. All domestic wastewater treatment plants operating in Parczew District use a technological system with a septic tank and infiltration drainage, which is highly undesirable. According to many authors, the drainage treatment plants should not be approved for common use, because they do not allow to control the quality of treated sewage, and discharge of mechanically treated wastewater to the soil and water environment can cause its degradation

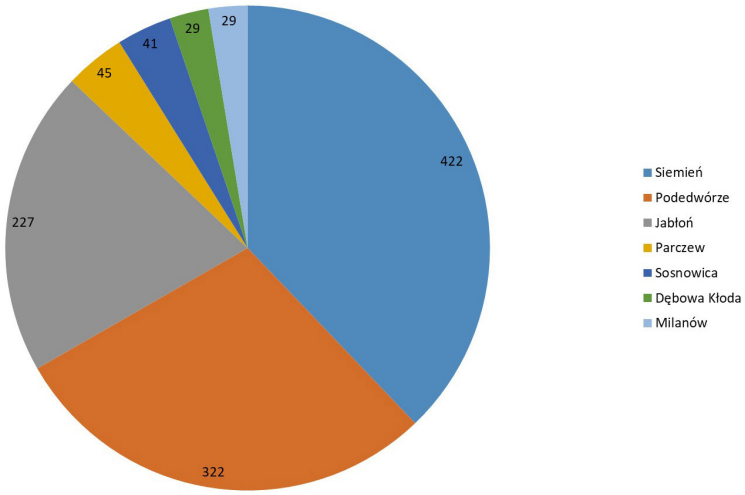

Fig. 5. Number of domestic sewage treatment plants in the communes of Parczew District in 2016

[Jucherski and Walczowski 2001; Jóźwiakowski et al. 2014; Pawełek and Bugajski 2017]. Therefore, emphasis should be placed on promoting and implementing solutions that are most beneficial for the environment, thus minimizing the possibility of environmental pollution. In this context, the possibility of using constructed wetlands, which are highly reliable and efficient in removing contaminants from sewage, should be mentioned [Dębska et al. 2015; Gajewska et al. 2015; Jóźwiakowski et al. 2015; Gizińska et al. 2016; Jóźwiakowski et al. 2017b; Jóźwiakowski et al. 2018; Jucherski et al. 2017].

CONCLUSIONS

1. The water supply system in the district of Parczew is quite well developed, both in terms of the length of the water supply pipelines (630 km), and the proportion of inhabitants using the network (over 87%).
2. Compared to the water supply infrastructure, the sanitation infrastructure is being developed very slowly. There are very large disparities between the two systems. The length of the water supply network exceeds the length of the sewerage network almost four times.
3. Large differences in access to the sewerage network were found between the urban-rural commune of Parczew and the remaining communes of the district.
4. In 2016, twelve collective wastewater treatment plants with a total capacity of approximately 3400 m^3/d operated in the district.
5. In the communes of Parczew District which were not connected to a collective sewerage system, wastewater was discharged into septic tanks or transported by gully emptiers to collective wastewater treatment plants.
6. The network of domestic wastewater treatment plants in Parczew District is made up entirely of systems with infiltration drainage, which may pose a serious threat to the soil and water environment.
7. The condition of the sewerage infrastructure in Parczew District, especially in the rural communes, is unsatisfactory and requires the investment activities aimed at expanding and modernizing the existing collective sewage disposal and treatment systems as well as developing a network of reliable, high-efficiency domestic wastewater treatment plants.

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