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DOMESTIC WASTEWATER TREATMENT FACILITIES AS AN IMPORTANT COMPONENT OF THE WATER AND SEWAGE MANAGEMENT INFRASTRUCTURE IN RURAL AREAS

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ABSTRACT: The objective of the study has been to evaluate the current state of household wastewater and sewage discharge facilities available in rural areas, with special attention paid to domestic wastewater treatment plants. Considerable differences have been determined in the access to water and sewage management infrastructure in individual provinces in total and within rural areas. In the countryside, especially where houses are scattered, domestic wastewater treatment plants seem to be a good solution. By being a form of lasting investment, they can generate ecological and economic benefits over a longer period of time. The analyses showed a constant growth in the number of domestic wastewater treatment facilities, coinciding with a decrease in the number of septic tanks.

KEY WORDS: domestic wastewater treatment plants, infrastructure

Introduction and methodology

Scattered farmsteads are a serious obstacle to the development of sewage and wastewater management in rural areas. Building or extending sewage systems necessitates installing long sections of sewer pipes. Moreover, a considerable distance to the nearest wastewater treatment plant raises the costs due to both the length of a system and the need to install many pumps. This explains why local communities often decide against developing sewage systems, despite the available capacity of wastewater treatment plants, and continue to exploit decentralized infrastructure (septic tanks). High costs of maintaining and emptying the tanks are the reason why some people are tempted to dispose of sewage from households by spreading it onto arable fields. This causes pollution of surface and ground waters as well as soil.

A good solution to these problems is an on-site domestic wastewater treatment plant, which – by being a form of lasting investment – can generate ecological and economic benefits over a longer time. Wiśniewska-Kadzajon (2013), who analyzed costs of constructing and maintaining septic tanks versus domestic wastewater plants, concluded that while the cost of building a tank is lower than the cost of installing a household wastewater treatment facility, the costs of using a septic tank are considerably higher than the cost of maintaining a domestic WTP. An additional advantage of domestic wastewater treatment facilities lies in ecology. Household wastewater treatment plants must satisfy the legally required quality of treated sewage. More information on the efficiency of wastewater treatment in domestic WTP can be found in Wiśniewska-Kadzajon (2013) after Grygorczuk-Petersons.

The purpose of this study has been to make an evaluation of the rural areas in Poland in terms of household grey water and sewage disposal systems, and in particular domestic wastewater treatment facilities. The data originated from the Local Data Bank and covered the years 2008-2014. The statistical information was processed using basic mathematical calculations and statistical measures. The infrastructure and intensity per capita indices were computed and the dynamics of changes was analyzed using a fixed base index (data of 2008 were taken as 100%). For a more complete picture of the issue, the data for villages were compared with the analogous information for towns.

Changes in water and wastewater and sewage management in Poland in 2008-2014

Following Poland's access to the EU, the availability of EU funds has stimulated investment projects into water and sewage management. Since 2008, the share of the population with access to piped water and sewers has been on the increase (table 1).

Table 1. Share of population with access to sewerage and waterworks in Poland in 2008-2014 [%]

| Year | Town | | Village | | Total | |
|------|----------|------------|----------|------------|----------|------------|
| | sewerage | waterworks | sewerage | waterworks | sewerage | waterworks |
| 2008 | 85.8 | 95.6 | 22.4 | 73.7 | 61.0 | 87.0 |
| 2010 | 86.1 | 95.3 | 24.8 | 75.2 | 62.0 | 87.4 |
| 2012 | 87.0 | 95.4 | 29.4 | 76.2 | 64.3 | 87.9 |
| 2014 | 89.3 | 96.4 | 37.3 | 84.3 | 68.7 | 91.6 |

Source: developed from Local Data Bank information.

A more intensive growth has been observed in the share of the population having access to sewerage, which was due to certain backwardness of rural areas in this sphere in comparison to the supply of waterworks. More on this subject in Witkowska-Dąbrowska et al. (2015).

