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PRELIMINARY ANALYSIS OF SEWAGE MANAGEMENT IN SOKÓLSKI DISTRICT

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Abstract

Rural areas, similar with the amount of produced sewage to urban areas, are rarely parts of agglomerations. Because of dispersed buildings and often poor infrastructure, sewage management regulation in rural areas can be difficult. Caring for the environment include aquatic environment protection. Sewage economy regulations, especially in rural areas, is a key issue in water contaminations counteracting. Often inappropriate sewage disposal and treatment methods choice could cause ecological imbalance and water pollution as the result.

The aim of this paper was to evaluate water and sewage economy development in Sokólski District in Poland. In the study were used Central Statistical Office of Poland data from 2008–2016. There was considered cesspit and household sewage treatment plants amount and water and wastewater systems length. Also, sewage systems built in recent years and planned in the analysed area were considered.

In recent years reducing trend in a number of cesspits was observed. In 2008–2016 there was an increase in a number of household sewage treatment plants by 919 and about 50 kilometres of the sewage system, while there were 400 cesspits less.

Keywords: Cesspit; concentration ratio of sewage system; household sewage treatment plant; sewage system.

1. INTRODUCTION

Water and wastewater management in Poland is characterized by a large disproportion between water supply and wastewater discharge systems coverage. In 2016 waterworks length reached almost 301 000 kilometres, while sewage systems length was just over 154 000 kilometres [1].

Sewage system, as one of the most expensive infrastructure component, requires precise technical and economic analysis. Properly planned sewage management, beside avoiding unnecessary expense, could allow protecting the environment against pollution, especially in relation to surface water. In 2010–2016 over 93% of surface waters in Poland were characterized by bad condition [2]. According to Polish Water Law [19] agglomeration is an area, where population or economic activity are enough focused to gather and transfer sewage to the sewage treatment plant or other wastewater discharge. Furthermore, agglomeration over 2000 population equivalent should be equipped with sewage systems for municipal wastewater [8]. Therefore, it was established, that wastewater systems coverage should not be less than 95% and population not connected with the sewage system ought to use other wastewater treatment systems providing same environment protection level [19]. In turn, concentration ratio (population per 1 kilometre of newly built sewage system) should not be less than 120, although investment should be economic and technical reasonable [13]. Planning wastewater systems need to be based on the principles of sustainable development, and therefore consider political, economic and social aspects in accordance with environment balance and sustainability of fundamental natural processes [20].

However, rural areas, similar to the produced sewage amount to the urban areas, are very rarely part of the agglomerations. The wastewater management regulation in rural areas is, therefore, a big challenge. As can be seen in Fig. 1, rural areas produce almost half of the sewage in Poland. The septic tanks, often old and in poor technical condition, are still predominant there [9].



Planning sewage systems in rural areas is complex, mainly due to the dispersed development, varied land falls and sewage receiver location. To the difficulties we can also include demographic development, often observed abandonment of the countryside, which can increase sewage systems operating costs [12].

The average population per one kilometre for the Podlaskie Voivodship reached 175 in 2016, while in 2008 there were 245 people per one kilometre of the sewage system. A similar tendency in decreasing concentration ratio is observed in particular districts and communes of Podlaskie Voivodeship. In 2008-2016, the average population per one kilometre in Sokólski district declined from 200 to 151 people per one kilometre [1].

2. DESCRIPTION OF THE RESEARCH AREA

Water and wastewater management in Sokólski Disctict in Poland was analysed (Fig. 2). There were chosen two communes vary in area and population. The study was based on the Central Statistical Office's Local Data Bank and information from communes' bureaus.



Location of Nowy Dwór and Dąbrowa Białostocka communes in Sokólski District [3]

2.1. Nowy Dwór Commune

The Nowy Dwór Commune is in the eastern, borderland part of the Podlasie Voivodeship, in the Sokólski District. It is a typical rural commune in which only four out of 19 village councils have a population of over 200. At 2875 inhabitants, only 23.1% of them had access to the sewage system (data for 2015). Most of the sewage is discharged into cesspits, the number of which is amounted to 171 in 2016 [11]. The commune is not an agglomeration as defined in the Water Law [19].

2.2. Dąbrowa Białostocka Commune

The Dąbrowa Białostocka Commune, with an area of 264 km², is in the central-eastern part of the Podlasie Voivodeship, in the northern part of the Sokólski District. The administrative and economic centre is the city of Dąbrowa Białostocka. In 2015, the sewage system was 86.6% (urban area), 4.7% (rural area) and 44.1% in total [10]. Dąbrowa Białostocka Commune is an agglomeration according to the Water Law, with an equivalent of 10 502 inhabitants. [18, 19].

