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# WATER SUPPLY AND SEWERAGE INFRASTRUCTURE IN THE KRAKOW METROPOLITAN AREA OVER THE PERIOD 2003-2013

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***Abstract***

Water supply and sewerage infrastructure, which characterizes a particular territorial unit, is one of the key elements of its economic development. The sustainability index of water and sewage management system of the specific area, for which the total lengths of both water supply system and sewerage system are similar as it can be clearly seen, looking at the urban units of the Krakow Metropolitan Area, is absolutely vital. The apparent disparity between the lengths of both the water supply system and sewage system in the urban-rural and rural communes with a particularly significant shortage of sewerage infrastructure was shown. This proves the unsustainability of water and sewage management system in the area. A significant improvement in the condition of infrastructure in the analysed decade should be noted. This is clearly linked with the main objective of the Water Framework Directive and the subsequent participation of the analyzed area of KMA in the EU funds and other aid programs which aim at achieving a good level of water by 2015.

**Keywords**: Krakow Metropolitan Area, water supply and sewerage infrastructure, commune, the municipality, the Water Framework Directive

## INTRODUCTION

Expansion of water and sewerage infrastructure is an important determinant of the development of the domestic economy and of improving the standard of living of the population (Piasecki 2013b). Municipal infrastructure, especially sewage and water supply systems, within the Krakow Metropolitan Area showed at the very beginning of establishing the specific functional region of Malopolska a considerable degree of diversity in its various constituent governments. The report of the Statistical Office in Krakow (2013), summarizing the development of the Krakow Metropolitan Area in the years 2004 and 2011, states that water and sewerage infrastructure in the indicated period, as well as in the previous years, was systematically modernized. Intensification of investment in this respect is related to the adjustment of the level of municipal infrastructure to the requirements of the EU law and reasserted in the Water Framework Directive (WFD) the EU 2000/60/EC in which the year of 2015 was set as the date of achieving an optimal state of water and sewerage infrastructure by Poland (Piasecki 2013a). Undertaken investments are also part of a trend of overcoming infrastructure stagnation during and after political transformation in the field of water and sewage management system, particularly in rural communes resulting from negligence of the post-war period (Piasecki 2013c, Kwapisz 2005). In this context, the evaluation of the development of water and sewerage infrastructure of the Krakow Metropolitan Area after the first decade of its functioning provides grounds for research.

## THE PURPOSE AND METHODOLOGY OF RESEARCH

The purpose of the study was to determine the saturation and dynamics of changes in water and sewerage infrastructure in the years 2003-2013 in urban, urban-rural, rural communes and towns with county rights being part of the Krakow Metropolitan Area. The data obtained allowed to determine whether establishing in 2003 the urban settlements with the city of Krakow as an economic and administrative centre, contributed within a decade of functioning of the metropolitan area to the increase of water and sewerage infrastructure saturation of municipalities, communes and towns with county rights being part of the area. Individual communes of Malopolska counties, that are Bochnia, Krakow, Miechow, Myślenice, Proszowice, Olkusz and Wieliczka's counties, were incorporated into the Krakow Metropolitan Area. Due to the fact that not all communes of Bochnia, Proszowice, Wadowice, Miechow and Olkusz's counties had been included in the Krakow Metropolitan Area, communes and towns which had county rights were considered as the basic administrative unit thereby

resigning from taking a county as the basic research unit. The condition of water and sewerage infrastructure in the years 2003 and 2013 was described using saturation indicators. To determine the indicators have been taken into consideration the length of collective sewerage system and the length of distributive water supply system based on surface area of 100 km$^2$ (Gruszczyński, Kwapisz 2000). The obtained results were used to determine a degree of saturation change and a pace of saturation of the mentioned infrastructure in the decade considered in the research consecutively for towns with county rights, municipalities, urban-rural and rural communes. To make the full characteristics of the development of water and sewerage infrastructure of KMA in the analyzed period the assessment of number of water supply and sewerage connections as well as the number of people using the water supply and sewerage systems was carried out. The pace of change in this area was estimated using a dynamic percentage index. The source data was collected on the basis of resources from Local Data Bank of CSO.