With respect to the total piped water network, the share of the Polish population with access to piped water at home has risen by nearly 5 per cent points since 2008, and the increase in the countryside was much higher, i.e. by 11 per cent point. A much more rapid increase has been noted in the development of sewerage: 8 per cent points in Poland in total, and 15 per cent points in the countryside. This increase, however, failed to achieve the target objectives laid out in the National Programme for Municipal Wastewater Treatment (Polish acronym KPOŚK). The updated version of the programme, published in 2010, assumed that by the year 2015 approximately 28.7 million residents of Poland, including nearly 100% of urban inhabitants and about 60% of countryside dwellers, would have gained access to sewerage and wastewater treatment plants (Krajowy Program Oczyszczania Ścieków Komunalnych 2003). More on tangible inputs into the water and sewage management in Poland and the achieved output can be found in Rosiek (2013). Importantly, as the share of the population with access to sewers has been increasing, the amount of wastewater and sewage produced in Poland, including municipal greywater and sewage, has been decreasing.

This, as Górką and Their (2013) claim, is the result of water saving efforts. At the same time, the quantity of untreated sewage and wastewater has fallen down by nearly 12-fold, while the degree of pollutant removal from treated sewage and wastewater has risen. Some of the rural population in Poland have gained access to communal wastewater treatment plants (table 2).

Table 2. Share of rural and urban population with access to municipal wastewater treatment plants [%]

| Specification | 2008 | | 2010 | | 2012 | | 2014 | |
|---------------------|---------|------|---------|-------|---------|------|---------|------|
| | village | town | village | town | village | town | village | town |
| Poland | 25.7 | 86.9 | 28.5 | 88.00 | 33.1 | 91.7 | 37.4 | 93.9 |
| Łódzkie | 13.3 | 94.9 | 16.1 | 94.2 | 18.8 | 94.6 | 24.2 | 93.3 |
| Mazowieckie | 17.1 | 66.7 | 22.3 | 70.1 | 23.9 | 86.1 | 26.8 | 93.8 |
| Małopolskie | 20.9 | 89.1 | 23.5 | 88.4 | 27.5 | 90.1 | 33.3 | 93.8 |
| Śląskie | 26.5 | 82.0 | 28.2 | 84.5 | 38.0 | 87.3 | 42.1 | 89.6 |
| Lubelskie | 15.8 | 93.8 | 18.3 | 92.8 | 20.6 | 94.5 | 23.0 | 95.2 |
| Podkarpackie | 37.2 | 92.4 | 42.4 | 93.1 | 50.6 | 94.4 | 54.3 | 95.9 |
| Podlaskie | 19.3 | 93.8 | 17.5 | 92.4 | 20.1 | 95.3 | 22.0 | 96.1 |
| Świętokrzyskie | 16.9 | 95.4 | 18.1 | 86.2 | 24.3 | 89.5 | 29.6 | 94.2 |
| Lubuskie | 25.2 | 93.0 | 25.3 | 91.8 | 32.6 | 92.1 | 35.7 | 93.9 |
| Wielkopolskie | 29.5 | 90.6 | 31.7 | 86.8 | 35.8 | 90.5 | 40.1 | 93.3 |
| Zachodniopomorskie | 40.7 | 68.9 | 44.8 | 93.4 | 50.3 | 94.7 | 54.2 | 94.9 |
| Dolnośląskie | 27.8 | 96.1 | 31.2 | 95.2 | 36.8 | 94.9 | 41.8 | 94.9 |
| Opolskie | 26.9 | 95.3 | 34.3 | 95.1 | 39.3 | 95.5 | 47.2 | 95.2 |
| Kujawsko-pomorskie | 34.1 | 92.5 | 32.5 | 94.1 | 33.8 | 95.6 | 36.5 | 95.2 |
| Pomorskie | 45.2 | 98.6 | 47.9 | 95.5 | 54.6 | 96.3 | 59.8 | 96.6 |
| Warmińsko-mazurskie | 33.3 | 98.2 | 33.4 | 96.3 | 37.7 | 97.9 | 43.4 | 96.8 |

Source: developed from Local Data bank information.

