REPAiR

REsource Management in Peri-urban AReas: Going Beyond Urban Metabolism

D.3.5. Process model for the follow-up cases: Łódź

Version 2

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Publishable Summary

Deliverable 3.5 of Work Package 3 REPAiR project presents an integrated analysis of the caste study in the Łódź region with a focus on organic waste (Vegetable, Fruit and Garden waste fraction) production and processing, and the transition to a circular society. It comprises spatial, social and material flow analyses of this case study area and follows the guidelines of D3.1 and D3.3. The main goal of the report is to present the status quo of a waste management system in Łódź. The report delivers Spatial, Material Flow and Social Analyses for the Łódź Metropolitan Area. Taking into account assumptions of the REPAiR project, selecting the appropriate type of waste, which will be subjected to a detailed analysis become a necessity. Considering statements of the User Board members, PULL workshops' participants and bearing in mind challenges facing the Łódź agglomeration in the field of proper waste management, it was decided to conduct the material flow analysis concerning- biodegradable municipal waste regarding the Vegetable, Fruit and Garden (VFG waste) fraction. Finally, this report reflects on the factors disturbing the waste flow and summarize with some policy recommendations.

1. Introduction

This report – Deliverable 3.5 of WP3 – concerns an integrated analysis of the follow-up case of Łódź of the scope of waste generation and treatment. It comprises spatial, social and material flow analyses of this case study area and follows the guidelines of D3.1 (Geldermans et al., 2017) and D3.3 (Geldermans et al., 2018). The main goal of the report is to present the status quo of a waste management system in Łódź.

Chapter 2 is dedicated to the Spatial and Social Analyses. It presents the research results of the Poland and Łódź case study. It starts with a spatial and socio-economic analysis and is divided into a numerous subtasks: geographical situation and the natural environment, demography, labour force, economy, transportation, wastescapes. An elementary spatial and socio-economic analysis on a national level precedes and more detailed analysis on focus area level. As well that part concern the analysis of waste sensitivity addressed by local stakeholders.

Chapter 3 enables the identification of key activities and actors with their geolocation related to material flows to allow a spatial understanding of the network of actors at the focus area level. This understanding is crucial for the development of suiting eco-innovative solutions. Taking into account assumptions of the REPAiR project, selecting the appropriate type of waste, which will be subjected to a detailed analysis become a necessity. Considering statements of the User Board members, PULL workshops' participants and bearing in mind challenges facing the Łódź agglomeration in the field of proper waste management, it was decided to conduct the material flow analysis concerning- biodegradable municipal waste regarding the Vegetable, Fruit and Garden (VFG waste) fraction.

Chapter 4 concerns a reflection on the case study in the Łódź.

2. Spatial and socio-economic analysis

2.1 Spatial and socio-economic analysis – Poland

2.1.1. Geographical location and the natural environment

Poland is mainly a lowland country located in Central Europe. The landscape is diversified in the north by numerous lakes and post-glacial hills, whereas in the south is enriched by the mountain ranges of the Sudetes and the Carpathians. Temperate transitional climate is characterized by a varied impact of air masses flowing from diverse directions. In the east the continental, whereas in the west the oceanic impact are more pronounced. In general, climatic conditions foster diversification of vegetation and enable agricultural cultivation of a large variety of plants (Kondracki, 2011).

The drainage system runs along the south-north axis and is dominated by tributaries of two main rivers - the Vistula and the Oder, which flow into the Baltic Sea. Forests comprise about 29% of the state's territory with a predominance of coniferous association composed of pine and spruce. A relatively large area is occupied by semi-

natural landscapes, many of which are embraced by various forms of legal protection. The most unique are the Białowieża National Park with the last natural forest in the East European Plain, the Biebrza National Park comprising the largest swamp area in Europe with numerous species of rare marsh birds, and the Bieszczady National Park representing natural refuge gathering mountain plants and animals (kondracki, 2011).

Areas characterized by the highest extent of anthropopressure are located in central and southern Poland. Particularly significant environmental transformation have taken place in densely populated areas in the south of the country stretching from Kraków, through Upper Silesia to Wrocław. Relatively good agro-ecological conditions have caused over 50% of the country's area to be occupied by agricultural land.

2.1.2. Demography

The total number of inhabitants in Poland is approximately 38 million, which gives a population density of 122 people per km2. About 60% of residents live in cities, and this value is gradually decreasing, which is related to enhancing migration from urban to suburban areas. This is a relatively recent process (last 20 years). Previously, the level of urbanization was dynamically growing. However, in the case of typical rural areas, located peripherally to large cities, a permanent population decline is generally observed (Bański, 2017).

As provided by data of the 2002 National Census, over 96% of respondents declared Polish nationality. Among the minorities, the largest groups by number are as follows: Germans, Ukrainians and Belarusians (Statistical Atlas of Poland, 2018).

Until the beginning of the 1990s, there has been a gradual and moderate increase in the number of Poland’s inhabitants. In the last three decades, population number has been stabilizing, however over the last few years, a slight decrease of the population has been observed. Permanent migration has largely contributed to population loss (international migration balance for permanent residence has been negative for a number of years). Moreover, the family model has changed and the multiple children families are no longer common. Women’s fertility rate for in 2016 was 1.29, while in 1970 over 2.1.

As an aftermath of changes occurring in demographic processes, including dramatic decrease in the number of children born in the 1990s and early 2000s, the share of young inhabitants aged 0-17 in population is declining. In 1990, they comprised 29%, while in 2011 merely 18.5% of the total. Currently, the government's provisions, in form of financial incentives (e.g. the "500+"programme) are aimed at improving demographic situation by increasing the number of births. The program has been implemented for two years, therefore it is difficult to assess its results.

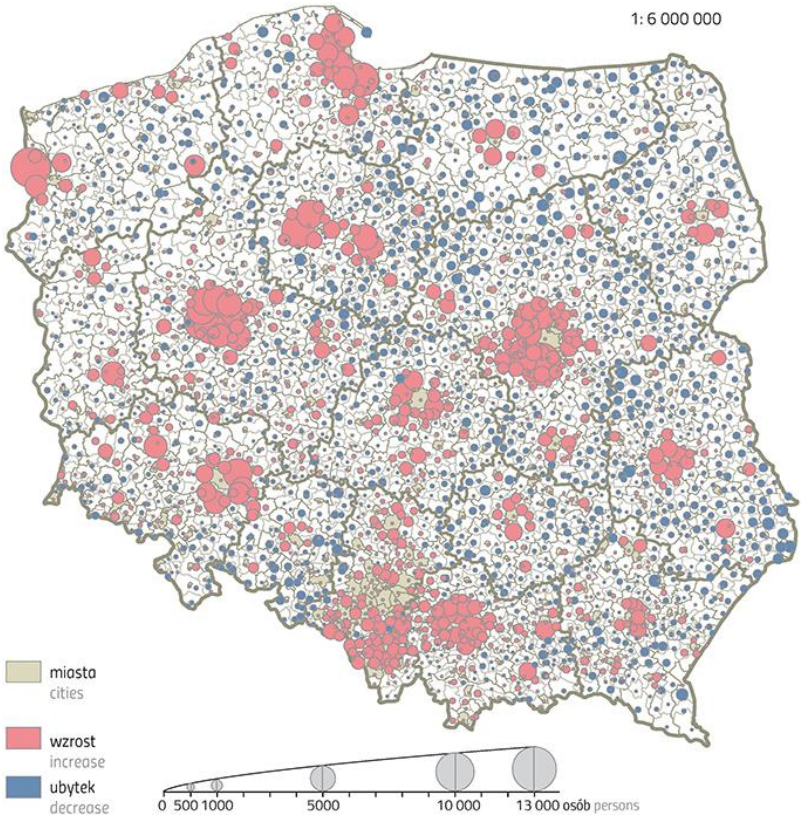


Fig. 1. Net domestic migration rate in rural areas by communes, 1995-2012.

