Sewage Management Changes in the North-eastern Poland After Accession to the European Union

Szymon Skarżyński[1,*], and *Izabela* Bartkowska[2]

[1,2]Bialystok University of Technology, Faculty of Civil and Environmental Engineering, Department of Technology and Systems in Environmental Engineering, Wiejska 45A, 15-351 Bialystok, Poland

Abstract. Poland's accession to the European Union contributed to the infrastructure development of the whole country. One of the elements of the modernized infrastructure is the sewage network and facilities on this network, as well as facilities for waste water treatment and disposal of sludge. A wide stream of funds flowing to the country, and consequently also to the north-eastern polish voivodeships (Podlaskie, Warmian-Masurian, Lublin), allowed modernization, organize, and sometimes to build a new sewage management of this part of the country. The main factors and parameters that allow us to evaluate the development of the sewage management in north-eastern Poland are included: percentage of population using sewage treatment plants, number of municipal sewage plants with the division of their type, number of industrial plants, number of septic tanks, amount of sewage purified in a year, amount of sludge produced in the year, design capacity of sewage treatment plant, size of plant in population equivalent (PE). From a number of investments in the field of wastewater management carried out in the discussed area in the period after Poland's accession to the European Union, 9 investments were considered the most important, 3 from each of the voivodeships.

1 Introduction

Poland's accession to the European Union contributed to the infrastructure development of the whole country. One of the elements of the modernized infrastructure is the sewage network and facilities on this network, as well as facilities for sewage treatment and disposal of sludge. A wide stream of funds flowing to the country, and consequently also to the north-eastern Polish voivodeships, allowed modernization, organize, sometimes to build a new sewage management of this part of the country.

2 Characteristics of north-eastern Poland Voivodeships

The definition of north-eastern Poland defines three voivodeships: the Podlaskie Voivodeship (with the seat of the authorities in Białystok), the Warmian-Masurian

* Corresponding author: s.skarzynski@doktoranci.pb.edu.pl

Voivodeship (with the seat of the authorities in Olsztyn) and the Lublin Voivodeship (with the seat of the authorities in Lublin). As of 31 December 2016, the voivodeships covered by this area are inhabited by more than 4.76 million people on an area of nearly 70.000 km^2, resulting in a population density of 67.8 persons/km^2 [1]. Figure 1 present the location of the voivodeships on the Polish map and Table 1 presents the characteristics of each voivodeship.

Figure 1. Location of the voivodeships on the Polish map.

Table 1. Data characterizing chosen voivodeships and their comparison to national data [1].

Voivodeship	Population		Area		Population density
	person	% of total country	km^2	% of total country	person/km^2
Podlaskie	1,187,587	3.09	20,187.02	6.46	58.8
Warmian-Masurian	1,437,812	3.74	24,173.17	7.73	59.5
Lublin	2,135,715	5.56	25,122.46	8.03	85.0
Total	4,761,114	12.39	69,482.65	22.22	67.8
Poland	38,432,992	100.00	312,679.00	100.00	123.0

Analysing the above data, it can be noticed that the largest population, surface area and population density are Lublin Voivodeships, while the lowest values reach Podlaskie Voivodeship. The analysed voivodeships cover a total of nearly 12.5% of the country territory, and is inhabited by just over 22% of the population of the whole country. The population density in these voivodeships reaches 67.8 person/km^2 (123.0 person/km^2 in the whole country).

2.1 Podlaskie Voivodeship

The Podlaskie Voivodeship is located in the north-eastern part of Poland, in the geographical center of Europe. The seat of the province authorities is Białystok. Through its center flows the river Narew. The voivodeship occupy the area of 20,187.02 km^2 and is

inhabited by 1,187,587 people, giving a population density of 58.8 persons/km^2. The Podlaskie Voivodeship is divided into 14 counties (consisting of 118 communes) and 3 cities with county status. The largest cities are Białystok (about 300 thousand inhabitants), Suwałki (about 70 thousand inhabitants) and Łomża (about 63 thousand inhabitants) [1].

The voivodeship is bordered by: Belarus, Lithuania, Lublin Voivodeships, Masovian Voivodeships and Warmian-Masurian Voivodeship. In the voivodeships there are 4 national parks, including the oldest in Poland, Białowieża National Park, as well as the largest area, the Biebrza National Park. The other two national parks are Wigry and Narew. Protection of nature and the environment in Podlaskie Voivodeship also includes 3 landscape parks, 85 nature reserves and 2051 nature monuments [1].