Most of treated sewage originated from the sewerage system while a smaller amount was delivered from septic tanks by vacuum tankers. In general, the percentage of people using municipal wastewater treatment plants increased over the years analyzed, both in towns and villages, in all the Polish provinces. In total for whole Poland, this percentage was considerably higher in urban than in rural areas: by 61.2 per cent points in 2008 and by about 56.7 per cent points in 2014. The difference between towns and villages in this respect decreased by just about 5 per cent points over the given time period.

The share of the population with access to municipal WTPs in towns had a rather uniform distribution between the provinces. Conversely, differences between the provinces with regard to rural areas and use of WTPs were evident. On average, the share of population connected to municipal and communal wastewater treatment plants in the countryside in 2014 was 37.4%, having risen by nearly 12 per cent points since 2008. The biggest difference, in 2014, which equalled as much as 37.8 per cent points, occurred between the podlaskie (22%) and pomorskie (59.8%) provinces. The gap grew significantly larger since 2008.

All efforts undertaken to reduce emission of sewage in rural areas are likely to be continued. The Programme for the Development of Rural Areas for 2014-2020 admits that the degree of saturation of rural areas with sewerage systems in Poland still remains very low. This impedes the development of entrepreneurship and has a negative impact on the living standard. It is assumed that the support given to the water and sewage management under the programme's framework will stimulate the economic development of rural areas and improve the quality of life. This will contribute to the achievement of the Programme's detailed aim, such as support of local development in rural areas. The support will be given to relevant actions in localities situated outside the agglomerations identified in the KPOŚ (Europejski Fundusz Rolny na rzecz Rozwoju Obszarów Wiejskich).

Supply of rural areas with domestic sewage disposal systems in Poland

The increasing share of the population connected to municipal wastewater treatment plants is a good direction followed in the sewage management over the recent years. Another positive development worth our attention is the increasing number of domestic wastewater and sewage treatment facilities, which replace septic tanks. According to statistics, in 2014, there were 2,373 thousand on-site sewage discharge systems (septic tanks and domestic WTPs), of which 98% were septic tanks (table 3).

Most of these installations were in the countryside, namely 83% of all septic tanks and 91% of domestic wastewater treatment facilities (Infrastruktura komunalna 2014). The number of septic tanks fell down from around 2,439 thousand in 2008 r. to 2,192 thousand in 2014, while the number of domestic WTP rose from about 51 thousand in 2008 to about 181 thousand in 2014.

Table 3. Number of septic tanks and domestic wastewater treatment plants [thousand]

| Specification | | 2008 | 2010 | 2012 | 2014 |
|--------------------------------------|-------------|------|------|------|------|
| Septic tanks | total | 2439 | 2407 | 2257 | 2192 |
| | in villages | 1978 | 1966 | 1903 | 1826 |
| Domestic wastewater treatment plants | total | 51 | 81 | 155 | 181 |
| | in villages | 45 | 72 | 114 | 166 |

Source: developed from Local Data Bank information.

In individual provinces, the number of septic tanks per capita remained on a similar level or decreased over the analyzed time period (table 4).

Table 4. Number of septic tanks in the countryside per one resident (actual residence as of 31 December)