Source: Atlas obszarów wiejskich w Polsce (2016).

Since the beginning of the 1990s, there has been a pronounced shift in the peak women's fertility rate from the 20-24 to 25-29 age group. Moreover, fertility in the 30-34 age group has also significantly increased, which is the result of the so-called postponed births. The new social and cultural models are characterized, among others, by commencing an intensive career by young people before starting a family and postponing plans related to having children for later. Young people first decide to acquire a certain level of education and financial stabilization and only then they start families. Other phenomena are conducive to such processes. For instance, education level of youth is increasing. In relation to the early 1990s, the percentage of mothers with higher education increased from 6% to 32% (as of 2008).

Considering the gender structure, there is a general predominance of women, with an excess of 1.2 million in absolute value comparing to men. The gender structure varies depending on the age group. In the youngest age group (0-14 years), men prevail, in the group of 15-64 proportion between genders is balanced, while the majority of the oldest inhabitants are definitely women. This is related to the average life expectancy in these two groups - life expectancy for men is around 71.9, while 80.1 for women (as of 2008).

Demographic and social structure of Poland's population is clearly differentiated in spatial terms. Generally, the area of the southern Carpathian foothills and the Kashubian Lake District in the north of the country is demographically younger and is distinct for a

balanced age structure. The largest demographic problems related to population aging, migration outflow of well-educated inhabitants and population occur in the eastern regions of Poland (Atlas obszarów wiejskich w Polsce, 2016).

2.1.3. Labour force

According to data gathered by the Central Statistical Office, in 2018 the number of working population was 16,565,000 (of which 5,182,000 are employed in industry, 1,604,000 in agriculture and 9,703,000 in service and trade). There is a growing lack of employees in the Polish labour market, mainly in the field of construction, medical service and trade. In recent years, shortages in specific professions are filled by foreigners mainly coming from Ukraine and to a lesser extent Belarus. Some of them are employed illegally and transfer funds to their home countries. It is estimated that over 1 million Ukrainians are already working in Poland. The most recent trend in Poland's labour market is related to inflow of employees from Asia (e.g. India).

In mid-2018, the registered unemployment rate was 5.8%, being the lowest value since 1990. The total number of registered unemployed was 959,000. However, the unemployment rate indicator is a statistical mean, because in reality there are large areas where its value is 3-4 times higher. This pertains mainly to peripheral areas and border regions, distant to large cities comprising large labour markets. In such territories, a considerable number of inhabitants benefit from various forms of social assistance. This is however excessively used - there is a group of people who, despite vacancies in the labour market, prefer not to work.

2.1.4. Economy

In 2015, Poland was the sixth EU economy considering the GDP level (according to the purchasing power parity) and in this respect was ranked 24th in global terms. The economy of the country is mixed, with predominance of the private sector, in 2015 its share in gross value added was over 80%.

The Polish economy has been developing very dynamically in recent years. In 2017, the GDP increased by 4.6%. However, being under the Soviet sphere of influence for half a century has caused severe delay in the socio-economic development in relation to Western European countries. The GDP in 2017 (nominally) per capita amounted to USD 13,811, which is just over 40% of the average for the EU countries.

As provided by the UN analysis, the quality of life in Poland is also improving and this is considered a stable process. In 2015, the value of the Human Development Index (HDI) was 0.855, which gave Poland 36th position among all 188 examined states. This index in 2013 was accounted to value of 0.821 ranking Poland as 39th on the UN list.

There is an evident regional polarization in terms of socio-economic development in Poland. Central regions are characterized by the highest level of development (Mazowieckie Voivodeship is the richest region in the country and in 2014 reached GDP

per capita in purchasing power parity at the level of 108% the EU's average), while the eastern regions are regarded as least developed in socio-economic terms (Lubelskie Voivodeship is the poorest region with the GDP level at 47% of the EU's average). Regions belonging to the so-called Eastern Wall of Poland are supported by an additional Eastern Poland Economic Promotion Programme, whose aim is above all to accelerate economic development of these areas and to mitigate disparities in relation to other Polish regions (launching and developing start-ups, providing support for small and medium-sized enterprises, establishing innovative products or services, investment in public transport, roads and railways, etc.).

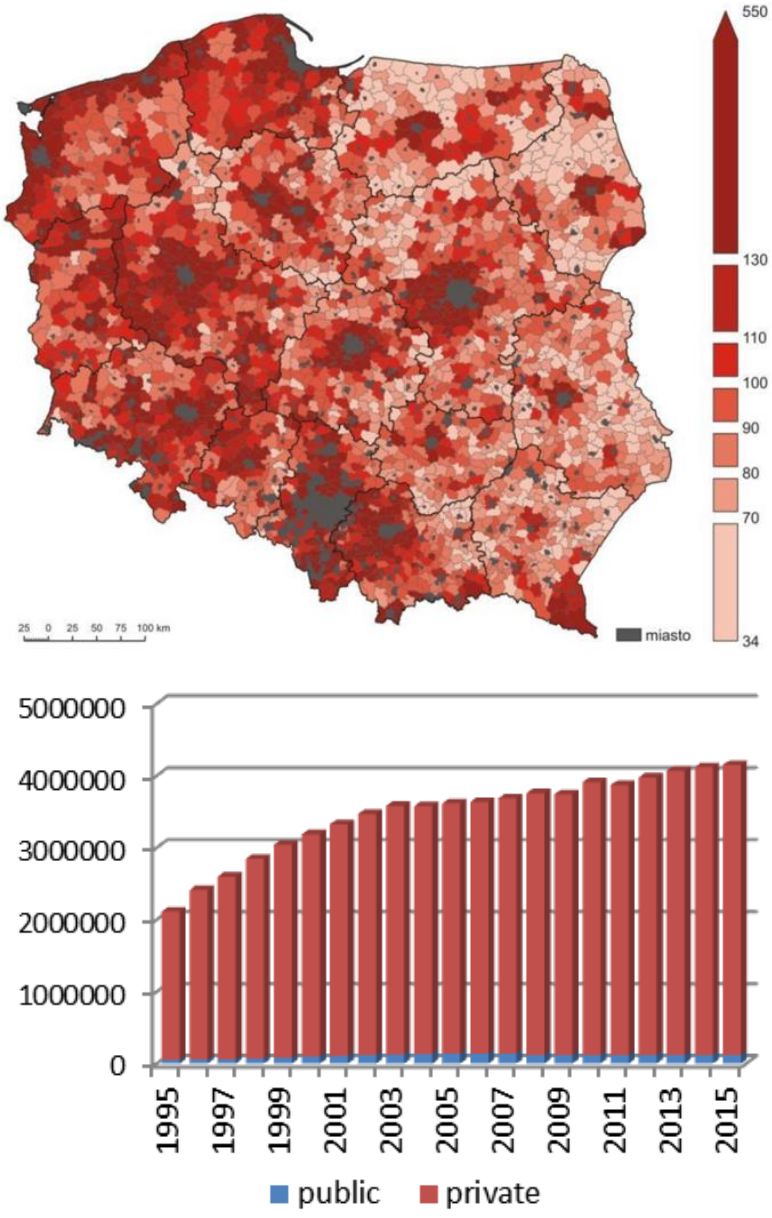


Fig. 2. Private and public economic entities in Poland 1995-2014.