3. WATER AND WASTEWATER MANAGE-MENT IN 2008–2016

3.1. Waterworks

Urban area sewage system length in Dąbrowa Białostocka Commune has slightly risen from 23 to 24.1 km in 2008–2016, while in a rural area has increased from 210 to 228.5 km. In turn, Nowy Dwór Commune's waterworks length has changed from 104.4 km to 109.7 km. Considering territory area, waterworks density in analysed communes is similar. There is about 1 km of waterworks per 1 km² in the urban area of Dąbrowa Białostocka, and 0.9 km/km² in rural areas of Dąbrowa Białostocka and Nowy Dwór Communes.

Dąbrowa Białostocka and Nowy Dwór Communes' rural areas citizens are plugged into waterworks accordingly in 73.5% and 78.2% (2016). By contrast, the urban area of Dąbrowa Białostocka Commune has 96.9% of citizens are connected to the water system.

As shown in the Fig. 3 biggest increase in waterworks length in 2008–2016 was in Dąbrowa Białostocka Commune's rural area with 18.5 km. In Nowy Dwór Commune during the considered period there was only 1.1 km of waterworks more.

3.2. Sewage systems

The large disproportion between waterworks and sewage systems length is observed. On 1 kilometre of sewage systems there was about 1.5 km (2008) and 1.1 km (in 2016) of waterworks in Dąbrowa Białostocka Commune's urban area. In turn, in rural areas of Dąbrowa Białostocka and Nowy Dwór Communes there was adequately over 116.7 km (2008) and 126.9 km (2016), and 9.5 km in 2008 to 10 km in 2016.

While percentile of people using waterworks in analysed communes is about 97% (Dąbrowa Białostocka Commune's urban area – 2016) and 74% to 78% (rural areas of Dąbrowa Białostocka and Nowy Dwór Communes), percentile usage of sewage systems reached 87% in urban area, 23.4% in Dąbrowa Białostocka Commune's rural area, and barely 4.7% in Nowy Dwór Commune.

The first kilometres of the sewage system in the Nowy Dwór Commune were built at the beginning of the 1990s. However, the first inhabitants were not connected to the network till 2002, with a concentration ratio equal to 123 people per kilometre. The following year, the sewage system in the commune was enriched by 11 km, but as a result of this investment, less than 500 people were connected, so the concentration ratio reached only 45 people per 1 km of the sewage system. Currently on 1 kilometre of sewage system marks about 58 people. In 2016, 1 m³ of sewage discharging cost was 3.40 PLN, while in 2008 it was 2.20 PLN [15, 16].

Sewage system length amounting to 11 km and remained to this day, whereas in 2008–2016 there was



Waterworks length in Dabrowa Białostocka and Nowy Dwór Communes in 2008-2016 (own study based on [1])



Figure 4.

Sewage system length in 2008–2016 in Dąbrowa Białostocka and Nowy Dwór Communes (own study based on [1])

a decrease in a number of people using the system by 6. A similar trend in sewage system length can be observed in other communes' rural areas within Sokólski district, like Janów, Szudziałowo, and analysed Dąbrowa Białostocka. In the coming years, Nowy Dwór Commune is planning to expand the sewage system by 10 km in the villages of Plebanowice, Chworościany, and Kudrawka, in which lives total 342 inhabitants.

In 1993, Dąbrowa Białostocka Commune's first wastewater treatment plant was built. A municipal sewage system was connected to it, the length of which was 8.6 km. [5, 14].

The sewage system was being developed only in the urban areas of the Dabrowa Białostocka Commune, in subsequent years. In 2001, 4.2 km of sewage system was built. In 2004 it was 1 km more, while 12 new system users were plugged. Further investments in 2008 (+ 0.4 km), 2009 (+ 1.7 km), 2012 (+ 0.8 km) and 2014 (+ 4.8 km) also did not entail a significant increase in the number of people using sewage system (Fig. 4). On the contrary, in 2008–2016, the number of people using the system decreased by 237 people (urban areas), while a decrease in the number of inhabitants by 387 [10]. In addition, in the years 2008–2016, the cost of discharging 1 m³ of sewage increased from PLN 3.05 PLN to 5.10 PLN [4, 17]. However, the concentration ratios of both urban and rural areas of Dabrowa Białostocka Commune are higher than 120 pp km. According to the Dabrowa Białostocka Commune's Local Development Plan, in 2016-2020 it is planned to connect water and sewage systems with investment areas in Dąbrowa Białostocka [10].