2.2 Warmian-Masurian Voivodeship

The Warmian-Masurian Voivodeship is located in the north-eastern part of Poland. The seat of the voivodeship authorities is Olsztyn. The voivodeship occupy the area of 24,173.17 km^2 and is inhabited by 1,437,812 people, giving a population density of 59.5 persons/km^2. Warmian-Masurian Voivodeship is divided into 19 counties (consisting of 116 communes) and 2 cities with county status. The largest cities are Olsztyn (about 173 thousand inhabitants), Elbląg (about 121 thousand inhabitants) and Ełk (about 60 thousand inhabitants) [1].

The voivodeship is bordered by: Russia, Kuyavian-Pomeranian Voivodeship, Masovian Voivodeship, Podlaskie Voivodeship, Pomeranian Voivodeship. From the north-west it borders the Vistula Lagoon. Protected areas in voivodeship occupy a total of 1,126,155.3 ha, which accounts for 46.6% of the voivodeship. In the region there are 8 landscape parks, 110 nature reserves, 71 protected landscape areas, 2,576 natural monuments, 14 special bird protection areas, 41 areas of Community importance, 297 ecological grounds, 18 natural-landscape teams and one documentation stand [1].

2.3 Lublin Voivodeship

Lublin Voivodeship is located in the northern part of Poland. The seat of the voivodeship authorities is Lublin. The voivodeship occupy the area of 25,122.46 km^2 and is inhabited by 2,133,340 people, giving a population density of 85.0 persons/km^2. Lublin Voivodeship is divided into 20 counties (consisting of 213 communes) and 4 cities with county status. The largest cities are Lublin (about 340 thousand inhabitants), Zamość (about 65 thousand inhabitants), Chełm (about 64 thousand inhabitants) and Biała Podlaska (about 57 thousand inhabitants) [1].

The voivodeship is located between the Vistula and the Bug River and borders with the Belarus, Ukraine, Subcarpathian Voivodeship, Podlaskie Voivodeship, Masovian Voivodeship and Świętokrzyskie Voivodeship. Lublin Voivodeship there are two national parks (Polesie National Park, Roztocze National Park), 17 landscape parks, 87 nature reserves, 1,513 nature monuments, 7 documentation stands, 267 ecological grounds and 7 natural-landscape teams [1].

3 Parameters of sewage management in the north-eastern Voivodeships of Poland

The main factors and parameters that allow us to evaluate the development of the sewage management in north-eastern Poland are presented in table 2. All data was obtained from the Local Data Bank provided by the Central Statistical Office.

Table 2. Parameters of sewage management in north-eastern Poland [1]

Parameter	Voivodeship								
	Podlaskie			Warmian-Masurian			Lublin		
	2003	2009	2015	2003	2009	2015	2003	2009	2015
population using sewage treatment plants [%]	60.20	62.49	67.40	67.53	72.72	75.90	49.93	52.84	57.20
total municipal sewage plants [units]	96	113	122	173	222	237	217	260	286
*mechanical	0	0	0	6	0	0	15	12	3
*biological	69	80	93	112	158	172	182	216	255
*with increased biogenic removal	27	33	29	55	64	65	20	32	28
industrial plants [units]	30	30	26	51	21	18	106	68	66
Onsite sewage facilities (OSSF) [units]	**nd**	3.90	13.79	**nd**	1.14	5.34	**nd**	7.68	22.33
septic tanks [units]	**nd**	80.20	74.33	**nd**	53.35	48.50	**nd**	184.30	171.25
sewage purified in a year [dam^3]	32.38	34.07	32.02	49.62	46.51	44.80	50.66	50.26	49.14
sludge produced [t/year]	13.31	17.41	14.45	24.58	27.87	18.74	20.94	23.00	19.73
total designed capacity of sewage treatment plant [m^3/d]	234.59	234.71	237.96	381.49	321.34	324.9	355.67	347.87	350.40
*mechanical	0	0	0	172	0	0	688	559	81
*biological	55.89	38.26	42.16	127.51	65.39	64.85	235.62	75.28	75.80
*with increased biogenic removal	178.70	196.45	195.80	253.81	255.95	260.05	119.37	272.04	274.52
size of municipal sewage plants [thousand PE]	1.23	1.26	1.36	2.19	1.94	2.03	1.90	2.20	2.32