Source: own elaboration based on GUS data.

2.1.5. Waste sensitivity

In 2015, a total of 142 million tons of waste was generated in Poland, of which 11 million tons comprised municipal waste, and 131 million tons - other waste, more than half of which is attributable to mining and related industry. The amount of municipal waste increases every year by several percent. On average, one inhabitant of Poland generated 282 kg of municipal waste in 2015. This is one of the lowest values among the EU states (the average for the European Union was 474 kg per capita).

As it is described in the deliverable No. 3.2. of the REPAiR project, corporate environmentalism refers the recognition and integration of environmental concerns into a firm's decision-making process, is one way that business can address environmental issues (Banerjee 2002). Firm's pro-environmental behaviours can be twofold. One of them is 'externally' regulated (by a meta-governmental, governmental, local governmental organisation). The other one – that is more important from the point of view of environmental consciousness - is self-regulatory mechanism. It is attributed to a variety of different motives (and as an interdependent phenomenon, 'understanding what really motivates corporate environmentalism is important for policymakers, since the effectiveness of government environmental policies depends in large part on how corporations will respond to them' (Lyon & Maxwell 2004: 16). The latter approach (self-regulatory mechanism) – that is also called as corporate environmentalism (Banerjee 2002) – is usually manifested in the use of environmental management systems such as the EU's Eco-Management and Audit Scheme (EMAS) and the International Organization for Standardization's ISO 14001 (Hillarya & Thorsenb, 1999; Neugebauer 2012). The first version of EMAS was issued in 1993 while the first version of ISO 14001 was launched in 1996.

'ISO 14001:2004 specifies requirements for an environmental management system to enable an organization to develop and implement a policy and objectives which take into account legal requirements and other requirements to which the organization subscribes, and information about significant environmental aspects. 'ISO 14001:2015 revised this management system including more strict regulations for firms applying for the certification (www.iso.org).

Concerning the ISO database in 2016 Poland had 3034 ISO 14001:2004 certificates on 2773 sites and 150 ISO 14001:2015 certificates on 99 sites. The number of firms (3034) with ISO 14001 means that 2% of the ISO 14001 certificates can be found in Poland from Europe. The trend in this certificates shows an increase in Poland with three increasing phases (Figure X).According to the ISO survey of 2016, an increase in ISO 14001 standards is observed in Poland and this growth is more rapid than on average in Europe. However, this primarily results from a significantly lower number of certificates issued so far in Poland comparing to such countries as the Netherlands, Germany or Italy.

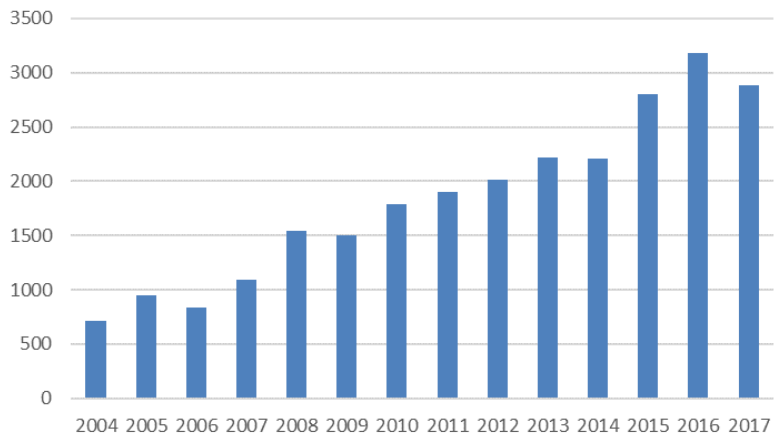


Fig. 3. ISO 14001 certificates in Poland according to ISO survey of 2017.

Source: https://www.iso.org/the-iso-survey.html

In his empirical investigation, Kudłak (2017) analysed the most important drivers motivating companies to implement ISO 14001 environmental management systems (EMS). Although the research on the period of 1996-2006 (and analysed 3 different sub-periods) the order of drivers revealed remained in the same order with similar 'indication percentage'. The chief three drivers was found by Kudłak are (1) the effort to eliminate their adverse impact on the natural environment (58.36%), (2) the wish to enhance their image (58.36%), and (3) the wish to comply with environmental regulations. Kudłak also pointed out that the importance of economic drivers and the stakeholder's pressure remained relatively low as well (Kudłak 2017).

Having regarded the EMAS database 72 certifications are reported in 2017 in Poland, 2 of them from Łódź, both from public administration sector. (In Poland, the two major sector bearing EMAS certification is the public administration (almost 28%) and the waste management sector (22%).

In Deliverable 3.2 it was outlined SSCA-1 (the first phase of the Secondary Socio-cultural Analysis) based on data obtained from Flash Eurobarometer 388. The elaborated composite index of Waste-conscious Behaviour (WCB) comprised an 11-item variable about various waste-related individual perceptions and attitudes. Accordingly, the WCB index used individual responses which later aggregated on national level (for details, please, see: Deliverable 3.2 of the REPAiR project). In the WCB-rank of the EU member states Poland's score (6.82 from the 0–11 scale) was close to the EU mean value (6.89). It can be stated that the awareness of Polish society in the field of "waste-related issues" is relatively high. The index (taking values between 0 and 11) is the highest eastern and southern regions. Generally, spatial disparities are inconsiderable; the peak value is 7.06, while the lowest - 6.55. The selected case study region is the closest one to the national mean value. However, it should be considered whether the methodological assumptions of the indicator are correct, due to surprising results that all regions of Poland exceeded the average value of this indicator for the Netherlands (6.32), in which ecological awareness of residents seems higher.

