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DEVELOPMENT OF WATER AND WASTEWATER MANAGEMENT IN THE EASTERN PROVINCES OF POLAND

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ROZWÓJ INFRASTRUKTURY GOSPODARKI WODNO-ŚCIEKOWEJ W WOJEWÓDZTWACH WSCHODNIEJ POLSKI

STRESZCZENIE: Celem tego artykułu jest zwrócenie uwagi na rozwój gospodarki wodno-ściekowej w Polsce Wschodniej i porównanie do sytuacji w pozostałej części kraju. Dowiedziono znaczący rozwój we wszystkich elementach infrastruktury wodno-ściekowej. Jednakże największy wzrost został zaobserwowany w obszarze infrastruktury odpowiedzialnej za transport, magazynowanie i utylizację ścieków. Zrealizowane inwestycje zminimalizowały istniejącą różnicę infrastrukturalną pomiędzy województwami Polski Wschodniej a pozostałą częścią kraju. W tym zakresie kluczową rolę odegrały fundusze z Unii Europejskiej. Bez nich nie byłaby możliwa tak złożona I szybka modernizacja, a także rozbudowa poszczególnych elementów infrastruktury związanej z gospodarką wodno-ściekową. W artykule podkreślono również konieczność prowadzenia dalszych inwestycji, które powinny być skierowane na obszary wiejskie.

SŁOWA KLUCZOWE: sieć wodno-kanalizacyjna, ścieki, obszary wiejskie, fundusze Unii Europejskiej

Introduction

The concept of development is related to some sort of purposeful and irreversible continuous changes occurring within the structure of complex objects, i.e. systems. Those changes may refer to the quantitative aspect, therefore augmentation or dwindling of certain object features, as well as to their quantitative aspect, i.e. emergence of new object features[1]. With reference to these regions this concept is commonly perceived as a broadly understood socio-economic development. It is important to note that spatial differentiation of region development with reference to individual areas has often subjective character and results from the geographical area diversification[2,3].One of the basic elements determining appropriate regions development in area of social and as well as economic realm is an adequate level of technical infrastructure. Transmission networks and nodal infrastructure related to the water and wastewater management are part of this mentioned infrastructure. This management plays a meaningful role in the regions development. It is the base of long-range changes through the elevation of population life standard and investment attractiveness whilst simultaneously protecting the natural environment.

Enlargement of the European Union highlighted the problem of differences in the interregional development in the whole Commonwealth as well as in the individual countries. The intensification of economic integration in the Europe turned out to be most beneficial in case of better developed countries and regions. In less developed areas a number of disadvantageous phenomena such as a lack of stimulus for continuous development, low social activity and entrepreneurship or strengthening population low life standard have been observed. It should be noted that in the longer time perspective the persistence of excessive differences between regions is unprofitable for socio-economic development of individual countries and whole European Union[4].

Provinces in Poland in terms of development are often divided into four groups. The highest level of development occurs in Mazovian Province and amounts to 70% of the European mean, for the EU-25. The second group con-

1 S. Kurek, *Przestrzenne zróżnicowanie poziomu rozwoju regionalnego w Unii Europejskiej w świetle wybranych mierników*, „Prace Komisji Geografii Przemysłu" 2010 nr 16, s. 87.

2 Z. Szymla, *Podstawy badań rozwoju regionalnego*, „Zeszyty Naukowe Wyższej Szkoły Ekonomicznej w Bochni" 2005 nr 3, s. 102.

3 A. Dubel, L. Preisner, *Ryzyko powodzi i suszy: osiągnięcia i wyzwania*, „Gospodarka Wodna" 2015 nr 8, s. 246.

4 Program Operacyjny Rozwój Polski Wschodniej 2007-2013, www.porpw.parp.gov.pl [15-02-2016]

sists of provinces with development level amounting at around 45% of the European mean, i.e. Silesian, Greater Poland, Lower Silesian and Pomeranian. To the third group one may account six provinces with development level equal to the 40% of European mean. To the last group which is characterized by the lowest level of development (about 33% of the European mean) one may count among: Warmian-Masurian, Podlaskie, Lublin, Świętokrzyskie and Podkarpackie provinces[5]. Listed group of provinces, under the common name Eastern Poland (EP) belongs to the regions of the lowest development level amongst all European Union regions.