nd – no data

The above table shows the three years data for the voivodeships. The year 2003 shows the situation before Poland's accession to the European Union, 2009 after several years of presence in the European Union and in 2015, the most up-to-date. Analysing this data can be seen more of the following regularities:
• percentage of the population with access to sewage treatment plants in the voivodeships north-eastern Polish has increased by about 7 percent compared with 2003, Warmian-Masurian Voivodeships are in 4th place, Podlaskie Voivodeship at 11th place and Lublin Voivodeship at 14th place in Poland [12],
• during the presence of Poland in the European Union the number of mechanical sewage treatment plants was reduced (and in some cases they were completely liquidated), however were noted more biological sewage treatment plants and sewage treatment plants with increased biogenic removal,
• in the analysed years, the number of industrial sewage treatment plants and septic tanks slightly decreased, while the number of industrial sewage treatment plants was greatly increased,
• the amount of sewage treated during the year remained relatively constant, but can be observed an increase (of 2009) and a slight decrease compared to 2003,
• the amount of sludge produced shows similar trends in the amount of sewage,
• the designed capacity of the sewage treatment plant has been slightly increasing in the Podlaskie Voivodeship, while in the remaining voivodeships, it has decreased in comparison with the base year 2003,
• noteworthy is the fact that the increased amount of sewage treated in sewage treatment plants with increased removal of biogenic.

4 Characteristics of the most important investments in sludge management

From a number of investments in the field of wastewater management carried out in the discussed area in the period after Poland's accession to the European Union, 9 investments were considered the most important, 3 from each of the voivodeships. These investments have the highest social and environmental importance and their cost to be significant [2].

4.1 Podlaskie Voivodeship

The most important investment in the field of sewage management in Podlaskie Voivodeship was the development and modernization of the water and sewage system in Białystok and the community of Wasilków. The aim of the project was to ensure the compliance of the Bialystok agglomeration requirements contained in the relevant EU Directives and Polish law regarding the conduct of water and sewage management. The scope of the project was [3]:
• construction of water supply and sanitary sewage systems in areas not covered by the sanitary sewage system,
• separation of sewerage channels through the construction of rain channels and the installation of equipment for the purification of rainwater from petroleum substances and suspensions,
• modernization and renovation of the existing sanitary sewage system to improve its functioning,

• modernization and renovation of the existing water supply network and the replacement of the network made from asbestos and steel pipes in order to improve the reliability of water supply and improve the quality of water intended for consumption,
• improve water distribution by supplementing the metering of water supply network.

This investment was co-financed by the Cohesion Fund under the Infrastructure and Environment Operational Program with the amount of almost 97 million PLN, with a total value of almost 144 million PLN, which constitutes approximately 67% of the co-financing. The project was realized in the years 2008 – 2013 [3, 4].

The second important investment in the voivodeship was "Improvement of water quality in Białystok". This four-step project assumed [3]:
• development of technological processes at the Water Treatment Station "Wasilków - Pietrasze",
• construction of a preliminary ozonation facility for the underground water treatment in the Water Treatment Station "Jurowce",
• modernization of fermenting chambers in Białystok sewage treatment plant,
• modernization of the biological part in the sewage treatment plant in Białystok.

This investment was co-financed by the Cohesion Fund under the Infrastructure and Environment Operational Program with an amount of over 41.6 million PLN, with a total project value of over 76.4 million PLN, which constitutes approximately 56% of the co-financing. The project was realized in the years 2004 – 2006 [3, 4].

The last investment to look out for is the modernization of the sewage treatment plant and the development of water and sewage infrastructure in Suwałki. This project has been divided into two phases. The general objectives of the project was the comprehensive modernization of the sewage treatment plant and extension of water supply and sewerage in Suwałki to improve infrastructure conditions necessary to ensure the proper socio-economic development of the area covered investment. Both stages of the described investment were co-financed from the Cohesion Fund under the Infrastructure and Environment Operational Program with an amount of over 34.6 million PLN, with a total project value of over 60.5 million PLN, which constitutes approximately 57% of the co-financing. The project was realized in the years 2007 – 2013 [4, 5].