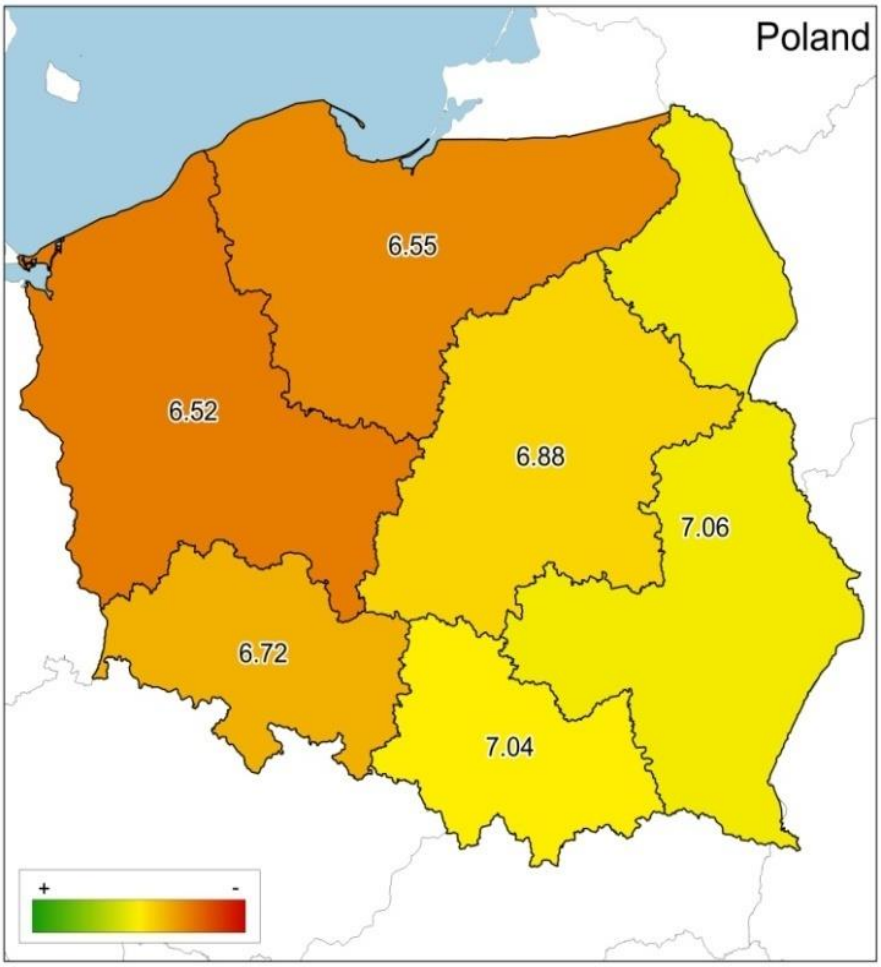


Fig. 4 Spatial distribution of WCB index in Poland

Source: Authors' elaboration based on data from Flash Eurobarometer 388

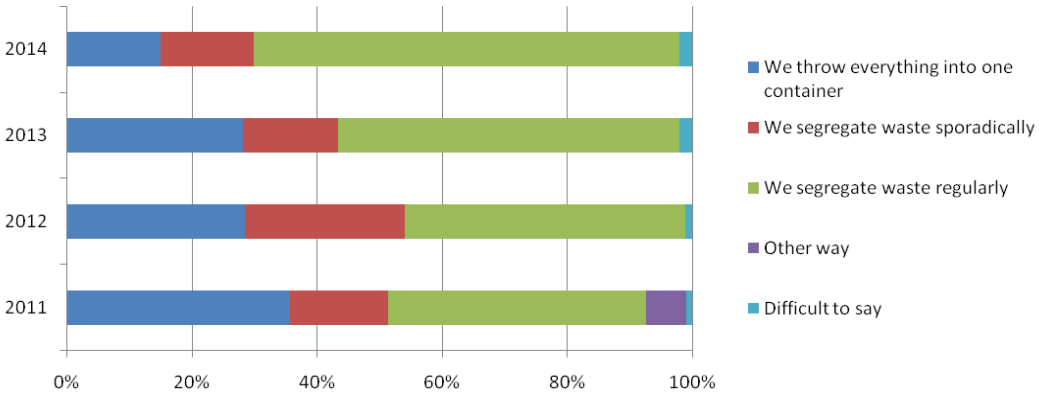


Fig. 5. Respondents' answers to the question: *How do you get rid of waste in your household?*
Source: Study on ecological awareness and behaviour of Poland's residents, Ministry for the Environment, 2014.

As provided by research conducted by the Ministry for the Environment, about 70% of Poland's residents segregate waste. Every third inhabitant segregates garbage occasionally or throws everything into one container. Among the reasons for not segregating waste, respondents most often declare lack of dedicated space for waste segregation or lack of appropriate containers around the place of residence. Among the segregated waste types, about 77% is glass, 76% plastics, and 67% paper. Inhabitants' opinion concerning waste management in Poland is also improving. In 2011, 34% of respondents rated waste management definitely well and rather well and 58% definitely bad and rather bad. By contrast, in 2014 these answers were reversed; 53% of respondents expressed positive, while 34% negative opinions.

2.2 Spatial and socio-economic analysis – Łódź Metropolitan Area

2.2.1. Geographical location and the natural environment

The Łódź Metropolitan Area (in Polish: Łódzki Obszar Metropolitalny, abbreviated as ŁOM) is located in central Poland and comprises the main communication hub on the north-south (Gdańsk-Upper Silesia) and east-west (Warsaw-Poznań) axes. The ŁOM area is characterized by a generally lowland landscape with slightly varied terrain relief. In the south, there are low hills associated with the transition area of the Małopolska Upland, while east of Łódź there are hills of the Wzniesienia Łódzkie Landscape Park being an aftermath of the Pleistocene glaciations. The drainage system is poorly developed, which generates issues related to water shortage. The number of water reservoirs is also inconsiderable.

The Łódź Metropolitan Area has been strongly transformed by human activity, mainly during the 19th century industrialization and accompanying processes of urbanization and development of the communication network. The vegetation is rather poor and forests comprise less than 20% of the Łódź agglomeration area (mean forested area for Poland is around 29%). Most of forest stands are damaged. Landscape parks account for 4.3% of the ŁOM area while nature reserves merely 0.3%. All the mentioned characteristics induce to consider this area to be rather unattractive from the environmental point of view and therefore tourist and recreational function is not regarded as a significant development factor.

ŁOM encompasses five counties – NUTS 4 administrative units (City of Łódź, Łódź East, Brzeziny, Zgierz and Pabianice) and has an area of 2500 km2. It consists of 28 communes NUTS 5 administrative units (Aleksandrów Łódzki, Andrespol, Brójce, Dłutów, Dmosin, Dobroń, Brzeziny town, Brzeziny commune, Głowno town, Głowno commune, Jeżów, Koluszki, Konstantynów Łódzki, Ksawerów, Lutomiersk, Łódź, Nowosolna, Ozorków town, Ozorków commune, Pabianice town, Pabianice commune, Parzęczew, Rogów, Rzgów, Stryków, Tuszyn, Zgierz town and Zgierz commune), inhabited by over 1.1 million people. Spatial distribution of 12 urban centres is relatively polycentric with a clear demographic and functional domination of the city of Łódź.

