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Selected problems of waste water disposal and sludge handling in the Mazovian province

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Abstract: During the past several years big changes have been observed in waste water disposal, noticeable particularly in the improvement of water protection and sewage treatment. An important element of waste water disposal still requiring improvement is a low development of sewage systems in rural and urban areas. The main problem is an increasing amount of sludge, high degree of sediment hydration and considerable ability to anaerobic decomposition, a lack of areas for managing sediments near big cities and deposits of sediments on storage areas. Selected issues of waste water disposal and sludge handling in the Mazovian Province against a background of waste water disposal and sludge handling in Poland were presented in the article.

Key words: *sludge, waste-water, waste-water treatment plants*

INTRODUCTION

The settlement network of Mazovian Province is made of 85 cities and 8 720 rural places. One can distinguish Warsaw agglomeration with big economic development and areas of the remaining part of the province with poorer development. The area of the province is divided into 6 subregions. In the end of the year 2007, 5 188 500 inhabitants lived in the province, which gave it the first place in the whole country in the number of population. There were 3 356 400 inhabitants in cities (most living in Warsaw – 50.8%), whereas 1 832 100 people inhabited rural areas.

The area of Mazovian Province is 35 558 km^2, which makes about 11.4% of the country area. The largest part of the province (about 40%) is arable lands, afforested areas cover about 22.5% and permanent meadows and pastures occupy 13.6% of the area. Land management is the main index of human impact on environment. The negative effects are visible in almost all areas; urban, industrial, communication and agricultural.

Water pollution is the essential ecological problem in the Mazovian Province. The main reasons of troublesome situation in that aspect are: excessive water consumption in relation to resources, waste-water outflow from industrial and municipal sources, insufficient sewage treatment systems in urban areas, an inappropriate processing of storm waters and many others (Stan środowiska…, 2008).

In the Mazovian Province 2 924.2 hm^3 of water were taken up in the year 2006 and 2 854.2 hm^3 in 2007 (Ochrona…, 2008). In both years the amount of taken up water in the province made about 25% of all waters taken up in Poland.

In 2007 a slight decrease of water consumption (by about 2.4%) was noticed in comparison with that in the year 2006. Nevertheless, an increase in the amount of surface water consumption in 2000–2007 is alarming. It is worth pointing out that surface waters provide over 95% of the total amount of water supply.

The decrease in water consumption for municipal use is noticeable, which is the effect of limited water losses during distribution, installation of water meters and increasing prices of water and hence its more economical use. At the same time, however, water consumption for production purposes increases, mainly due to sewage disposal, waste disposal, sanitary services, building and production of electric power and gas.

WASTE WATER DISPOSAL

Water consumption and its use influences waste water disposal as far as natural environment is concerned. At present the law forbids raw sewage disposal and requires proper conditions of waste waters before introducing them into surface waters or ground. In reality, these regulations are not fully respected and part of untreated sewage is discharged to receivers. In the year 2007, 2 718.7 hm^3 of waste water including 2 462.0 hm^3 of leading waters (not requiring purification) were disposed from the area of Mazovian province. The emission of industrial and municipal sewage requiring purification was 238.6 hm^3 in 2007, whereas 90% of it was municipal waste waters (Stan środowiska…, 2008). The structure of sewage treatment in Mazovian province against a background of the whole country is presented in Figure 1.

Analysing the total amount of waste water during the past several years in Mazovian province, we can say that in the year 2007 it decreased by about 5% in relation to 2000, and by about 3.6% compared with 2004. Assuming the year 2000 as a basis, the amount of treated sewage in relation to the total amount of sewage requiring purification increased by 22%.The big decrease in the amount of untreated sewage was due to the installation of waste water treatment plants in some parts of Warsaw. Eighteen out of all the cities of the province have unsolved sewage treatment problems.