4.2 Warmian-Masurian Voivodeship

One of the most important investments realized in the Warmian-Masurian Voivodeship was a project called "Water and sewage management in Olsztyn". The aim of the project was to introduce a modern three-stage sewage pollutant removal method, which contributed to the protection of Łyna River waters of the, and finally the Baltic Sea or the achievement of European standards for municipal sewage treatment. In addition, the aim was to improve the quality of drinking water and supply all residents with drinking water, improving the efficiency of the sewage system and rainwater, reduce flooding with rainwater and reduce surface water pollution resulting from discharges of rainwater, as well as the long-term solution to the problem of final disposal of sludge. The investment was co-financed by the Cohesion Fund under the Infrastructure and Environment Operational Program with the amount of almost 92.8 million PLN, with a total value of nearly 296.9 million PLN, which constitutes over 31% of the co-financing. The project was realized in the years 2004 – 2006 [4, 6].

Another important investment in the sewage management of the Warmian-Masurian Voivodeship was a project called "Improvement of water and sewage management in the agglomeration of Ełk". The scope of the project included comprehensive rebuilding of sewage pumping stations, sanitary sewers, sewage wells, and water supply with

replacement of equipment. Reconstruction of canals and water pipeline was implemented by trenchless methods. The investment was co-financed by the Cohesion Fund under the Infrastructure and Environment Operational Program with the amount of almost 33.2 million PLN, with the total value of the project equalling nearly 72.7 million PLN, which constitutes over 46% of the co-financing. The project was realized in the years 2007 – 2013 [4, 7].

The last investment to look out for is "Construction of industrial sewage treatment plant for Tymbark Sp. z o.o. Sp. k. in Olsztynek". The purpose of the project was to expand and modernize the sewage treatment plant installation to fruit and vegetable processing. Industrial sewage is purified in an anaerobic-aerobic process, using the resulting biogas combustion in the local boiler room. As part of the investment were constructed facilities and technological equipment: the mechanical and biological part of the sewage treatment plant, as well as sewage sludge processing elements. The investment was co-financed by the European Regional Development Fund under the Infrastructure and Environment Operational Program with an amount of almost 10.3 million PLN, with a total project value of almost 43.0 million PLN, which constitutes over 24% of the co-financing. The project was realized in the years 2007 – 2013 [4, 8].

4.3 Lublin Voivodeship

A significant investment in the Lublin Voivodeship was "Development and modernization of water supply and sewage disposal in Lublin". The main objective of the project was to organize the water and sewage systems in the city of Lublin. For the purposes of side include [9]:

- maintaining the quality and reliability of drinking water supply in Lublin, including the reduction of water losses in the network,
- elimination of ground sources pollution and surface waters in the form of individual septic tanks,
- reducing the negative impact of the sewerage system on groundwater,
- ensuring the reliability of the operation of the "Hajda" Sewage Treatment Plant,
- improving the comfort of the inhabitants,
- improving the efficiency of the water system in Lublin,
- improving the economic development of Lublin and its surroundings,
- development of the sewerage system in the currently unarmed area.

This investment was co-financed by the European Cohesion Fund under the Infrastructure and Environment Operational Program with the amount of nearly 147.4 million PLN, with a total project value of over 311.8 million PLN, which constitutes over 47% of the co-financing. The project was realized in the years 2007 – 2013 [4, 9].

Another project of the Lublin Voivodeship was called "Inter-municipal water and sewage system within the agglomeration of Puławy". The main aim of the project was to adjust the Puławy agglomeration area to the current national and European standards by including [10]:

- increase channelling agglomeration Puławy from 88.3% to 95.2%,
- providing access to water of adequate quality and quantity for the inhabitants of the agglomeration of Puławy,
- allowing the connection to the sanitary sewage system of inhabitants from the agglomeration,
- elimination of local sources of pollution of soil, groundwater and surface by liquidations of individual septic tanks,
- reducing the negative impact of the sanitary sewage system on the environment by modernizing emergency and exploited sections of the sewer system in Puławy,

• increasing the economic development potential of Puławy, Końskowola and Żyrzyn communes,
• increasing the aesthetic appeal of the countryside,
• to create a single, common system of sewage management,
• connection to sanitary sewage system over 4 thousand people,
• connection to the water supply network over 2 thousand people.

This investment was co-financed by the European Cohesion Fund under the Infrastructure and Environment Operational Program with an amount of nearly 44.2 million PLN, with a total project value of over 89.7 million PLN, which constitutes almost 50% of the co-financing. The project was realized in the years 2007 – 2013 [4, 10].