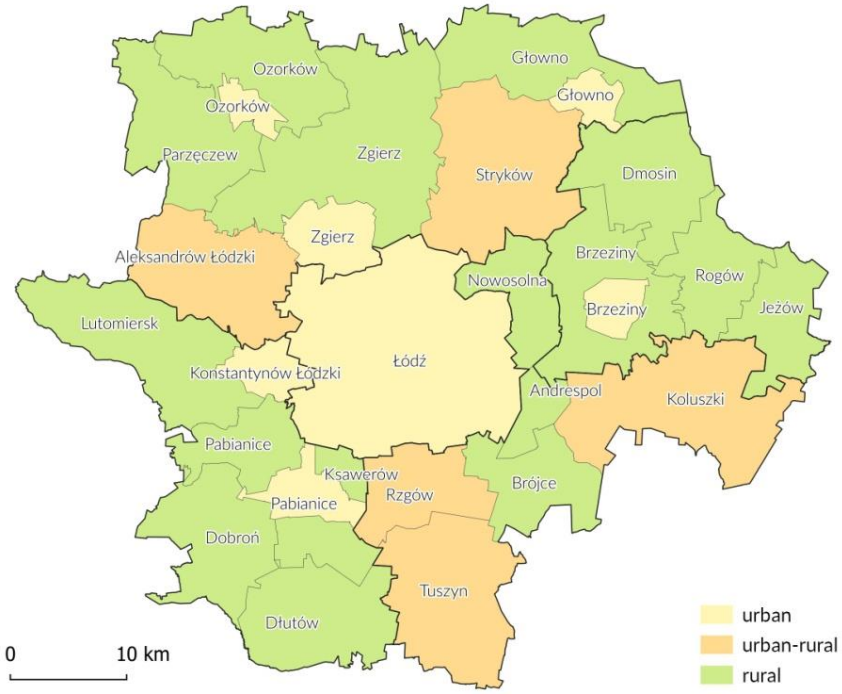


Fig. 6. Łódź Metropolitan Area (ŁOM) administrative units.

Source: own elaboration.

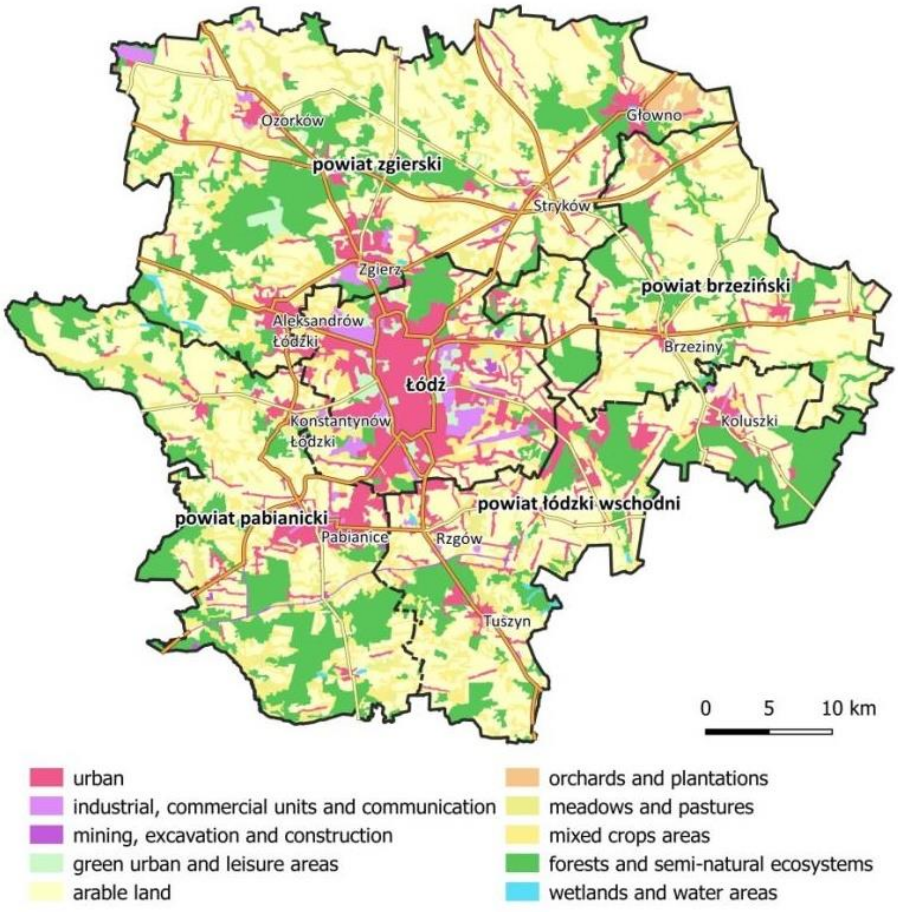


Fig. 7. Land use in Łódź Metropolitan Area, 2012.
Source: own elaboration based on Corine Land Cover data.

Photo 1. Different types of built-up areas – city centre of Łódź, new suburbs, traditional village.

Source: K. Czapiewski, A. Traczyk

2.2.2. Demography

The Łódź Metropolitan Area is inhabited by 1.1 million people of which 706,000 are residents of the city of Łódź. The remaining 35% of the population mainly inhabits its vicinity – adjacent communes. The mean population density of the examined area exceeds 441 people/km2 while in urban areas it is as high as 1800 people/km2 while in rural and urban-rural communes there are 72 people/km2.

In the last two decades there has been a decline in the number of Łódź inhabitants and concurrently an increase in the number of residents in its vicinity. Since 2002, the migration balance is negative in the city of Łódź, whereas positive in the neighbouring communes. This is mainly related to intense settlement of former Łódź residents in communes adjacent to the city, as confirmed by dynamic development of single-family housing.

For a number of years Łódź had been the most important textile industry centre in Poland[1]. Among the employees of this sector, the number women massively migrating to the city largely exceeded men. As a result, the gender structure has been clearly deformed. For instance, in 1968, Łódź had the highest feminization rate in Poland - 115.5. Until today, ŁOM is the most feminized region. Currently, the city of Łódź is characterized by feminization index of about 120, and the Łódź agglomeration - 110. The most feminized age group pertains to inhabitants of Łódź in the post-productive age; with 175 women per 100 men.

Likewise in other regions of Poland, the aging process is also observed in the ŁOM. The number of people in the post-working age is increasing while the share of the youngest age groups is declining. This process has a greater pace in the city of Łódź than its vicinity. Currently in the city there are averagely 1.7 people in the post-working per one person in the pre-working age. In the case of the Łódź suburban area, this value is significantly lower and amounts to 1.2.

Both the national and ethnic structure of the Łódź agglomeration area does not differ significantly from the statistical average for Poland.

[1] Great portrait of the development of Łódź in 19th century can be found in the novel “The Promised Land” (Polish: Ziemia obiecana) from 1899 by the Polish author and Nobel laureate, Władysław Reymont. Set in Łódź, “The Promised Land” tells the story of three close friends and ruthless young industrialists: a Pole, a German and a Jew, struggling to build their own factory in the heartless world of the late 19th century labour exploitation. Reymont's novel vividly paints a portrait of the rapid industrialization of Łódź and its cruel effects on workers and mill owners. Reymont writes: "For that 'promised land' – for that tumour – villages were deserted, forests died out, the land was depleted of its treasures, the rivers dried up, people were born. And it sucked everything into itself. And in its powerful jaws it crushed and chewed up people and things, sky and earth, in return giving useless millions to a handful of people, and hunger and hardship to the whole throng". (source: Wikipedia).