The aim of this paper was to conduct the analysis and assessment of water and sewage management development in the Eastern Poland, with reference to the situation in remaining country regions. The area of study selection was dictated by the willingness to verify the consequences of increased efforts and founds dedicated to the elimination of broadly understood underdevelopment of this part of Poland. In this paper attention has been paid to the water and wastewater management, because it is perceived as a determinate factor of an appropriate region development.

Materials and methods

The source of data used in this study was the Local Data Bank of Central Statistical Office in Poland and Yearbooks of the Environmental Protection. Information regarding founds dedicated to the realization of selected investments in area of water and sewage infrastructure was obtained from the Polish Ministry of Regional Development website[6]. In this research common statistical parameters and selected measures and indicators have been applied. The analysis of processes intensity has been done by means of measures calculated based on: the population (people served by waterworks and sewage system) and with reference to the area (waterworks and sewage system saturation). The chain index of dynamics has been determined, which principle is to pertain the current level of investigated phenomenon to the level from the preceding period.

In order to visualize the obtained results a cartographic method of diagram map has been applied. It enabled simultaneous presentation of water volume consumption and waterworks saturation. A significant advantage of this method is the possibility of spatial quantitative analysis which makes it easier to discern existing dependencies.

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5 K. Fiedorowicz, J. Duda, *Polska Wschodnia-warunki wyjścia z niedorozwoju*, „Nierówności Społeczne a Wzrost Gospodarczy" 2007 nr 11, s. 612.

6 Ministry of Regional Development, www.mapadotacji.gov.pl [10-02-2016]

Results and discussion

In the mid-1990s the water and wastewater infrastructure on the area of whole country was significantly underfunded. In this respect significant discrepancies existed amongst individual provinces and within themselves. Particularly visible was disproportion between analyzed infrastructure in cities and rural areas, for the benefit of the first ones[7,8]. It is important to underlie that the total length and number of waterworks connections was several times greater than those of sewage systems.

In the years 1995-2013 the total length of waterworks increased by about several dozen percent. The Eastern Poland provinces at the background prevalent number of regions were characterized by the greatest increase in terms of the waterworks length. It did not translate into an adequate increase of waterworks connections, except Świętokrzyskie and Podlaskie provinces. This indicates much greater dispersed development in the remaining three provinces of the Eastern Poland. A confirmation in that regard may be a significantly lesser population density, which is one of the lowest in Poland.

Development of sewage system in the analyzed period was characterized by a much greater dynamics than it was in the case of waterworks. The mean annual growth rate is a confirmation of this phenomenon, which in reference to the sewage systems amounted from 5.6 to 13.1% (on average 7.6%) and in case of waterworks from 1.5 to 6.1% (on average 3.3%). As a result, in most of the provinces the total length of sewage system increase two or even three times. In the Eastern Poland provinces the length of analyzed network increased to the same extent an exception is Podkarpacie Province where this growth was almost nine fold. What is more this dynamic development of sewage system was accompanied by a simultaneous increase in number of household's connections (table 1).

Juxtaposition of waterworks and sewage system saturation indices (figure 1) points out to the increase of their value and a decrease in disproportion between provinces. Amongst EP provinces the situation underwent significant improvement, however to a different extent. Present waterworks and sewage system saturation in EP provinces is relatively high and does not significantly deviate from remaining provinces. One negative example is Pod-

7 B. Pięcek, *Infrastrukturalne uwarunkowania rozwoju przedsiębiorczości na obszarach wiejskich*, w: M. Kłodziński, A. Rosner (red.), *Ekonomiczne i społeczne uwarunkowania i możliwości wielofunkcyjnego rozwoju wsi w Polsce*, Warszawa 1997, s. 118.