## CHARACTERISTICS OF THE RESEARCHED AREA

The Krakow Metropolitan Area (KMA) was appointed by the Act No. XV/174/03 of the Malopolska Regional Assembly on 22 December 2003 during modification the zoning plan of the Malopolska Region. The territory of KMA is 4 065,1km$^2$, covering an area of 50 municipalities (including the City of Krakow), urban-rural and rural communes located in the north-western part of the Malopolska Region (Figure 1). The Krakow Metropolitan Area is located in the area of the Krakow-Czestochowa Upland, the Malopolska Upland, the Sandomierz Basin, the Oswiecim Basin and the Carpathian Foothills. Density of population stands at 370 persons$\times 10^3$m$^{-2}$. The population oscillates at around 1.5 million, representing 44.6% of the total inhabitants of the Malopolska Region. A concentration of the population is visible in the metropolis (50.6%) and in the municipalities directly adjacent to it. The coefficient of urbanization in 2011 reached the level of 62.6%. Urban-rural and rural communes show a comparable percentage of the population (approx. 23.5%), half lower than in municipalities (53%). The most densely populated urban-rural communes are Wieliczka, Świątniki Górne and Skawina, while the most densely populated rural commune is Zielonki commune. The lowest population density was recorded in rural communes: Gołcza and Drwina. The analyzed settlement area is characterized by significant industrialization and a high share of the service sector in the economy of the region, with their visible concentration in Krakow and neighbouring municipalities. Agricultural communes dominate the northern part of the Metropolitan Area (Report *Krakow Metropolitan Area in the years 2004-2011*,

the US in Krakow in 2013; Report on the condition of zoning of Malopolska Region 2014; *Krakow Metropolitan Area*, Statistical Handbook of Regional Civil Servant 2015).

Source: *Krakow Metropolitan Area*, Statistical Handbook of Regional Civil Servant 2015

**Figure 1.** The administrative structure of the Krakow Metropolitan Area

## RESULTS AND DISCUSSION

In 2003 the total length of the water supply system in the rural communes of KMA amounted to 3501.7 kilometres. Of the 36 rural communes three of them: Tokarnia, Lubień and Trzciana did not have a water supply system. The water supply infrastructure saturation index reached the level of $127.9 \cdot 10^3 m \times 10^5 m^{-2}$. By 2013, there had been an increase of the total length of the system by 733,9 km.

Among the group of the rural communes only the Tokarnia commune still did not have a public water supply system. In the decade 2003-2013 was observed an increase of saturation of water supply infrastructure at 21% (Table 1).

**Table 1.** Saturation of distributive water supply systems and collective sewerage systems in rural communes of KMA in the years 2003 and 2013.

| Rural communes | The length of water supply system in km 2003 | The length of water supply system in km 2013 | The length of sewerage system in km 2003 | The length of sewerage system in km 2013 |
|---|---|---|---|---|
| Biskupice | 40,3 | 101,1 | 0,0 | 0,0 |
| Gdów | 233,0 | 257,9 | 30 | 37,5 |
| Kłaj | 104,7 | 92,5 | 47,5 | 46,7 |
| Brzeźnica | 139,2 | 136,1 | 15,1 | 23,1 |
| Trzyciąż | 104,8 | 106 | 9,0 | 18,4 |
| Lanckorona | 26,8 | 82,5 | 2,6 | 9,5 |
| Stryszów | 26,4 | 53,3 | 0,0 | 92,5 |
| Proszowice | 180,9 | 223,1 | 21,4 | 28,5 |
| Koniusza | 218,8 | 221 | 10,8 | 52,3 |
| Koszyce | 39,6 | 95 | 24,2 | 115,0 |
| Nowe Brzesko[1] | 98,7 | 101,8 | 5,1 | 0,0 |
| Lubień | 0,0 | 8,4 | 75 | 42,2 |
| Pcim | 3,4 | 3,4 | 8,6 | 18,0 |
| Raciechowice | 64,7 | 66,7 | 3,5 | 3,5 |
| Siepraw | 100,7 | 106 | 32,3 | 85,2 |
| Tokarnia | 0,0 | 0,0 | 0,3 | 24,2 |
| Wiśniowa | 35,1 | 56,6 | 15,3 | 53,1 |
| Gołcza | 124,1 | 128,7 | 0,0 | 23,1 |
| Czernichów | 132,8 | 137 | 48,4 | 83,4 |
| Igołomia-Wawrzeńczyce | 5,3 | 77,5 | 1,3 | 0,0 |
| Iwanowice | 155,7 | 162,2 | 0,0 | 12,4 |
| Jerzmanowice-Przeginia | 108,9 | 121,5 | 0,0 | 34,3 |
| Kocmyrzów-Luborzyca | 204,4 | 211,2 | 0,0 | 33,2 |
| Liszki | 166,8 | 178,0 | 25,2 | 90 |
| Michałowice | 101 | 101,4 | 3,6 | 18,5 |
| Mogilany | 125,8 | 137,3 | 31,9 | 47,6 |
| Sułoszowa | 88,0 | 91,9 | 0,0 | 39,2 |