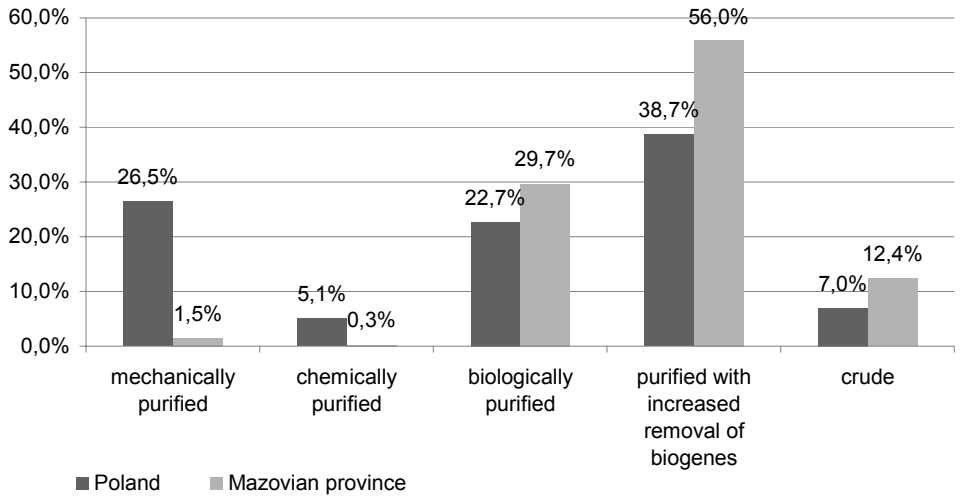

Fig. 1. The structure of sewage treatment in Poland and in Mazovian province in the year 2007

In the year 2007 there were 407 sewage treatment plants in the area of Mazovian province, 141 objects were industrial sewage treatment plants (about 34,6%) and 266 – municipal sewage treatment plants (65.4%). Among industrial sewage treatment plants, 106 used biological treatment; their share in the total number of treatment plants was 75.2%. The share of biological treatment plants in municipal sewage treatment plants is similar. In the year 2007, 200 biological treatment plants were registered and 63 objects i.e. 23.7% of treatment plants operated with enhanced nutrient removal. For Poland, in comparison with Mazovian province, the percentage of biological treatment plants is lower – 72.7%, whereas the participation of treatment plants with enhanced nutrient removal is slightly higher – 25.2%. The detailed structure of sewage treatment plants in particular subregions of Mazovian province is presented in Figure 2. In the majority of subregions, a considerable predominance of biological treatment plants over the treatment plants with enhanced nutrient removal is noticeable, except for the subregion of the capital city Warsaw and Warsaw-West subregion, where the number of both kinds of treatment plants is similar.

In all 85 cities of Mazovian province there are sewage treatment plants including 51 biological treatment plants and 34 treatment plants with enhanced nutrient removal. In the year 2004 the number of these treatment plants was 66 and 18, respectively. One must notice that the number of treatment plants with enhanced nutrient removal is increasing, and the amount of waste water purified with these methods increase accordingly. In Mazovian province the majority of sewage was purified biologically with simultaneous increase in the removal of nutrients. In 2007 the latter constituted 74.8% of all treated sewage in cities and 56.1% of sew-