8 I. Kropsz, *Zastosowanie metody analizy skupień oraz wielowymiarowej analizy korespondencji do oceny poziomu infrastruktury obszarów wiejskich*, "Journal of Agrobusiness and Rural Development" 2009 nr 3(13), s. 129.

Table 1. Changes in water and wastewater networks length along with the number of household's connections by provinces in the years 1995-2013

Province	Waterworks			Sewage system			Waterworks connections			Sewage connections		
	1995	2013	1995-2013	1995	2014	1995-2013	1995	2013	1995-2013	1995	2014	1995-2013
	[kkm]		[%]	[kkm]		[%]	[kkm]		[%]	[kkm]		[%]
Lublin	9,8	20,6	109,2	1,5	5,5	260,5	193,4	358,8	85,5	28,1	117,0	316,5
Podkarpacie	7,8	14,2	82,4	1,5	15,1	929,0	163,9	315,4	92,4	30,5	254,7	734,1
Podlasie	6,0	13,1	119,7	0,7	3,2	324,9	106,5	188,0	76,4	15,8	84,5	433,9
Świętokrzyskie	5,8	13,2	126,0	0,9	5,2	456,5	111,6	239,8	114,8	21,4	98,1	358,2
Warmia-Masuria	6,3	15,3	144,0	1,7	6,3	281,2	95,8	165,7	72,9	28,9	88,3	205,1
Lower Silesian	9,6	15,1	57,4	3,4	9,6	180,6	193,7	331,5	71,1	84,5	202,3	139,5
Kuyavian-Pomeranian	13,8	22,7	64,9	1,9	7,4	292,1	169,5	269,6	59,1	44,1	141,3	220,3
Lubuskie	3,7	6,7	80,4	1,0	3,3	225,3	76,4	129,0	68,9	23,6	65,2	176,7
Łódź	12,8	22,4	75,5	2,0	6,0	197,0	229,9	382,1	66,2	37,5	135,2	260,7
Lesser Poland	10,3	18,5	78,9	2,6	12,4	384,5	251,1	437,5	74,3	57,6	251,7	337,3
Mazovia	13,8	42,3	206,2	3,6	13,1	265,9	261,8	715,1	173,2	64,8	312,7	382,8
Opole	5,0	7,1	42,0	0,8	4,0	385,0	113,7	161,7	42,2	21,5	90,2	320,5
Pomerania	8,4	15,0	79,3	2,5	9,6	281,9	151,4	268,3	77,2	56,6	182,9	223,1
Silesia	15,4	20,5	33,3	4,4	13,5	206,2	402,0	591,9	47,3	98,2	321,7	227,4
Wielkopolska	20,9	30,4	45,0	2,7	11,5	326,5	340,8	538,5	58,0	69,6	294,1	322,6
West Pomeranian	6,1	10,6	73,3	2,3	7,3	219,8	117,4	180,3	53,6	49,9	124,1	148,6

Source: own elaboration based on Local Data Bank CSO data.

laskie province in which the sewage system length saturation remained at a relatively low level (15.7 km per 100 km^2).

Despite significant development of water and wastewater infrastructure in the analyzed period of time, a simultaneous decrease in terms of consumed water which leads to smaller volume of wastewater is being observed in the whole country. This situation results from the changes in the industry which occurred at the break of the 1980-90 of 20th century. The socio-economic transformation forced dismantling of many manufacturing facilities and extorted their liquidation[9]. At the same time these were the factories which could be characterized by a significant consumption of water. In case of households the factor which led to a decrease in consumed water was an introduction of measuring devices and increase in water prices. Additionally in the analyzed period the waster squandering has been minimized thanks to modern apparatus and the modernization of waterworks and sanitary devices[10].

The greatest decline in terms of consumed water and resulting wastewater were observed in most industrialized regions. Easter Poland provinces, except Świetokrzyskie are characterized by a relatively low number of water intensive branches of economy. Therefore the observed decline in consumed water in those regions was relatively low.