| Rural communes | The length of water supply system in km 2003 | The length of water supply system in km 2013 | The length of sewerage system in km 2003 | The length of sewerage system in km 2013 |
|---|---|---|---|---|
| Wielka Wieś | 78,7 | 95 | 14,2 | 111,1 |
| Zabierzów | 209,0 | 232,4 | 117,0 | 334,4 |
| Zielonki | 126,6 | 161,6 | 48,2 | 167,5 |
| Bochnia | 198,1 | 219,7 | 36,1 | 133,5 |
| Drwinia | 29,8 | 120,4 | 0,0 | 0,0 |
| Łapanów | 125,2 | 159,2 | 22,6 | 28,0 |
| Rzezawa | 78,0 | 108,6 | 23,7 | 95,8 |
| Trzciana | 0,0 | 52,6 | 0,8 | 34,6 |
| Żegocina | 26,4 | 28,0 | 13,5 | 23,7 |
| Total length of systems for rural communes of KMA ($10^3$m) | 3501,7 | 4235,6 | 687,2 | 1960,0 |
| The area of rural communes of KMA ($10^3m^2$) | 2736,91 | | | |
| *Saturation index for rural communes of KMA ($10^3m \times 10^5m^{-2}$)* | 127,9 | 154,8 | 25,1 | 71,6 |
| *Dynamic index (%)* | 21,0 | | 185,2 | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

The total length of the sewerage system in rural communes of the Metropolitan Area in 2003 amounted to 687.2 km. Eight of the 36 rural communes among which were Biskupice, Stryszów, Gołcza, Iwanowice, Jerzmanowice-Przeginia, Kocmyrzów-Luborzyca, Sułoszowa, Drwinia did not have a sewerage system. The sewerage infrastructure saturation index equalled to $25.1 \cdot 10^3m \times 10^5m^{-2}$. By 2013, there had been an increase of 1272.8 km of the total length of the sewerage system in the group of rural communes. But two of them, which are Drwina and Biskupice, still do not have a sewerage system, while Igołomia-Wawrzeńczyce and Brzesko communes, which in 2003 had access to the researched infrastructure, there was no active sewerage system in 2013. However, in the decade was observed a significant increase of 185.2% in the sewerage infrastructure saturation index (Table 1).

In the rural communes the number of water supply connections in 2003 amounted to 61816 units. Of the 36 rural communes, residents of three communes: Tokarnia, Lubień and Trzciana did not have water supply connections. By 2013,

[1]The Ordinance of the Council of Ministers of 20 December 2010 classified Municipality of Nowe Brzesko as urban-rural commune from 1st January 2011. For statistical purposes because of the area and nature of the municipality it was adopted as a rural commune.

the number of connections had increased by 37%. But, at the end of the research period residents of the Tokarnia commune still did not have access to water supply connections (Table 2).