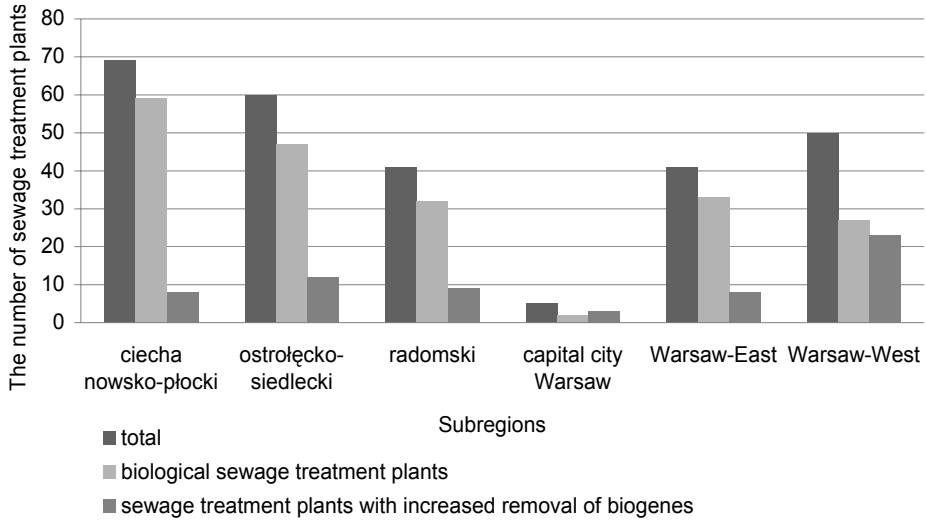

Fig. 2. The number of municipal sewage treatment plants in subregions of Mazovian province in the year 2007

age treated in rural areas. Only a small percent of sewage (about 0.2%) was treated mechanically. In Poland this percent is considerably higher – approximately 1% (Ochrona…, 2008).

All municipal sewage treatment plants in Mazovian province had a total flow capacity of 1 115 357 $m^3 \cdot d^{-1}$ at the equivalent number of inhabitants = 5 997 200. The number of people served by sewage treatment plants was 2 622 000 inhabitants which makes about 50.5% of the total number of inhabitants. There were great differences between people served by sewage treatment plants in cities and rural areas in particular subregions of the province (Tab. 1).

An important element of waste water disposal requiring improvement is a low degree of sewerage system of suburban and rural areas. The length of the sewerage network in the whole country in 2007 was about 90 thousand km and increased in

Table 1. The number of people served by sewage treatment plants as percent of the total number of inhabitants in the year 2007

Subregions	The number people served by sewage treatment plants, %		
	in general	cities	rural areas
Ciechanowsko-płocki	50.20	94.77	11.56
Ostrołęcko-siedlecki	42.34	91.75	11.84
Radomski	56.24	95.34	16.95
Warsaw	52.42	52.42	–
Warsaw-East	44.78	71.88	14.15
Warsaw-West	55.80	86.49	25.79

relation to the previous year by about 5% (5 thousand km). In rural areas the new networks involved 3 thousand km – an increase by 8.1% in relation to 2006 (in cities they increased by 1000 km – 3.1%). The largest increase in the length of sewerage system was noted in Mazovian province (383.2 km). The longest sewerage system (over 100 km) was built in Piaseczno and West-Warsaw administrative district (Stan…, 2008). Nevertheless, the disproportion between the length of sewerage and water supply networks in the rural areas of Mazovian province is still considerable. The most frequent way of waste water treatment in rural households is septic tanks with no outlet which are often leaky. Raw sewage from these tanks is often disposed to forests, water courses and fields.

Rural areas are characterized by big dispersion of buildings. In such conditions building a cumulative sewage system net and sewage treatment plant is economically groundless, that is why a better solution seems exploitation of adjacent sewage treatment plants.

SLUDGE HANDLING

Sewage sludges made in municipal sewage treatment plants are classified in the stream of sewage into category Q9. Sludge made in municipal sewage treatment plants may include remains from pollution removal processes (e.g. sewage sludge, slimes from washers, dusts from filters, used filters, etc.). Taking into consideration the tendency of introducing the third degree of sewage treatment (phosphorus precipitation), one can expect an increase in the quantity of sewage sludge in municipal sewage treatment plants. Using inorganic coagulants increases the amount of sludge and makes its treatment and final neutralization difficult.

1088.8 thousand tonnes of dry matter of sludge were produced in Poland in the year 2007; 555.4 thousand tonnes of dry matter in industrial sewage treatment plants and 533,4 thousand tonnes of dry matter of sludge in municipal sewage treatment plants (Ochrona…, 2008). The amount of sludge produced in industrial sewage treatment plants systematically decreases. A 21% decrease in the amount of produced sludge was noted between 2000 and 2007. On the other hand, the amount of sludge from municipal sewage treatment plants increased by 48%.