Intensive development of water and wastewater infrastructure led to a meaningful increase in number of population served by these facilities (table 2). A significant growth was observed in case of population having access to sewage systems. In the Eastern Poland provinces the increase in population using both elements of mentioned infrastructure belonged to the highest. It is important to note that this index gained much more in rural areas than in cities. A relatively high share of population served by sewage system occurs in rural areas of Subcarpathian province. It results from very high rural population in this region[11].

Despite significant growths the population served by water and wastewater infrastructure in the Eastern Poland regions remains at the lowest level in the whole country.

Because not always from an economic and technical point of view an investment in sewage system is possible, it is essential to equip those areas

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9 H. Hotloś, *Badania zmian poboru wody w wybranych miastach Polski*, „Ochrona Środowiska" 2010 nr 32(3), s. 39.

10 W. Marszelewski, A. Piasecki, *Analiza rozwoju infrastruktury ściekowej w Polsce w aspekcie ekologicznym i ekonomicznym*, „Zeszyty Naukowe SGGW Polityka Europejska, Finanse i Marketing" 2014 nr 11(60), s. 128.

11 A. Czudec, *Ekspertyza dotycząca województwa Podkarpackiego*, w: *Ekspertyzy do Strategii Rozwoju Społeczno-Gospodarczego Polski Wschodniej do roku 2020*, t. 2, Warszawa 2007, s. 845.