**Table 2.** Water supply and sewage connections in rural communes of KMA in years 2003 and 2013.

| Rural communes | The number of water supply connections 2003 | The number of water supply connections 2013 | The number of sewerage connections 2003 | The number of sewerage connections 2013 |
|---|---|---|---|---|
| Biskupice | 1052 | 2132 | 0 | 0 |
| Gdów | 3675 | 3989 | 512 | 988 |
| Kłaj | 2757 | 2750 | 943 | 1126 |
| Brzeźnica | 2255 | 2600 | 161 | 281 |
| Trzyciąż | 1894 | 2043 | 215 | 333 |
| Lanckorona | 412 | 1246 | 14 | 133 |
| Stryszów | 427 | 835 | 0 | 1229 |
| Proszowice | 2748 | 3471 | 755 | 918 |
| Koniusza | 1957 | 2182 | 103 | 409 |
| Koszyce | 681 | 838 | 387 | 1048 |
| Nowe Brzesko | 1384 | 1444 | 233 | 309 |
| Lubień | 0 | 262 | 1130 | 614 |
| Pcim | 42 | 62 | 115 | 277 |
| Raciechowice | 636 | 844 | 59 | 74 |
| Siepraw | 1295 | 1902 | 423 | 832 |
| Tokarnia | 0 | 0 | 6 | 429 |
| Wiśniowa | 504 | 1023 | 270 | 697 |
| Gołcza | 1690 | 1790 | 0 | 378 |
| Czernichów | 3164 | 4041 | 779 | 1356 |
| Igołomia-Wawrzeńczyce | 99 | 1038 | 12 | 0 |
| Iwanowice | 1992 | 2426 | 0 | 236 |
| Jerzmanowice-Przeginia | 2607 | 2841 | 0 | 497 |
| Kocmyrzów-Luborzyca | 2924 | 4373 | 0 | 497 |
| Liszki | 3601 | 4442 | 630 | 1990 |
| Michałowice | 1964 | 3452 | 64 | 231 |
| Mogilany | 2060 | 3772 | 825 | 1219 |
| Sułoszowa | 1351 | 1457 | 0 | 793 |

| Rural communes | The number of water supply connections 2003 | The number of water supply connections 2013 | The number of sewerage connections 2003 | The number of sewerage connections 2013 |
|---|---|---|---|---|
| Wielka Wieś | 2580 | 3669 | 245 | 1706 |
| Zabierzów | 5191 | 6741 | 1854 | 6101 |
| Zielonki | 3375 | 5998 | 1365 | 3755 |
| Bochnia | 3647 | 4896 | 4387 | 10209 |
| Drwinia | 398 | 1329 | 0 | 0 |
| Łapanów | 1344 | 1813 | 323 | 456 |
| Rzezawa | 1650 | 1916 | 481 | 1791 |
| Trzciana | 0 | 326 | 39 | 459 |
| Żegocina | 460 | 740 | 256 | 685 |
| The total number of connections for rural communes of KMA | 61816 | 84683 | 16586 | 42056 |
| Dynamic index (%) | 37 | | 154 | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

The number of sewerage connections in rural communes in 2003 amounted to 16586 units. In the group of 36 rural communes residents of eight of them among which were Biskupice, Stryszów, Gołcza, Iwanowice, Jerzmanowice-Przeginia, Kocmyrzów-Luborzyca, Sułoszowa, Drwinia did not have sewerage connections. By 2013, the number of connections had increased by 154%. But still, in two communes Biskupice and Drwina there were no sewer connections while in Igołomia-Wawrzeńczyce commune, which in 2003 had 12 connections, no increase has been observed by 2013 (Table 2).

The number of people using a water supply system in rural communes of KMA in 2003 amounted to 225.3 thousand residents. In the decade was observed an increase of 22% in the number of residents using water supply infrastructure (Table 3).

In 2003 the number of people using sewerage infrastructure in rural communes of KMA amounted to 53.7 thousand residents. By 2013 there had been a significant increase of 129% in the number of residents using a sewerage system (Table 3).

In urban-rural communes of the Krakow Metropolitan Area in 2003, the total length of the water mains was 1,528.5 km. Of the 12 urban and rural communes all of them had water supply systems. The water supply infrastructure saturation index was equal to $157.3 \cdot 10^3 m \times 10^5 m^{-2}$. By 2013 there had been an increase of 388.5km of the total length of the system. Thus, the water supply infrastructure saturation index increased by 25.4% compared to 2003 (Table 4).