In Mazovian province 94.1 thousand tonnes of dry matter of sludge were produced in 2007; 25.5 thousand tonnes were from industrial sewage treatment plants and 68.7 thousand tonnes (73% of the total) were from municipal sewage treatment plants (Ochrona…, 2008).

Municipal sewage sludge can be used if stabilized and properly prepared for a given aim and way use by exposing it to biological, chemical, thermal and other treatments that decrease its susceptibility to putrefaction and reduces environmental and or peoples' health risk. The lack of data on the quality of sludge is a barrier for proper choice of direction and way of further action (WANDRASZ *et al*., 2005).

The main way of final management of sewage sludge is its storage or use for land reclamation. The considerable agricultural or natural limit of using sludge is their chemical composition inappropriate in view of some law regulations (Rozporządzenie…, 2002; Ustawa…, 2007) and the reluctance of individual farmers to use sludge. This is confirmed by data given in Table 2, which show insignificant changes in sludge utilisation. Positive changes are noted in deposition of sludge on storage yards, which show clear decreasing tendency.

Table 2. Some ways of managing sludge produced in municipal sewage treatment plants in Poland in selected years (in percent of the total) (Ochrona…, 2008)

Details	2000	2005	2006	2007
	%			
In agriculture	–	13.6	16.1	18.4
For land reclamation in agricultural grounds	–	24.8	21.9	22.2
For growing plants appropriate for compost production	7.1	5.6	5.6	4.8
Thermally transformed	1.6	1.3	0.9	0.3
Stored	42.1	31.0	29.3	23.3
Stored temporary and other ways	49.2	23.7	26.2	31.0

Particular ways of managing sludge produced in municipal sewage treatment plants in the area of Mazovian province and in particular subregions in 2007 are presented in Figures 3 and 4. A large amount of sludge – 20.4 thousand tonnes of dry matter – was used for land reclamation. However, the use of 25.8 thousand tonnes of dry matter of sludge specified as "different" is wondering. One should notice that in 2007 in Mazovian province there was no thermal processing of sludge from municipal sewage treatment plants. Apart from sludge produced during a given year, sewage treatment plants deal with the problem of sludge stored before in their own area. In the end of the year 2006 there were 753.3 thousand tonnes of dry matter of sludge stored on plants' own areas in Poland, i.e. over 40% more than the amount of sludge produced in the following year. In 2004 the sludge stored on plots, in lagoons and ponds located in the areas of treatment plants made about 90% of sludge produced in this year. The reason of increasing amount of sludge stored in the treatment plants is the fear of environmental pollution by heavy metals, synthetic substances and pathogenic organisms. According to (PALUCH and PULIKOWSKI, 2008) most pollutants dangerous for natural environment are kept in primary settling tank, less in mixed sludge and the least in secondary sludge.

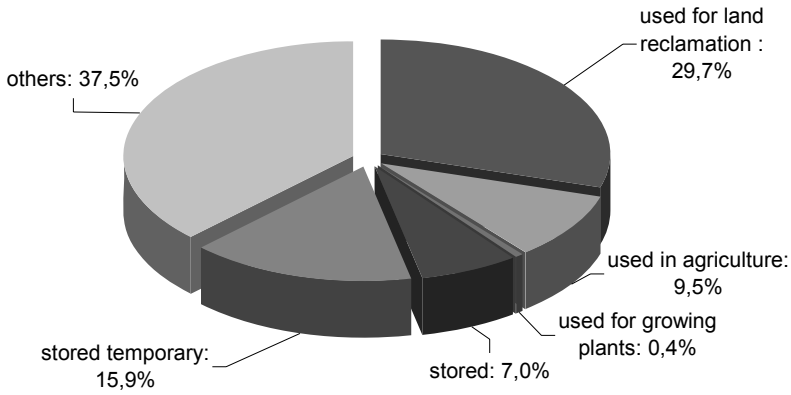

Fig. 3. Ways of managing sludge produced in municipal sewage treatment plants in the area of Mazovian province