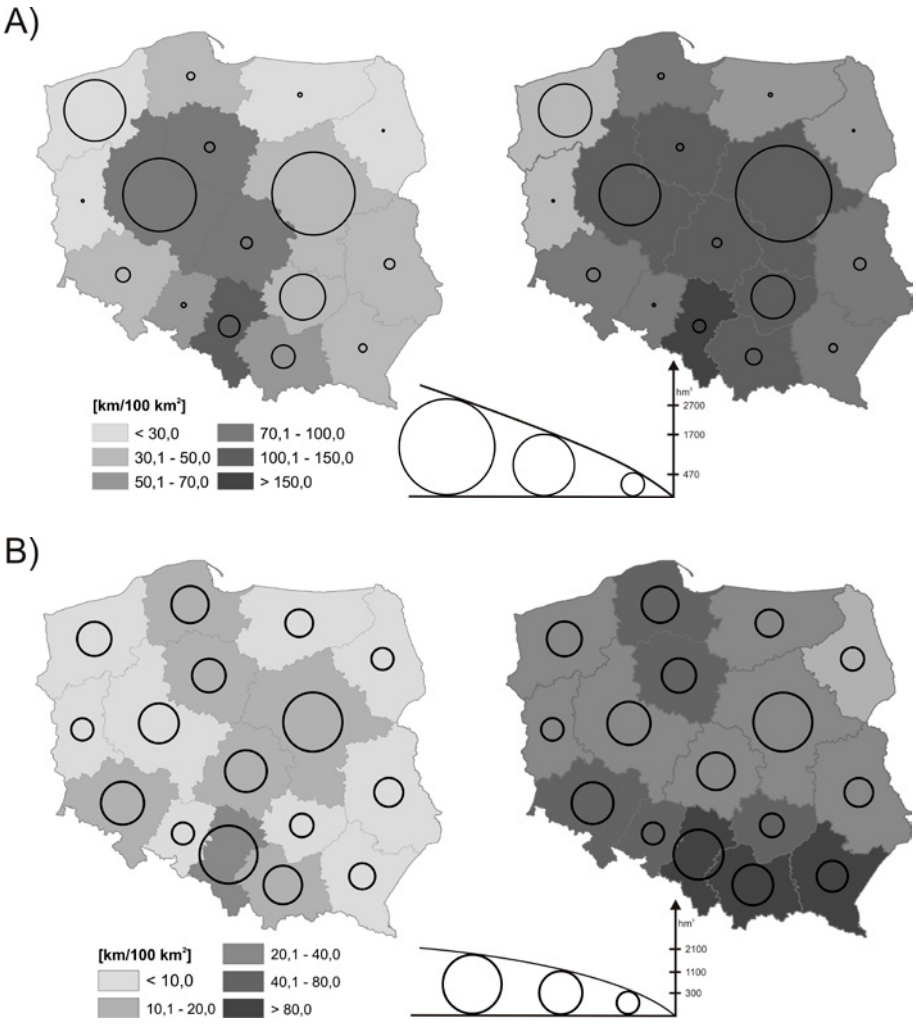

Figure 1. Waterworks (A) and sewage system (B) saturation, consumed water (A) and discharged wastewater

Source: own elaboration based on Local Data Bank CSO data.

with installations enabling storage and then reprocessing of impurities. Till the end of the 20th century the most common solution were holding tanks so called cesspools (figure 2). Currently the greatest number of holding tanks is located in Mazovia and Łódź Provinces however this value is systematically decreasing.

Table 2. Population served by waterworks and sewage system, by provinces

Province	Waterworks						Sewage system					
	overall		city		village		overall		city		village	
	[%]						[%]					
Lublin Province	77,1	81,9	92,7	94,0	63,5	71,5	43,0	49,7	83,5	86,7	7,6	17,7
Podkarpacie Province	72,4	76,7	90,5	92,4	60,0	65,7	44,5	62,6	81,7	86,9	19,3	45,5
Podlasie Province	84,8	88,2	95,2	96,1	69,9	76,2	55,3	62,1	85,9	90,4	11,3	19
Świętokrzyskie Province	79,6	84,8	93,6	95,1	67,7	76,5	41,1	52,5	80,9	85	7,6	26,1
Warmia-Masuria Province	86,4	89,4	96,9	97,5	70,6	77,7	62,1	68,3	90,8	93,1	18,7	32,3
Lower Silesian Province	90,3	92,1	96,4	96,9	75,1	81,2	55,0	60,9	80,8	85,1	7,3	19
Kuyavian-Pomeranian Province	89,2	91,2	95,7	96,2	78,4	83,7	55,5	64,7	81,6	87,8	8	23,2
Lubuskie Province	86,9	89,9	94,9	96,0	72,5	79,4	45,7	56,0	80,6	85,9	10,5	27,6
Łódź Province	88,0	89,9	93,9	94,5	77,1	82,0	65,5	71,5	78,8	82,9	15,4	32,3
Lesser Poland Province	70,5	76,4	90,3	94,1	50,6	59,6	58,9	65,5	84	88,4	13,4	26,2
Mazovia Province	77,6	84,5	88,5	91,8	57,9	71,5	54,7	64,6	82,7	88	16,6	35,8
Opole Province	94,1	94,6	97,3	97,5	90,6	91,5	72,1	77,5	89,2	90,8	33,1	48,3
Pomerania Province	91,2	93,1	97,1	98,1	78,7	83,9	64,8	70,8	83,6	87,2	18,1	33,5
Silesia Province	92,6	93,6	96,7	97,2	77,1	81,4	50,1	63,3	85,1	88,1	11,5	36,2
Wielkopolska Province	91,2	93,1	95,9	96,8	84,8	88,5	59,2	66,1	84,5	88,6	17,6	32,3
West Pomeranian Province	92,7	93,7	96,6	96,9	83,7	86,7	71,3	77,9	91,8	94	27,9	48