**Table 3.** Number of people using the collective water supply and sewage systems in rural communes of KMA in years 2003 and 2013

| Rural communes | Users of water supply system 2003 | Users of water supply system 2013 | Users of sewerage system 2003 | Users of sewerage system 2013 |
|---|---|---|---|---|
| Biskupice | 3117 | 5820 | 0 | 0 |
| Gdów | 11895 | 13775 | 2093 | 4120 |
| Kłaj | 9778 | 9435 | 4025 | 4703 |
| Brzeźnica | 8230 | 8550 | 533 | 960 |
| Trzyciąż | 6732 | 6720 | 1044 | 1410 |
| Lanckorona | 1202 | 3209 | 52 | 589 |
| Stryszów | 860 | 2088 | 0 | 3484 |
| Proszowice | 12267 | 13184 | 5651 | 6275 |
| Koniusza | 7092 | 7483 | 541 | 1786 |
| Koszyce | 2135 | 2500 | 1433 | 2786 |
| Nowe Brzesko | 4442 | 4537 | 723 | 965 |
| Lubień | 8864 | 9657 | 2271 | 2721 |
| Pcim | 509 | 1015 | 1551 | 2282 |
| Raciechowice | 2555 | 3172 | 196 | 407 |
| Siepraw | 5359 | 6589 | 884 | 3041 |
| Tokarnia | 481 | 307 | 63 | 2158 |
| Wiśniowa | 1179 | 2756 | 781 | 2660 |
| Gołcza | 5417 | 5308 | 0 | 1224 |
| Czernichów | 9944 | 11417 | 2848 | 4537 |
| Igołomia-Wawrzeńczyce | 653 | 3412 | 122 | 127 |
| Iwanowice | 7114 | 7924 | 0 | 528 |
| Jerzmanowice-Przeginia | 10094 | 10496 | 0 | 2588 |
| Kocmyrzów-Luborzyca | 10432 | 12705 | 0 | 1756 |
| Liszki | 11584 | 13288 | 2031 | 6087 |
| Michałowice | 6467 | 9047 | 396 | 1331 |
| Mogilany | 6590 | 10220 | 2553 | 4362 |
| Sułoszowa | 5439 | 5362 | 0 | 2665 |
| Wielka Wieś | 8181 | 10395 | 1003 | 5562 |
| Zabierzów | 18052 | 21476 | 8718 | 17819 |
| Zielonki | 11851 | 17364 | 5023 | 11771 |
| Bochnia | 12375 | 15301 | 1075 | 3287 |

| Rural communes | Users of water supply system 2003 | Users of water supply system 2013 | Users of sewerage system 2003 | Users of sewerage system 2013 |
|---|---|---|---|---|
| Drwinia | 1635 | 3869 | 0 | 0 |
| Łapanów | 4833 | 5668 | 1367 | 2071 |
| Rzezawa | 5993 | 6977 | 2011 | 5549 |
| Trzciana | 0 | 1229 | 201 | 1721 |
| Żegocina | 1927 | 2804 | 1194 | 2602 |
| Percentage share in relation to the total population of KMA(%) | 15,0 | 18,4 | 3,6 | 8,2 |
| Dynamic index(%) | 22 | | 129 | |
| KMA population (2013) (thousand) | 1 498 499 | | | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

**Table 4.** Saturation of distributive water supply systems and collective sewerage systems in urban-rural communes of KMA in years 2003 and 2013.

| Urban-rural communes | The length of water supply systems in km 2003 | The length of water supply systems in km 2013 | The length of sewerage systems in km 2003 | The length of sewerage systems in km 2013 |
|---|---|---|---|---|
| Nowy Wiśnicz | 23,4 | 76,1 | 9,7 | 24,6 |
| Krzeszowice | 247,4 | 266,6 | 51,5 | 105,4 |
| Skała | 100,00 | 106,3 | 16,8 | 110,4 |
| Skawina | 156,8 | 254,2 | 36,6 | 91,5 |
| Słomniki | 146,3 | 174,2 | 9,4 | 16,9 |
| Świątniki Górne | 70,5 | 73,6 | 6,7 | 18,8 |
| Dobczyce | 133,9 | 145,7 | 28,3 | 46,3 |
| Myślenice | 198,5 | 256,5 | 97,6 | 292,6 |
| Sułkowice | 37,1 | 77,3 | 11,0 | 67,7 |
| Proszowice | 180,9 | 223,3 | 21,4 | 28,6 |
| Kalwaria Zebrzydowska | 127,7 | 138,2 | 9,2 | 16,2 |
| Wadowice | 106 | 125,0 | 98,1 | 157,9 |
| Total length of systems for urban-rural communes of KMA ($10^3$m) | 1528,5 | 1917,0 | 396,3 | 976,9 |