Sewage systems in analysed communes are not so evenly distributed as waterworks, where a number of kilometres of the system to the area in km² ration was close to 1. Sewage systems density in urban area of Dąbrowa Białostocka Commune has risen from 0.68 in 2008 to 1.01 in 2016. Analysed ration in rural areas was much lower: 0.01 km/km² in Dąbrowa Białostocka Commune and 0.09 in Nowy Dwór Commune.

To access one citizen, it was needed from 6 m in 2008 to 6.3 m of sewage system in 2016 (rural area of Dąbrowa Białostocka Commune) and from 17.1 m in 2008 to 17.2 m in 2016 (Nowy Dwór Commune). In comparison, an average number of sewage system metres per capita has risen from 4.99 m to 6.49 m in Sokólski District.

3.3. Household sewage treatment plants and cesspits

Sewage management in Sokólski District's rural area is based on cesspits, which average amount reach 455 in 2016. About 60% of residents have cesspits, over 22% have household sewage treatment plants, and the rest is connected to the sewage system. By the contrast, urban area's sewage management relies on the sewage system – in 2016, 94% of people have access to the sewage system.

Nowy Dwór Commune's residents in the clear majority use cesspits (Fig. 5). In 2016, 23 houses used household sewage treatment plants (HSTP). The lowest participation in sewage management marks to HSTPs, which in 2016 was 23. In Nowy Dwór Commune on one HSTP there are over 7 cesspits in 2016, while in 2008 there was no household sewage treatment plant. However, for the years 2017–2020 the commune is planning to invest 1.5 million PLN in building new HSTPs [11].



Figure 5.



As in the case of Sokólski District's percentage use of sewage management systems, Dąbrowa Białostocka Commune's urban area is based on the sewage system, used by over 97% of residents.

In turn, high changing dynamic can be seen in rural area. As shown in the fig. 6, during 2008–2016 amount of people using HSTPs has risen to 57.3%, while percentage use of cesspits decreased to 40%. Moreover, a number of cesspits to number of HSTPs ratio changed from 15.6 in 2008 to 0.7 in 2016.



Figure 6.

Percentage use of sewage management systems in the rural area of Dąbrowa Białostocka Commune (own study based on [1])

4. CONCLUSIONS

The Podlaskie Voivodeship is characterized by a relatively low level of urbanization and industrialization. Likewise, water and sewage systems density are not evenly distributed within the districts, especially in rural areas. A significant difference between the percentage of citizens plugged into waterworks and sewage system consistent with the necessity of sustainability sewage management and developing systems, which can provide same environment protection level as sewage systems. However, changes caused by sewage management investments and programs supporting the developing of individual wastewater treatment systems can already be seen.

The development of the sewage system depends on a considerable extent on whether the commune is part of the agglomeration, where the KPOŚK Programme has introduced a minimum percentage of sewage (amounting to 95% for agglomerations with p.e. <100,000). The article presents two communes of the Sokólski District: Nowy Dwór (not forming an agglomeration) and Dąbrowa Białostocka (with an agglomeration of 10 502) [6, 7].

Nowy Dwór, as a typical village commune, has a low concentration ratio. Sewage management is based on cesspits and sparse household wastewater treatment plants. Also planned investments could not connect a large amount of people. Changes in sewage management are happening slowly, in contrast to Dąbrowa Białostocka Commune. This commune, as a part of agglomeration, is developing sewage systems in the urban area. Unfortunately, subsequent investments were characterized by low concentration ratio, much below 120 people per kilometre because of legal requirements. Progressive city and communes depopulation have a significant impact on sewage disposal costs.

In order to improve sewage management in the analysed area, a technical and economic analysis, taking into account sewage disposal and treatment of various systems, would be extremely useful. Such study would affect better planning further development of wastewater management. In particular, identification of areas where sewage system building would be economically unjustified would facilitate the implementation of subsidies system for individual sewage treatment systems (HSTPs).