Source: own elaboration based on Local Data Bank CSO data

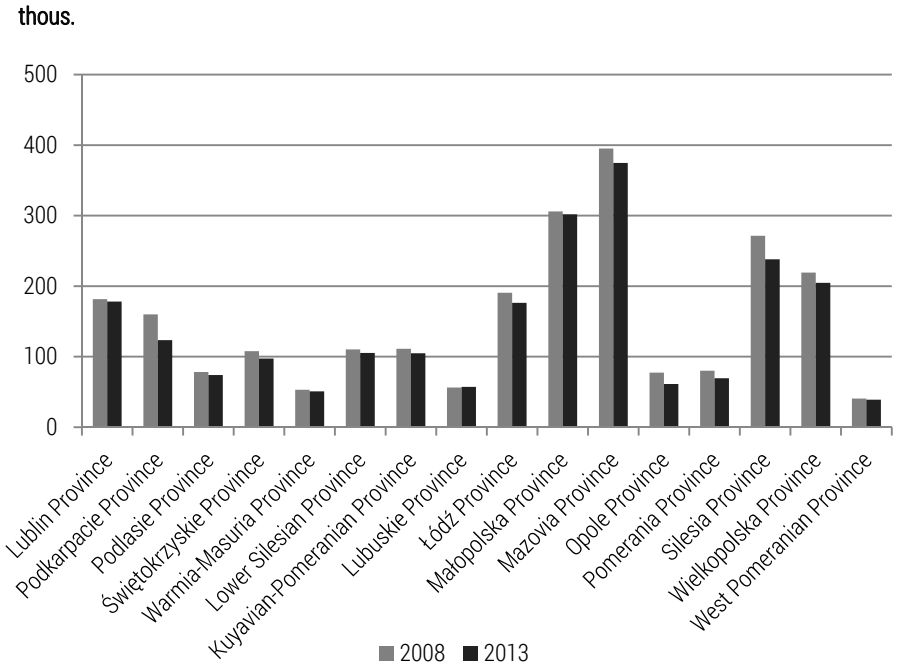

Figure 2. Number of wastewater holding tanks in the year 2008 and 2013

Source: own elaboration based on Local Data Bank CSO data.

Mainly ecological concerns caused that in recent years on non-sewered areas household treatment plants became a preferable solution (figure 3). The growth in terms of the number of individual wastewater treatment plants in the Eastern Poland was highest in Lublin province. Equally significant increase was observed in Podlaskie. It is important to highlight that both of these provinces were characterized by the lowest index of sewage system saturation. A contrary phenomenon occurred in the Podkarpacie province were the intensive development of sewage systems fulfilled population needs. However a relatively low number of individual wastewater treatment in Warmian-Masurian is a disturbing fact. In this case an ecological aspect is of vital importance, considering the large number of lakes prone to eutrophication.

For several years wastewater generated in municipal areas underwent only mechanical treatment, occasionally biological or chemical one. Poland accession to the European Union forced adjustment of national law and infrastructure to the commonwealth standards[12]. In consequence the increase in

[12] L. Kłos, *Stan infrastruktury wodno-kanalizacyjnej na obszarach wiejskich w Polsce a wymogi ramowej dyrektywy wodnej*, „Studia i Prace Wydziału Nauk Ekonomicznych i Zarządzania" 2011 nr 24, s. 75.