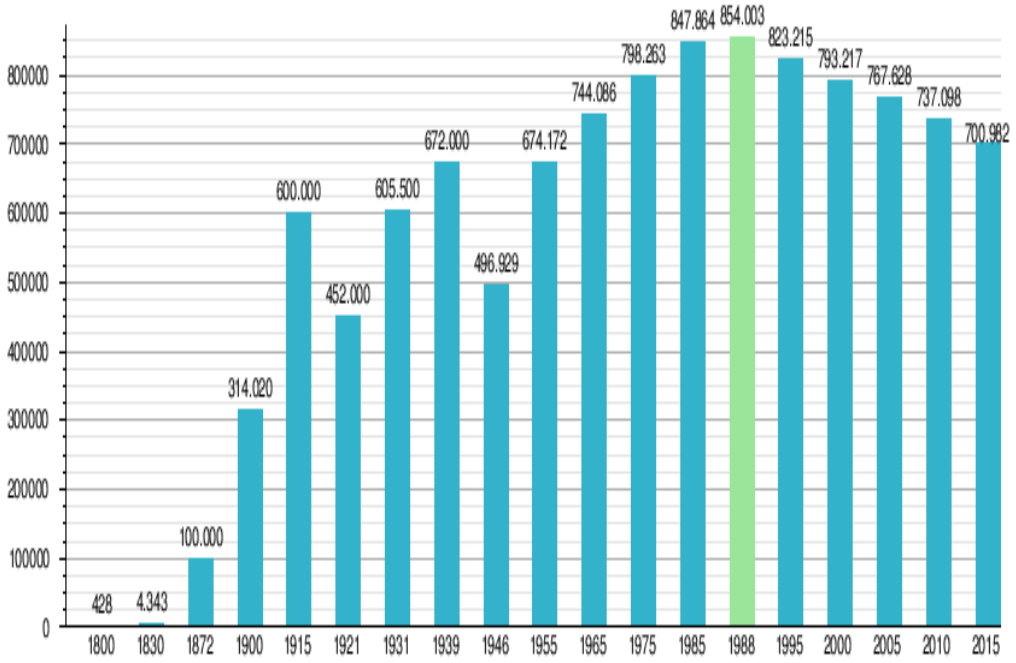


Fig. 8. Number of population in Łódź City in the years 1800-2015.

Source: own elaboration.

2.2.3. Labour force

The Łódź Metropolitan Area has a diversified employment structure. The city of Łódź is dominated by the service sector, engaging over 70% of employees. A large part of service is of exogenous nature, with range of impact extending beyond the city and even examined metropolitan area. These are primarily: education, culture and entertainment, health care and public administration. About 60% of employment in the service sector located in Łódź concerns education, health care and trade. In the vicinity of Łódź, there is a relatively high percentage of employed in industry (36%) and concurrently lower employment in the service sector (21%).

After the collapse of the centrally-planned socialist economic system, the majority of state-owned textile factories in Łódź were liquidated. Only a few entities have remain, although these engage a relatively high share of about 25% of the employed. Around 20% of employees are involved in construction, while in other industries (metal and electromechanical industry) employment is at the level of 5-8%.

The clothing and textile industry has also developed in other urban areas of ŁOM. It employs the largest percentage of population working in the industrial sector; depending on the town, it is 11% in Rzgów up to 36% in Zgierz.

The dominance of the city of Łódź as a working place for the ŁOM residents results in a large intensification of circular migration. As provided by the conducted survey by the means of questionnaire method, it is estimated that daily employee flows account for

70% of all types of commuting. Among the inhabitants of the Łódź suburbs, over half of respondents declare daily commuting to work beyond their place of residence. About 50% of all commuting from the Łódź Metropolitan Area takes place towards the city of Łódź.

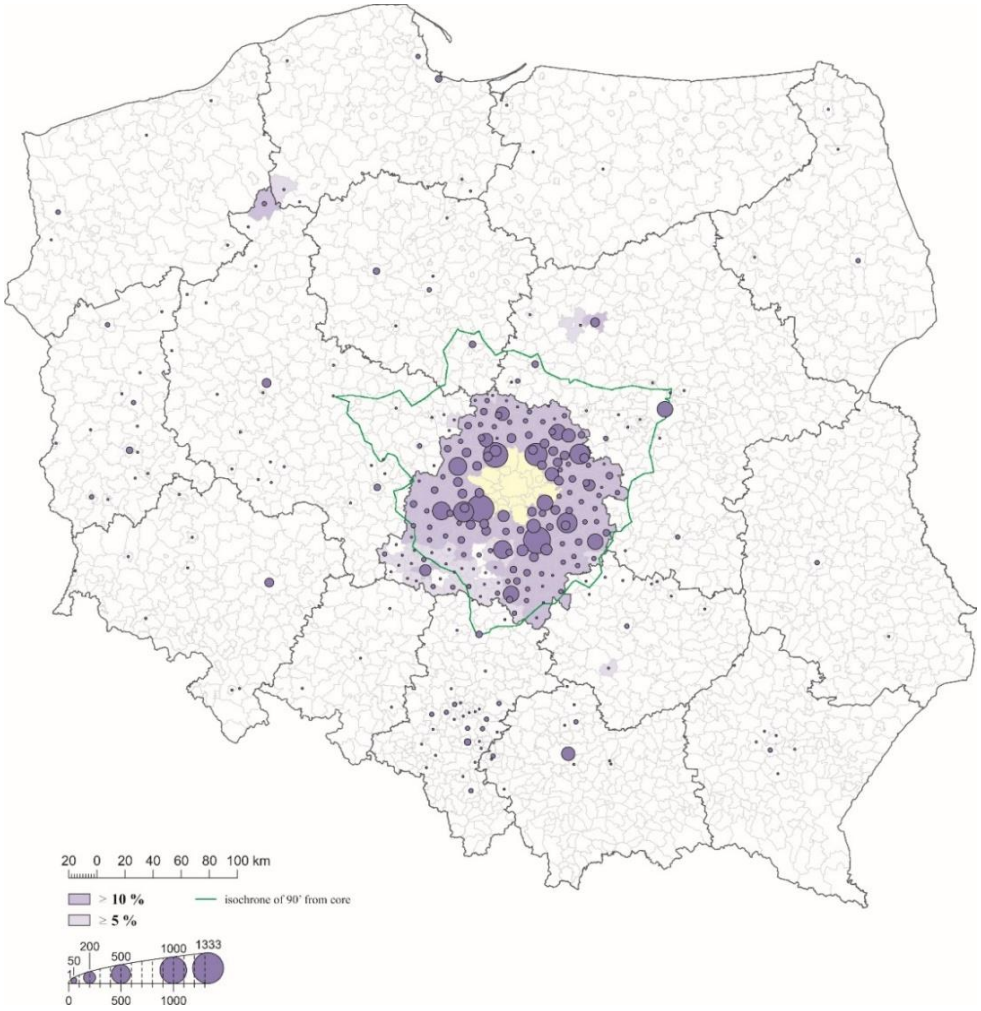


Fig. 9. Commuting to Łódź Metropolitan Area, 2011.
Source: own elaboration based on Central Statistical Office data.