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REFERENCES

- [1] GUS (2017). Bank Danych Lokalnych (Local Data Bank).
- [2] GUS (2017). Departament Badań Regionalnych i Środowiska. Ochrona Środowiska. Informacje i opracowania statystyczne (Regional and Environmental Surveys Department. Environment protection. Information and statistical information), Warszawa.
- [3] http://region.e-podlasie.pl [access: 22.02.2017 r.]
- [4] http://www.pgkim-dabrowa.pl/archiwum-2016/ [access: 25.04.2017 r.].
- [5] http://www.zkbiebrza.pl/index.php?id=110 [access: 22.04.2017 r.].
- [6] Informacje uzyskane z Urzędu Gminy w Dąbrowie Białostockiej (Information extracted from Municipal Office in Dąbrowa Białostocka).
- [7] Informacje uzyskane z Urzędu Gminy w Nowym Dworze (Information extracted from Municipal Office in Nowy Dwór).
- [8] KZGW (2017). Aktualizacja Krajowego programu oczyszczania ścieków komunalnych – AKPOŚK 2017. Załącznik 2: Wykaz aglomeracji oraz przedsięwzięć ujętych w AKPOŚK 2017 (Update of the National Municipal Sewage Treatment Program – AKPOŚK. Annex 2: List of agglomerations and ventures included in AKPOŚK 2017), Warszawa.
- [9] Najwyższa Izba Kontroli, Delegatura w Poznaniu (2012). Informacja o wynikach kontroli realizacji przez gminy województwa wielkopolskiego zadań z zakresu gospodarki ściekami bytowymi (National Audit Office, Regional Branch in Poznań (2012). Information about the results of control of the implementation by the Wielkopolska voivodeship's municipalities the tasks related to the domestic sewage management). Poznań, (LPO-4010-003/2011).
- [10] Plan Rozwoju Lokalnego Gminy Dąbrowa Białostocka na lata 2016–2020, Załącznik do Uchwały Nr XV/90/16 Rady Miejskiej w Dąbrowie Białostockiej z dnia 11 marca 2016 r. (Dąbrowa Białostocka Commune's Local Development Plan for the period 2016–2020, Annex to the Resolution XV/90/16 of Dąbrowa Białostocka City Council of 11 March 2016).
- [11] Plan Rozwoju Lokalnego Gminy Nowy Dwór na lata 2016 – 2020, Załącznik do uchwały nr XII/70/16 z dnia 26 lutego 2016 r. (Nowy Dwór Commune's Local Development Plan for the period 2016–2020, Annex to the Resolution XII/70/16 of 26 February 2016).

- [12] Rauba K. (2016). Metoda badania społecznej akceptowalności realizacji zbiorowego systemu odprowadzania i oczyszczania ścieków (Method of testing the social acceptance for the collective sewage collection and treatment system). *Ekonomia i Środowisko*, 2(57), 223–234.
- [13] Rozporządzenie Ministra Środowiska z dnia 22 lipca 2014 r. w sprawie sposobu wyznaczenia obszaru i granic aglomeracji (Regulation of the Environment Minister of 22 July 2014 on the method of determining the areas and borders of the agglomeration) (Dz. U. 2014 poz. 995).
- [14] Studium uwarunkowań i kierunków zagospodarowania przestrzennego miasta i Gminy Dąbrowa Białostocka, Załącznik do uchwały nr XXXVI-II/206/98 Rady Miejskiej w Dąbrowie Białostockiej z dnia 18.06.1998 r. (Dąbrowa Białostocka City's and Commune's study of conditions and directions of spatial development, Annex to the Regulation XXXVI-II/206/98 of Dąbrowa Białostocka City Council of 18 June 1998).
- [15] Uchwała Nr V/32/07 Rady Gminy Nowy Dwór z dnia 2 kwietnia 2007 r. (Municipal Council's of Nowy Dwór Regulation V/32/07 of 2 April 2007).
- [16] Uchwała Nr VIII/42/15 Rady Gminy Nowy Dwór z dnia 29 października 2015 r. (Municipal Council's of Nowy Dwór Regulation VIII/42/15 of 29 October 2015).
- [17] Uchwała Nr XII/87/08 Rady Miejskiej w Dąbrowie Białostockiej z dnia 29 stycznia 2008 r. (City Council's of Dąbrowa Białostocka Regulation XII/87/08 of 29 January 2008).
- [18] Uchwała nr XLV/535/14 Sejmiku Województwa Podlaskiego z dnia 6 listopada 2014 r. w sprawie wyznaczenia aglomeracji Dąbrowa Białostocka oraz likwidacji dotychczasowej aglomeracji (Sejmik of the Podlaskie Voivodeship Regulation XLV/535/14 of 6 November 2014 on the designation of Dąbrowa Białostocka's agglomeration and the liquidation of the existing agglomeration).
- [19] Ustawa z dnia 18 lipca 2001 r. Prawo wodne (Law of 18 July 2001. Water law) (Dz. U. 2001 nr 115 poz. 1229 z późn. zm.).
- [20] Ustawa z dnia 27 kwietnia 2001 r. Prawo ochrony środowiska (Law of 27 April 2001. Environment protection law) (Dz. U. 2001 nr 62 poz. 627 z późn. zm.).