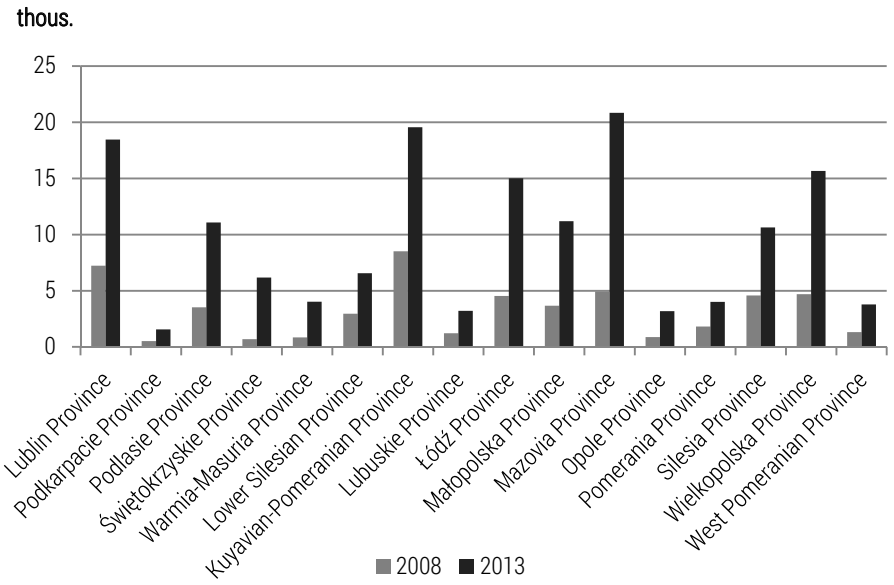

Figure 3. Number of individual treatment plants in the year 2008 and 2013
Source: own elaboration based on Local Data Bank CSO data.

number of biological wastewater treatment plant and those with increased bio gene removal (table 3). From an ecological point of view particularly important are wastewater treatment plants with increased bio gene removal. In comparison to other provinces the number of such plants in the Eastern Poland is relatively big. The greatest progress has been observed in Warmian-Masurian province. This fact should be perceived as a very positive one considering the previous remarks about other elements of water and wastewater infrastructure.

A swift orderliness of water and wastewater management in the area of largest cities was one of the priority targets created by the EU for Poland. The main problem was the amount of founds which should be spend to fulfill those requirements. The cost of creating water and wastewater infrastructure in cities are very high and result mainly from their complexity, the size of the whole waterworks and sewage system and local conditions. What is more a significant amount of funds had to be reserved for wastewater treatment plants and water intakes.

Table 3. Number of wastewater treatment plants by kind in the years 1995-2013

Provine	Wastewater treatment plants								
	mechanical			biological			with increased bio gene removal		
	1995	2004	2013	1995	2004	2013	1995	2004	2013
Lublin Province	4	13	9	75	187	246	4	22	31
Podkarpacie Province	6	5	0	49	153	190	2	31	37
Podlasie Province	0	0	1	28	67	83	1	33	30
Świętokrzyskie Province	5	2	0	28	59	80	0	30	35
Warmia-Masuria Province	17	6	0	44	115	166	3	60	66
Lower Silesian Province	14	1	5	92	141	159	2	57	66
Kuyavian-Pomeranian Province	13	2	0	54	88	109	1	31	31
Lubuskie Province	10	5	0	26	59	83	2	25	27
Łódź Province	4	0	2	42	80	159	6	36	39
Lesser Poland Province	9	3	0	83	189	180	2	35	63
Mazovia Province	6	4	2	75	195	236	5	46	71
Opole Province	13	1	2	22	45	44	0	18	25
Pomerania Province	6	10	3	51	172	142	5	42	42
Silesia Province	22	11	1	89	136	114	6	76	89
Wielkopolska Province	13	6	0	104	199	246	15	89	100
West Pomeranian Province	32	37	14	115	195	168	15	58	68

Source: own elaboration based on Local Data Bank CSO data.

From the beginning of the socio-economic transformation in Poland, one of the most important sources of founding were the EU aid programs. It started with Phare and then ISPA and SAPARD programs. In following years, the character of the EU help underwent gradual changes. At the beginning they aimed at boosting the system and economic transformation, but with the times they focused on integration. From 1 May 2004 Poland became a beneficiary of European structural funds and Cohesion Fund[13]. The biggest cities

[13] A. Piasecki, *Ramowa Dyrektywa Wodna a rozwój infrastruktury wodno-kanalizacyjnej w województwie kujawsko-pomorskim*, „Zeszyty Naukowe Szkoły Głównej Gospodarstwa Wiejskiego w Warszawie. Polityki Europejskie, Finanse i Marketing" 2013 nr 9(58), s. 356.

of the Eastern Poland used those funds very extensively when it comes to the development and modernization of water and wastewater infrastructure (table 4). Without them the realization of many investments would not be possible or strongly restricted.