| Urban-rural communes | The length of water supply systems in km 2003 | The length of water supply systems in km 2013 | The length of sewerage systems in km 2003 | The length of sewerage systems in km 2013 |
|---|---|---|---|---|
| The area of urban-rural communes of KMA ($10^3$m$^2$) | 971,43 | | | |
| Saturation index for urban-rural communes of KMA ($10^3m \times 10^5m^{-2}$) | 157,3 | 197,3 | 40,8 | 100,6 |
| Dynamic index (%) | 25,4 | | 146,5 | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

The total length of the sewerage system in urban-rural communes of KMA in 2003 amounted to 396.3 km. All of the analyzed municipalities and communes had a sewerage system. The saturation index was equalled $40.8 \cdot 10^3 m \times 10^5 m^{-2}$. By 2013, there had been an increase of 580.6 km of the total length of the sewage system. This indicates a significant increase of 146.5% in the sewerage infrastructure saturation index in the audited decade (Table 4).

The number of water supply connections in the urban-rural communes of the Krakow Metropolitan Area amounted to 12051 units in 2003. All of the 12 urban and rural communes had water connections. By 2013, there had been an increase of 26% in the number of connections (Table 5).

**Table 5.** Water supply and sewage connections in the urban-rural communes of KMA in years 2003 and 2013

| Urban-rural communes | Number of water supply connections 2003 | Number of water supply connections 2013 | Number of sewerage connections 2003 | Number of sewerage connections 2013 |
|---|---|---|---|---|
| Nowy Wiśnicz | 693 | 756 | 253 | 315 |
| Krzeszowice | 7684 | 8101 | 1734 | 2943 |
| Skała | 2866 | 3629 | 1082 | 2100 |
| Skawina | 4964 | 7272 | 908 | 2483 |
| Słomniki | 2033 | 2445 | 645 | 793 |
| Świątniki Górne | 1545 | 2553 | 168 | 322 |
| Dobczyce | 2910 | 3647 | 661 | 1193 |
| Myślenice | 5806 | 7671 | 3373 | 6560 |
| Sułkowice | 1325 | 2024 | 166 | 1119 |
| Proszowice | 2748 | 3471 | 755 | 918 |

| Urban-rural communes | Number of water supply connections 2003 | Number of water supply connections 2013 | Number of sewerage connections 2003 | Number of sewerage connections 2013 |
|---|---|---|---|---|
| Kalwaria Zebrzydowska | 3268 | 3930 | 294 | 316 |
| Wadowice | 4352 | 5048 | 2012 | 3347 |
| The total number of connections for urban-rural communes of KMA | 40194 | 50547 | 12051 | 22409 |
| Dynamic index (%) | 26 | | 66 | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

**Table 6.** Number of people using the collective water supply and sewage systems in urban-rural communes of KMA in years 2003 and 2013

| Urban-rural communes | Users of water supply systems 2003 | Users of water supply systems 2013 | Users of sewerage systems 2003 | Users of sewerage systems 2013 |
|---|---|---|---|---|
| Nowy Wiśnicz | 3191 | 5527 | 1122 | 2383 |
| Krzeszowice | 29470 | 30710 | 9723 | 13790 |
| Skała | 8549 | 9651 | 3419 | 5810 |
| Skawina | 34947 | 38504 | 18549 | 23309 |
| Słomniki | 9476 | 10036 | 3455 | 3759 |
| Świątniki Górne | 6268 | 7994 | 586 | 1297 |
| Dobczyce | 11395 | 13047 | 4292 | 6087 |
| Myślenice | 25403 | 30598 | 18955 | 28154 |
| Sułkowice | 6308 | 8353 | 1160 | 5426 |
| Proszowice | 12267 | 13184 | 5651 | 6275 |
| Kalwaria Zebrzydowska | 10557 | 12637 | 16360 | 1769 |
| Wadowice | 27880 | 29590 | 20732 | 25158 |
| Percentage share in relation to the total population of KMA(%) | 12,4 | 14,0 | 6,9 | 12,3 |
| Dynamic index(%) | 13,0 | | 18,5 | |
| KMA population (2013) (thousand) | 1 498 499 | | | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