2.2.4. Economy

According to provisions of the Łódź Metropolitan Area Development Strategy, the largest share of social and educational potential of ŁOM is concentrated in the city of Łódź , followed by areas in its immediate vicinity and other urban centres. Agriculture plays an important role in more remote rural areas, with the leading position of fruit growing.

A commonly shared attribute for the majority of urban centres is the key role of clothing and textile entities for the industrial sector. Within the ŁOM area there is a majority of the Łódź Special Economic Zone, with more than 200 companies operating in the field of service, household appliances, pharmaceutical and cosmetic, plastics and electronics industries.

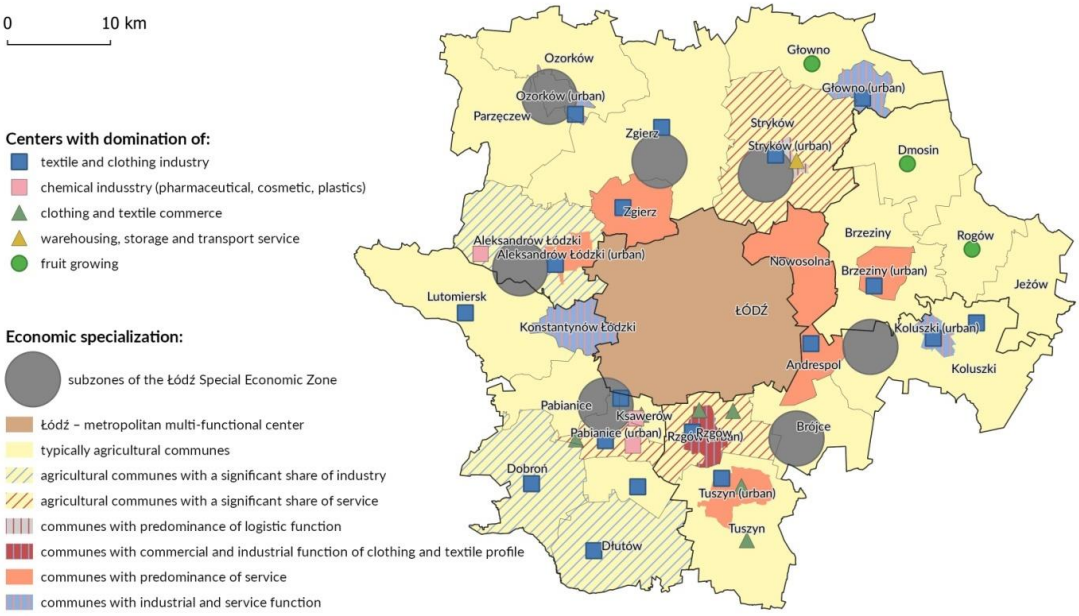


Fig. 10. Economic specialization of the Łódź Metropolitan Area communes.

Source: own elaboration based on Łódź Metropolitan Area Development Strategy

2.2.5. Transportation

The Łódź Metropolitan Area has favourable transport conditions and is well connected with other regions of Poland. This is mainly due to developed road transportation and the course of two A1 and A2 motorways, which function as the skeleton of state road system. These motorways intersect in the area of Stryków. Thanks to this ŁOM is well connected with Warsaw, Poznań, the Tri-City area (Gdańsk-Gdynia-Sopot) and Upper Silesia (Katowice agglomeration). An important element of the road system is the S8 express road connecting Łódź with Wrocław.

The inner-metropolitan radial-concentric road system includes 9 state roads (280 km in length) and 17 regional roads (170 km) supplemented with county and commune level roads. The total length of roads in ŁOM is about 25,000 km (road density of 196 km/km2), of which about 60% are commune level roads. The road system is conducive to good transport accessibility, which results in a large increase in daily commuting (this has been already discussed).

The railway transport network of the analysed area is also well developed. This is due to its favourable location as network of railway lines connecting Łódź with the main railway network of Poland runs through ŁOM. A special role in this regard is played by the line connecting Łódź and Koluszki in the eastern part of agglomeration. The total length of railway lines is about 220 km. Rail transport is supported by tram lines in the city of Łódź connecting it with several satellite towns (Ozorków, Zgierz, Konstantynów Łódzki, Pabianice).

Good transport accessibility is one of the most significant factors stimulating development of single-family housing in the vicinity of Łódź and induces favourable conditions for new investment in industry and service.

Fig. 11. Intersection of highways A1 and A2 on the background of a cadastral map.

Source: Marshal Office of Łódź Region.

Photo 2. Highway A1.

Source: K. Czapiewski

2.2.6. ŁOM Wastescapes

The territory of the Łódź Metropolitan Area has been strongly affected by suburbanization. Processes of urbanization and suburbanization are conditioned by changes in political and economic system occurring after 1989. J. Parysek (2008) points out, that suburbanization taking the form of “spreading out" or “sprawling" of the city

(the term "urban sprawl" is commonly used), achieved considerable intensity during the systemic transformation period and continues to this day. This phenomenon is accompanied by degradation processes in rural areas, mainly those identified as peri-urban. This is mainly due to uncontrolled changes, which have taken place in land use. These have been initiated by means of legislative changes as spatial planning was to be imposed to local authorities at communal level, which are mainly driven by economic considerations. For this reason, some areas with desired conditions for agriculture were allocated for housing purposes. In addition to such consequences as problems in the development of technical infrastructure, transport, and providing basic services (such as public transport), these areas are also characterized by increased pressure being exerted upon the natural environment. The outcome of uncontrolled residential development, which takes place in the Łódź Metropolitan Area, is i.a., fragmentation of ecosystems. The greatest changes related to discussed phenomenon occur mainly in the central part of the ŁOM. The largest area of agricultural land (in the period 2000-2012) decreased in Zgierz (-8%), Aleksandrów Łódzki, Andrespol, Brójce, Konstantynów Łódzki, Ksawerowa, Łódź, Ozorków and Nowosolna (over 4% in each of the communes). Intensive housing development is concentrated in larger cities and in the immediate vicinity of Łódź. On the other hand, in rural area there has been excessive extension of settlement along roads, which is regarded unfavourable both considering spatial order in the functional as well as aesthetic aspect.

Due to favourable location for communication, the ŁOM has become an area with significant concentration of logistics centres. Therefore, territorial self-governments by means of spatial development plans (so-called Local Plans) appoint areas designated for locating this type of investment. Such areas are mainly concentrated at the intersection of A1 and A2 motorways in the Stryków commune. The strategy of the city authorities includes i.a. designation of agricultural and forested areas to be developed by logistics infrastructure. However, investors are obliged to compensate for losses arising from degradation of the natural environment through investment in green areas in commune's territory (issues and solution concerning spatial planning in the Stryków commune were discussed at the first meeting with stakeholders in Stryków in 2016).