Tabela 4. Largest water and wastewater management projects in Eastern Poland co-financed from the European Union

City	Project title	Value in [mln PLN]	Co-financing from the EU [mln PLN]
Olsztyn	Water and wastewater management in Olsztyn	296,9	92,8
Elbląg	Drinking water supply in Elbląg	95,8	58,3
Kielce	Complex protection of underground water in Kielce agglomeration	196,8	105,0
Końskie	Orderliness of water and wastewater management on the area of Końskie city and commune	164,0	81,3
Białystok	Development and modernization of water and wastewater system on the area of Białystok and Wasilków commune	102,0	59,3
	Improvement of water quality in Białystok	76,4	41,6
Suwałki	Modernization of wastewater treatment plant and development of water and wastewater infrastructure in Suwałki – stage II	44,0	25,4
	Improvement of water quality in Suwałki	46,5	22,7
Mielec	Orderliness of wastewater collection and treatment system in Mielec	101,8	69,2
Rzeszów	Improvement of drinking water in Rzeszów agglomeration	129,3	63,1
Sanok	Improvement of water and wastewater management in Sanok agglomeration	121,8	61,2
Lublin	Development and modernization of water supply and wastewater discharge system in Lublin	311,6	147,4
Chełmn	Modernization of wastewater treatment plant along with development of water and wastewater system in Chełm	104,6	46,1

Source: own elaboration based on portal www.mapadotacji.gov.pl [20-02-2016].

The dynamics and development of water and wastewater management in the Eastern Poland provinces should be acknowledge as positive and very significant. The local conditions caused the in each regions the realization of investment followed its specific path. In result, the development of individual elements of water and wastewater infrastructure among provinces is at a different level. In juxtaposition to other regions the scale and range of invest-

ments in the EP was greater. Thanks to that, but with a few exceptions, the level of development and accessibility to the water and wastewater infrastructure is comparable. Specifically it relates to the urban areas. However on the rural areas there are observable lacks in the accessibility to the analyzed infrastructure. Therefore further investments are needed, since as the experiences from other countries show, a significant stimulus which attracts capital to the rural areas is a well-developed infrastructure.

Conclusions

An endeavor to eliminate discrepancies related to the level of development is one of the basic tasks of countries and local governments. In this aspect an essential issue is an adequate development of technical infrastructure. Water and wastewater infrastructure along the mains, gas grid and roads networks is the main element assuring economic development of region which simultaneously improves life standard. Transformations which occurred in this area in the Eastern Poland provinces since the beginning of 90th are very significant. They enabled elimination of infrastructural gap which existed between EP and other regions.

The basic tangible benefit resulting from the conducted investments is a curtailment in number of contaminants escaping into the natural environment. The main contribution to the above mentioned fact one should ascribe to the wastewater treatment plants with an increased bio gene removal. Also a significant increase has been observed in terms of the infrastructure availability. Development of waterworks and improvement in water quality unarguably lead to an increase in population life standard – mainly rural population. Notable is also a greater population ecological awareness which led to decreasing number of septic tank replaced by household treatment plants. Closing the mentioned infrastructural gap directly translated into increase in economical attractiveness of the EP provinces. It relates also to the tourism potential which relies mainly on pure and minimally remolded natural environment.

Such a rapid and significant progress in area of water and wastewater management in the EP provinces and remaining regions would not be possible without financial and legal stimulus from the European Union. The biggest cities of the EP were particularly large beneficiaries of the EU funds. In most cases, obtained funds allowed modernization and orderliness of water and wastewater management.

In the upcoming years one should expect further infrastructural investment in area of water supply and wastewater discharge. Further investments

are needed in water and sewage infrastructure on rural areas. Mechanical wastewater treatment in Lublin Province should be replaced or modernized. On rural areas where building wastewater infrastructure in not economical viable, household wastewater treatment plants must supersede septic tanks.

The contribution of the authors in the article

MSc. Adam Piasecki – concept and objectives, literature review, research (40%)
MSc. Eng. Jakub Jurasz – concept and objectives, literature review, research (40%)
MSc. Michał Mięsikowski – objectives, literature review, research (20%)

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