The number of sewage connections in the urban-rural communes amounted to 12051 units in 2003. Residents of all 12 urban and rural communes possessed sewage connections. By 2013, there had been an increase of 66% in the number of connections (Table 5). In 2003 the population using a water supply system in urban-rural communes of KMA amounted to 185.7 thousand residents. In the decade was observed an increase of 13% in the number of residents using water supply infrastructure (Table 6).

The number of people using sewerage infrastructure in the urban-rural communes of KMA in 2003 amounted to 104.0 thousand residents. By 2013, there had been a significant increase of 18.5% in the number of people with access to the sewerage system (Table 6).

In towns with county rights of the Krakow Metropolitan Area the total length of the water supply system in 2003was 1,121.4 km. The water supply infrastructure saturation index was equal to 343.1 persons$\times 10^3 m^{-2}$. By 2013, there had been an increase of 224.3 km of the total length of the system. Thus, the water supply infrastructure saturation index increased by 20% compared to 2003 (Table 7).

**Table 7.** Saturation of distributive water supply systems and collective sewerage systems in towns with county rights of the Krakow Metropolitan Area in years 2003 and 2013.

| Towns with county rights | The length of water supply systems in km 2003 | The length of water supply systems in km 2013 | The length of sewerage systems in km 2003 | The length of sewerage systems in km 2013 |
|---|---|---|---|---|
| Krakow | 1121,4 | 1345,7 | 1049,9 | 1360,0 |
| Area of KMA ($10^3 m^2$) | 326,85 | | | |
| Saturation index for towns with county rights of KMA ($10^3 m \times 10^5 m^{-2}$) | 343,1 | 411,7 | 321,2 | 416,1 |
| Dynamic index (%) | 20 | | 30 | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

The total length of the sewerage system in towns with county rights of KMA in 2003 amounted to 1049.9 kilometres. The saturation index amount came to 321.2 persons$\times 10^3 m^{-2}$. By 2013, there had been an increase of the total length of the sewage system of 310.1 km. This suggest an increase of 30% in the sewerage infrastructure saturation index in the audited decade (Table 7).

In the municipalities of the Krakow Metropolitan Area the total length of the water supply system in 2003 equalled 66.8 km. The water supply infrastructure saturation index was amounted to 223.3 persons$\times 10^3 m^{-2}$. By 2013, there

had been an increase of 12.5 km of the total length of the system. Thus, the water supply infrastructure saturation index increased by 19% compared to 2003 (Table 8).

**Table 8.** Saturation of distributive water supply systems and collective sewerage systems in municipalities of KMA in years 2003 and 2013.

| Municipalities | The length of water systems in km 2003 | The length of water systems in km 2013 | The length of sewerage systems in km 2003 | The length of sewerage systems in km 2013 |
|---|---|---|---|---|
| Bochnia | 66,8 | 79,3 | 69,6 | 150,6 |
| Area of KMA ($10^3$m$^2$) | 29,92 | | | |
| Saturation index for municipalities of KMA ($10^3m \times 10^5m^{-2}$) | 223,3 | 265,0 | 232,6 | 503,3 |
| Dynamic index (%) | 19 | | 116 | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

The total length of the sewerage system in the municipalities in 2003 amounted to 69.6 km. By 2013, there had been an increase of 81 km in the length of the sewerage system. The saturation index increased considerably by 116% in comparison with the year 2003 (Table 8).

In towns with county rights of the Krakow Metropolitan Area the number of water supply connections in 2003 amounted to 33,705 units, while in the municipalities to 3691 units. By 2013, there had been an increase in the number of connections in towns with county rights of 22% and in municipalities of 21% (Table 9).