The last investment of the Lublin Voivodeship was a project called "Modernization of the Chełm Wastewater Treatment Plant with the expansion of the water and sewerage system". The aim of the project was to equip the Chełm agglomeration with technical infrastructure enabling [11]:
• reception and cleaning of municipal sewage in the Chełm agglomerations in accordance with the requirements of Directive 91/271/EEC and the Ordinance of the Minister of the Environment of 24 July 2006,
• contribute to fulfilling the requirements of the National Program of Municipal Sewage Treatment,
• ensuring continuity of drinking water supply, corresponding to the standards laid down in Directive 80/778/EEC of 15 July 1980 and 98/83/EC of 3 November 1988 and the Ordinance of the Minister of Health of 29 March 2007.

This investment was co-financed by the European Cohesion Fund under the Infrastructure and Environment Operational Program with the amount of almost 40.5 million PLN, with the total value of the project equal to almost 84.5 million PLN, which constitutes almost 48% of the co-financing. The project was realized in the years 2007 – 2013 [4, 11].

5 Summary

Poland's accession to the European Union has significantly contributed to the modernization and expansion of the North-East Poland sewage infrastructure. Most of the funds came from the European Cohesion Fund under the Infrastructure and Environment Operational Program, contributing to improving the state of environment in Poland. In conclusion, it can be seen that:
• total amount of investments described in this article was 1,179.5 million PLN (280.9 million PLN in Podlaskie Voivodeship, 412.6 million PLN in Warmian-Masurian Voivodeship and 486.0 million PLN in Lublin Voivodeship),
• total amount of co-financing from European Union programs was 541.6 million PLN (173.2 million PLN in Podlaskie Voivodeship, 136.3 million PLN in Warmian-Masurian Voivodeship and 232.1 million PLN in Lublin Voivodeship),
• value of investment co-financing was on average 47.3% (60.0% in Podlaskie Voivodeship, 33.7% in Warmian-Masurian Voivodeship and 48.3% in Lublin Voivodeship).
• amount spent on investment per capita in the region was 248 PLN/person of which 114 PLN/person came from co-financing,
• amount spent on investment per capita in Podlaskie Voivodeship was 237 PLN/person of which 145 PLN/person coming from co-financing,
• amount spent on investment per capita in Warmian-Masurian Voivodeship was 287 PLN/person of which 95 PLN/person coming from co-financing,

• amount spent on investment per capita in Lublin Voivodeship was 228 PLN/person of which 109 PLN/person coming from co-financing.

The study was carried out within MB/WBiIŚ/10/2017 work and financed by the Ministry of Science and Higher Education.

References

1. Central Statistical Office Department of Demography and Labor Market Research (2017) Population and natural movement in 2016 in Poland, Warsaw.
2. EU subsidy map (www.mapadotacji.gov.pl) [access 27.03.2017].
3. Wodociągi Białostockie Sp. z o.o. (www.wobi.pl) [access 11.06.2017].
4. Infrastructure and Environment Operational Program (www.pois.gov.pl) [access 27.03.2017].
5. Przedsiębiorstwo Wodociągów i Kanalizacji w Suwałkach Sp. z o.o. (www.pwik.suwalki.pl) [access 11.06.2017].
6. Przedsiębiorstwo Wodociągów i Kanalizacji w Olsztynie Sp. z o.o. (www.pwik.olsztyn.pl) [access 11.06.2017].
7. Przedsiębiorstwo Wodociągów i Kanalizacji w Ełku Sp. z o.o. (www.pwik.elk.com.pl) [access 11.06.2017].
8. Tymbark - MWS Sp. z o.o. Sp.k. (www.tymbark.com) [access 11.06.2017].
9. Miejskie Przedsiębiorstwo Wodociągów i Kanalizacji w Lublinie Sp. z o.o. (www.mpwik.lublin.pl) [access 11.06.2017].
10. Miejskie Przedsiębiorstwo Wodociągów i Kanalizacji "Wodociągi Puławskie" Spółka z o.o. (www.mpwik.pulawy.pl) [access 11.06.2017].
11. Miejskie Przedsiębiorstwo Gospodarki Komunalnej w Chełmie Sp. z o.o. (www.mpgk.chelm.pl) [access 11.06.2017].
12. Strategia Rozwoju Województwa Podlaskiego do roku 2020, Urząd Marszałkowski Województwa Podlaskiego