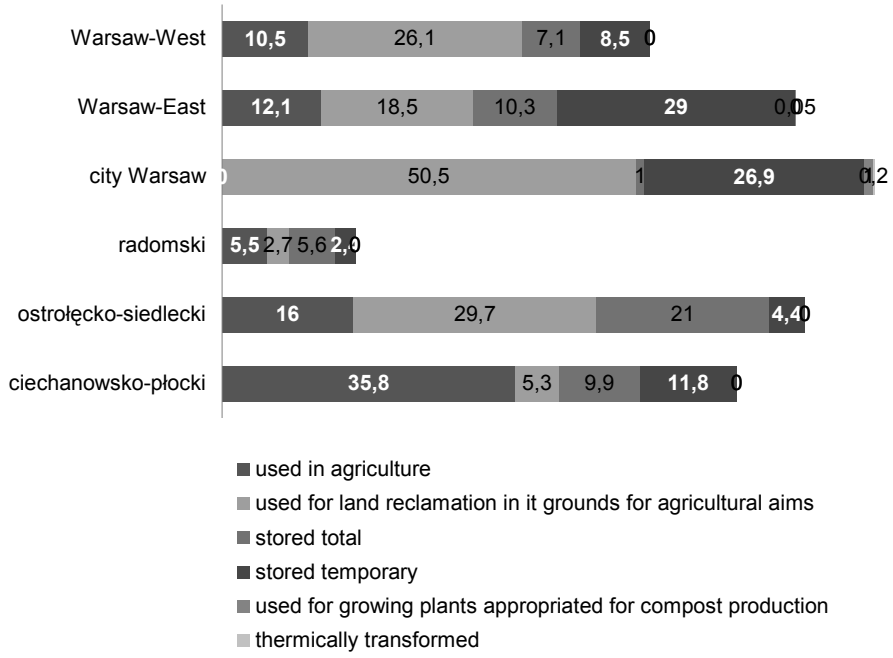

Fig. 4. The structure of sludge management in particular subregions of Mazovian province in the year 2007

PROGNOSIS AND ASSUMPTIONS

According to the assumptions of the National Programme of Municipal Sewage Treatment the sewerage systems will serve in 2015: at least 98% inhabitants in agglomerations having equivalent number of population ≤100 000, at least 90% inhabitants in agglomerations having this number in the range 15 000–100 000 and at least 80% inhabitants in agglomerations having equivalent number of population between 2000 and 15 000 (BŁASZCZYK and GROMIEC, 2006). For Mazovian province area the National Programme predicts the equipment of agglomeration with cumulative sewerage systems and sewage treatment plants with 83 objects up to the year 2015 (Krajowy program…, 2005; Strategia…, 2006).

The prognosis of the Environment Protection Institute some years ago said that in 2010 the total amount of sludge in Polish municipal sewage treatment plants might reach almost 0.5 million tonnes of dry matter. This amount was already reached in 2006. According to GUS prognosis the number of inhabitants of Mazovian province in 2015 will be 5 353 600. Therefore, one can expect also an increase in the amount of sludge. The amount of sludge in particular periods (Wojewódzki plan…, 2007) will then be:

- in 2011 – 60 462 tonnes of dry matter
- in 2015 – 70 581 tonnes of dry matter.

The quality of sludge will vary depending on chemical composition and sanitary – biological characteristics of purified sewage, the method of sewage treatment etc. It is necessary to eliminate or decrease the load of heavy metals in sewage, and so in sludge. One should introduce regulations that would prevent from delivering heavy metals to municipal sewerage system or would aim at implementing such technologies of sewage treatment which would eliminate the majority of chemical pollution. At present this pollution accumulates in sludge, worsens its parameters and disqualifies it from natural management. This is particularly true for sludge from sewage treatment plants serving big cities which do not fulfil the standards as far as agricultural or natural use is concerned.