| Specification | 2008 | 2010 | 2012 | 2014 |
|---------------------|------|------|------|------|
| Poland | 0.13 | 0.13 | 0.13 | 0.12 |
| Łódzkie | 0.16 | 0.17 | 0.16 | 0.15 |
| Mazowieckie | 0.16 | 0.16 | 0.15 | 0.15 |
| Małopolskie | 0.16 | 0.16 | 0.16 | 0.15 |
| Śląskie | 0.16 | 0.16 | 0.15 | 0.14 |
| Lubelskie | 0.16 | 0.14 | 0.14 | 0.14 |
| Podkarpackie | 0.12 | 0.10 | 0.09 | 0.08 |
| Podlaskie | 0.13 | 0.13 | 0.13 | 0.13 |
| Świętokrzyskie | 0.14 | 0.13 | 0.12 | 0.12 |
| Lubuskie | 0.14 | 0.14 | 0.13 | 0.13 |
| Wielkopolskie | 0.15 | 0.12 | 0.12 | 0.11 |
| Zachodniopomorskie | 0.08 | 0.06 | 0.06 | 0.06 |
| Dolnośląskie | 0.13 | 0.10 | 0.10 | 0.10 |
| Opolskie | 0.14 | 0.14 | 0.13 | 0.11 |
| Kujawsko-pomorskie | 0.14 | 0.11 | 0.11 | 0.11 |
| Pomorskie | 0.11 | 0.08 | 0.08 | 0.07 |
| Warmińsko-mazurskie | 0.09 | 0.08 | 0.08 | 0.07 |

Source: developed from Local Data Bank information.

The highest decrease in the number of septic tanks per one resident occurred in the following provinces: podkarpackie, wielkopolskie and pomorskie. In the podlaskie province, this number stayed almost unchanged.

It is assumed that the number of domestic wastewater treatment plants as well as the number of households connected to sewage systems, and therefore using municipal WTPs, increased to the 'disadvantage' of the number of septic tanks. According to the Main Statistical Office (GUS), there were 36 thousand domestic WTPs in Poland in 2002, and their number rose five-fold by the end of 2014. In 2008-2014, the number of domestic wastewater treatment facilities more than trebled (a 3.5-fold increase) in whole Poland, including rural areas. However, there were considerable differences between particular provinces regarding the number of domestic facilities per capita in villages. The highest number of domestic WTPs per one resident was recorded in the provinces podlaskie (0.027) and kujawsko-pomorskie (0.0025) (table 5).

Table 5. Number of domestic wastewater treatment plants per one resident, in the countryside (actual residence as of 31 December)

| Specification | 2008 | 2010 | 2012 | 2014 |
|---------------------|--------|--------|--------|-------|
| Poland | 0.003 | 0.005 | 0.008 | 0.011 |
| Łódzkie | 0.004 | 0.007 | 0.011 | 0.018 |
| Mazowieckie | 0.002 | 0.005 | 0.009 | 0.012 |
| Małopolskie | 0.002 | 0.003 | 0.004 | 0.007 |
| Śląskie | 0.002 | 0.002 | 0.003 | 0.006 |
| Lubelskie | 0.006 | 0.009 | 0.014 | 0.017 |
| Podkarpackie | 0.0004 | 0.0004 | 0.0008 | 0.002 |
| Podlaskie | 0.007 | 0.010 | 0.017 | 0.027 |
| Świętokrzyskie | 0.001 | 0.002 | 0.006 | 0.010 |
| Lubuskie | 0.003 | 0.047 | 0.006 | 0.010 |
| Wielkopolskie | 0.003 | 0.004 | 0.007 | 0.011 |
| Zachodniopomorskie | 0.002 | 0.003 | 0.005 | 0.007 |
| Dolnośląskie | 0.003 | 0.004 | 0.006 | 0.008 |
| Opolskie | 0.002 | 0.003 | 0.006 | 0.008 |
| Kujawsko-pomorskie | 0.010 | 0.014 | 0.019 | 0.025 |
| Pomorskie | 0.002 | 0.003 | 0.004 | 0.006 |
| Warmińsko-mazurskie | 0.001 | 0.003 | 0.005 | 0.008 |

Source developed from Local Data Bank information.

The greatest progress, however, took place in the podkarpackie province, where the above parameter was the lowest in 2008 and – although it still remained the lowest among all Polish provinces in 2014 – it increased by fivefold between 2008 and 2014. The podkarpackie province is noteworthy also because of a high share of the rural population with access to municipal wastewater treatment plants (54%). There is only one province in Poland, namely pomorskie, where this index is higher (59%).