**Table 9.** Water supply and sewage connections in towns with county rights and municipalities of KMA in years 2003 and 2013

| Towns with a county status | The number of water supply connections 2003 | The number of water supply connections 2013 | The number of sewerage connections 2003 | The number of sewerage connections 2013 |
|---|---|---|---|---|
| Krakow | 33705 | 40662 | 28476 | 37986 |
| Dynamic index (%) | 21 | | 33 | |
| Municipalities | | | | |
| Bochnia | 3691 | 4490 | 1891 | 3187 |
| Dynamic index (%) | 22 | | 69 | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

In 2003 the number of sewage connections in towns with county rights amounted to 28476 units. By 2013, there had been an increase of 33% in the number of connections. At the same time was noticed an increase of 69% in the number of connections in municipalities (Table 9).

The number of users the water supply system in towns with county rights of the Krakow Metropolitan Area amounted to 706.6 thousand residents. In the decade was observed an increase of the number of users water supply infrastructure of 7.1%. At the same time the number of residents using water supply system in the municipalities of KMA increased by 4.1% (Table 10).

**Table 10.** Number of users of water supply and sewerage systems in towns with county rights and municipalities of KMA in years 2003 and 2013.

| Towns with a county status | Users of water supply systems 2003 | Users of water supply systems 2013 | Users of sewerage systems 2003 | Users of sewerage systems 2013 |
|---|---|---|---|---|
| Krakow | 706650 | 756828 | 670646 | 692844 |
| Percentage share in relation to the total population of KMA (%) | 4,7 | 5,1 | 4,5 | 4,6 |
| Dynamic index (%) | 7,1 | | 3,3 | |
| KMA population (2013) (thousand) | 1 498 499 | | | |
| Municipalities | | | | |
| Bochnia | 26993 | 28102 | 23178 | 25413 |
| Percentage share in relation to the total population of KMA (%) | 1,8 | 1,9 | 1,5 | 1,7 |
| Dynamic index (%) | 4,1 | | 9,6 | |
| KMA population (2013) (thousand) | 1 498 499 | | | |

Source: own calculations based on the Local Data Bank of Central Statistical Office in Warsaw

The number of people using the sewerage system in towns with county rights of KMA in 2003 amounted to 670.6 thousand residents. In the decade was observed an increase of 3.3% in the number of residents using water supply infrastructure. At the same time the number of residents benefiting from a sewerage system amounted to 23.2 thousand in the municipalities of KMA. By 2013, the number of residents utilizing sewerage infrastructure had grown by 9.6% (Table 10).

## SUMMARY

Close values of the total lengths of both water and sewerage systems are a significant indicator of the sustainability of water and sewage management system of the given area. In the analyzed region a sustainable level of development of the water and sewage management system in 2013 was reached by the city of Krakow and the Bochnia Municipality with a constant upward trend of water and sewerage infrastructure saturation in these areas in the first decade of functioning of KMA. In 2013 in the urban-rural and rural communes was evident a significant disproportion between the lengths of water supply and sewerage systems with a significant shortage of sewerage infrastructure which indicates an unbalanced water and sewage management system in these municipalities in the analyzed decade.

For urban-rural municipalities in the year 2013, saturation factor increase of the water supply network by 25.4% while the sewerage network by 146.5% compared to the year 2003. The higher level of expansion of water supply system over sewerage system in the rural communities may result from the functional type of the communes and their focus on agriculture with the dominance of greenhouse cultivation and fruit farming. This trend is likely to continue in the coming years. In relation to 2003 in designated municipalities significantly increased the number of water supply and sewage connections in rural and urban-rural communes as well as the number of users the water and sewer infrastructure.

For rural municipalities in the year 2013, saturation factor increase of the water supply network by 21% while the sewerage network by 185.2% compared to the year 2003. There were municipalities, which in the years 2003-2013 did not undertake the construction of a sewerage system and numerous cases of municipalities that in the audited decade effectively finalized the construction process. All municipalities of the Krakow Metropolitan Area had had water supply system by 2013. Therefore it can be concluded that establishing the Krakow Metropolitan Area as an active beneficiary of national and the EU funds contributed overall to the increase of water supply and sewerage infrastructure saturation in the constituent municipalities, communes and towns with county rights.

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