Literature review of sludge handling realized in sewage treatment plants in the light of obligatory legal regulations (PALUCH *et al*., 2006; SIKORSKI and BAUMAN-KASZUBSKA, 2008; BERNACKA *et al*., 2001; BAUMAN-KASZUBSKA and SIKORSKI, 2008) shows that sludge from small objects, treating mainly domestic sewage or that with a small amount of industrial sewage is suitable for agricultural purposes. Such sludge does not contain excessive amounts of toxic substances like heavy metals. The only problem is its sanitary status. Sludge from larger sewage treatment plants contains less nitrogen but more phosphorus. Moreover, the main barrier which limits natural use of sludge from these sewage treatment plants is a high content of heavy metals: zinc, chromium and nickel (SIKORSKI and BAUMAN-KASZUBSKA, 2008). In such cases one should recommend thermal methods of sludge processing (BIEŃ *et al*., 2006).

Assumptions of the National Plan of Waste Management (Krajowy plan…, 2002) point out that the natural methods of sludge neutralisation belong to preferable and most frequent methods of their management. In the year 2014 approximately 50% of the total amount of sludge should be composted or used for land reclamation and fertilising grounds. Moreover, basic aims in managing municipal sewage sludge are based on a total ban for sludge storage until the year 2018 (Krajowy plan…, 2006).

SUMMARY

Main problems concerning waste water disposal and sludge handling are:

- insufficient part of sewage treated in the total amount of sewage requiring purification,
- disproportions between the length of water mains and sewerage system networks present mainly in rural areas and small cities causing environmental threat with raw sewage and making work of many sewage treatment plants difficult,
- increasing amount of sludge,
- poor quality of sludge and hence a small part of sludge used for agricultural or natural purposes.

According to ecological policy of the country and the assumptions of the National Plan of Waste Management (Krajowy plan…, 2002) and the National Programme of Municipal Sewage Treatment (Krajowy program…, 2005), the amount of sewage purified in Mazovian province increases systematically, which is connected with dynamic development of sewerage systems and building new treatment plants. The measurable positive effect is an increasing percentage of inhabitants served by sewage treatment plants. The number of sewage treatment plants with enhanced nutrient removal has grown dramatically and in the majority of them the equipment and technologies used fulfil the international standards. However, at the same time one can notice continuous increase in the amount of municipal sludge. Sludge removal should be part of sewage treatment concept in order to use all possible means and solutions aimed at reducing the amount of sludge, improving their quality, minimising costs and their final removal and increased natural and agricultural usage.

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STRESZCZENIE

Wybrane problemy gospodarki ściekowej i osadowej na przykładzie województwa mazowieckiego

Słowa kluczowe: *oczyszczalnia ścieków, osady ściekowe, ścieki, wykorzystanie osadów*

W minionych kilkunastu latach obserwuje się duże zmiany w zakresie gospodarki ściekowej, widoczne szczególnie w poprawie ochrony wód i oczyszczania ścieków. Ważnym elementem gospodarki ściekowej, wymagającym nadal poprawy, jest mały stopień skanalizowania terenów podmiejskich i wiejskich. Zdecydowanie gorzej przestawia się stan gospodarki osadowej. Główne problemy w tym zakresie to zwiększająca się ilość osadów ściekowych, ich wysoki stopień uwodnienia oraz znaczne zagniwanie, brak terenów do ich zagospodarowania w pobliżu dużych miast, a także deponowanie na składowiskach. W artykule zaprezentowane wybrane zagadnienia gospodarki ściekowej i osadowej województwa mazowieckiego na tle gospodarki ściekowej i osadowej całej Polski.

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