Another significant observation is that the number of domestic wastewater treatment plants per one resident of the countryside was steadily increasing in all provinces of Poland over the seven years analyzed.

The calculated values of the indices in each year (the previous year served as a basis for the study) confirm that the dynamics of growth was stable (figure 1).

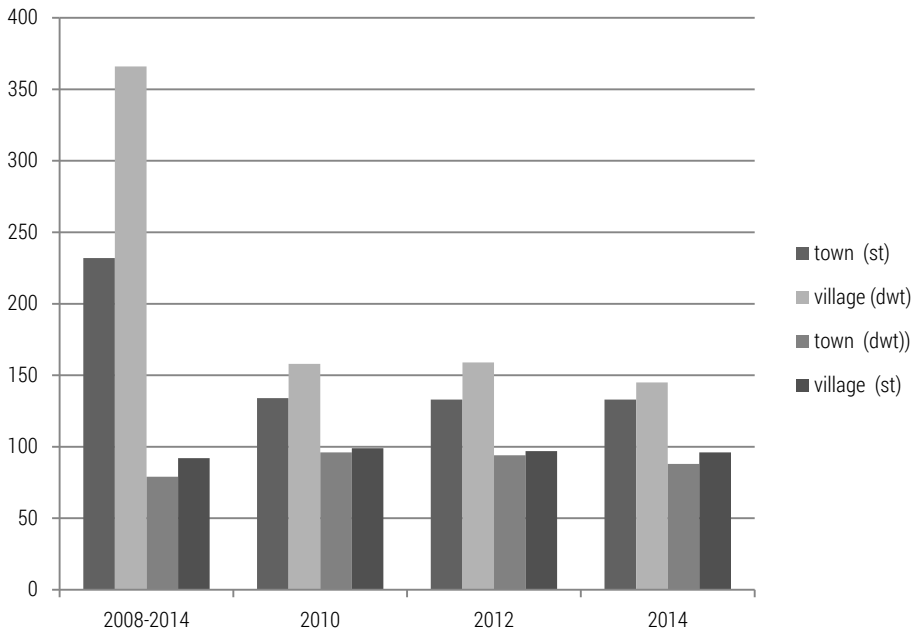


Figure 1. Dynamics of changes in numbers of septic tanks (st) and domestic water after treatment facilities (dwt) in 2008-2014 [%]

With respect to domestic wastewater treatment facilities, a relatively steady increase, by 40-50% compared to the previous year, was observed in each year. On the other hand, the number of septic tanks decreased steadily, each year falling down by a few per cent.

Recapitulation

The analyses presented in this paper substantiate the claim that a considerable improvement in the wastewater and sewage management infrastructure in rural areas was made in 2008-2014. It was a steady increase and concerned both the sewerage system and the supply of domestic wastewater treatment facilities. As a result, the share of the population with access to wastewater treatment plants (both municipal and domestic ones) increased, parallel to the constantly decreasing number of septic tanks, which are the least beneficial solution for collection of wastewater and sewage from the point of view of environmental protection.

Analyzing the above development from the spatial angle, with a division of Poland into administrative provinces, large differences were noted in the access to wastewater and sewage infrastructure in individual provinces, both in their total area and in the rural territories. An increase or at least a stable level of the analyzed parameters appeared in all the provinces. The greatest progress took place in less wealthy provinces.

The supply of rural areas with the infrastructure (including the so-called 'small infrastructure') of wastewater and sewage management will continue to be an action stretched over a long time. The underlying reasons include diverse conditions in rural areas (compact or scattered housing, distance to a municipal WTP, initiative of local authorities, present infrastructure, availability of funds and even awareness of local communities). The number of domestic wastewater treatment plants is increasing dynamically and this seems to be a lasting trend. The above justifies the conclusion that domestic wastewater treatment facilities have become a good alternative to septic tanks, which are expensive to maintain and not always completely leak-proof.

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