Photo 3. Logistic park in Stryków. *Source: A. Traczyk*

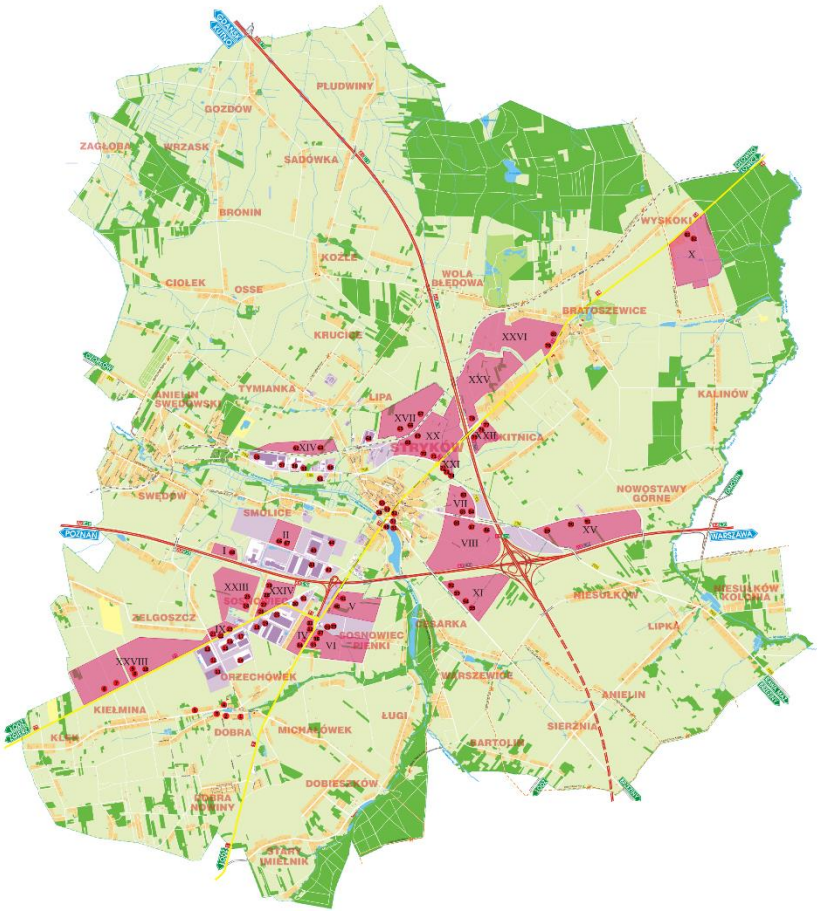


Fig. 12. Map of logistic parks in Stryków commune on the intersection of highways.

Source: Stryków Commune.

The process of suburbanization is associated not only with consumption of agricultural areas, but also with severe degradation of soils. The processes of soil degradation and pollution of surface and underground waters is closely related to the development of settlements in the ŁOM area. At present, almost the entire area being examined is characterized by poor or medium quality soils.

Urban areas within the ŁOM are characterized by a high extent of pollution with respect to atmospheric air as well as groundwater and surface water. The surface water pollution particularly affects ŁOM's urban areas. This issue also concerns majority of rural areas in the western part of the Łódź Metropolitan Area. The suburban areas of Łódź are characterized by very poor quality of underground and surface waters.

Air pollution is associated with four types of emission: point, linear, surface and dust. The point emitters comprise high chimneys, linear - car and railway transport, surface (low emission) - compact building areas. Dust pollutants are in turn formed from a mixture of solid particles suspended in the air. The largest concentration of exceeding air quality standards occurs in the central part of the Łódź Metropolitan Area and in larger cities, where the four mentioned types of air pollution emitters are concentrated.

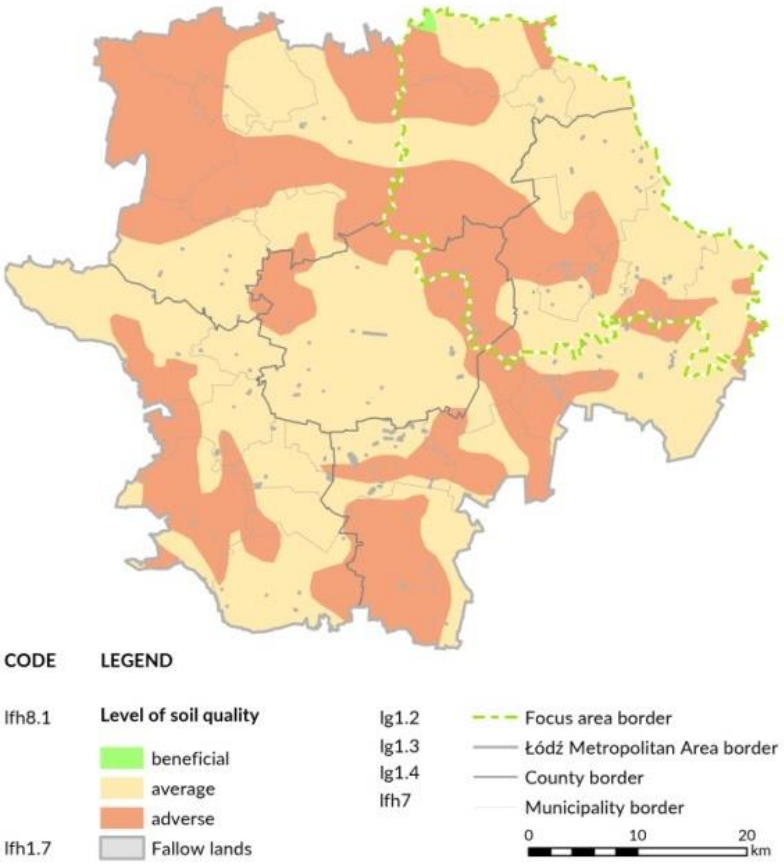


Fig. 13. Degraded land. *Source: Program Ochrony Środowiska….*

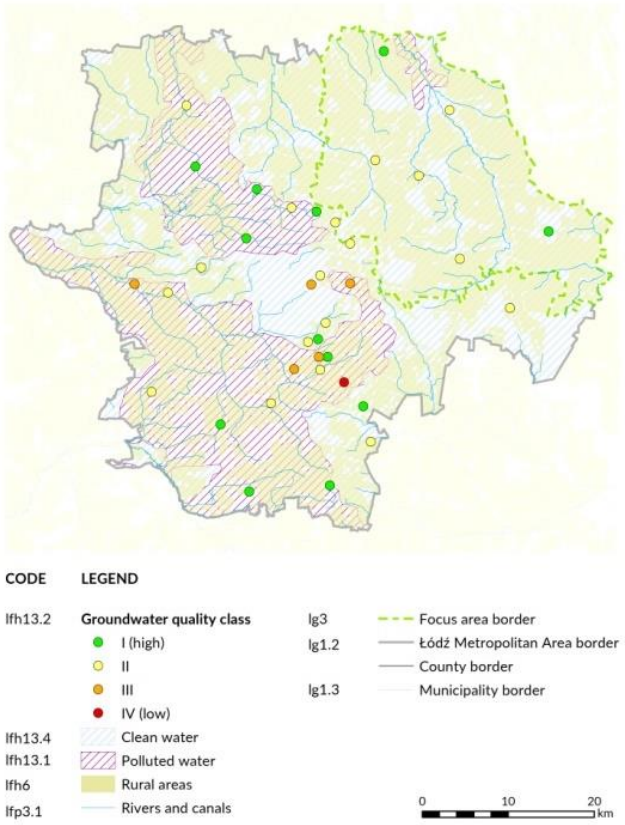


Fig. 14. Water in crisis. *Source: GIOŚ.*

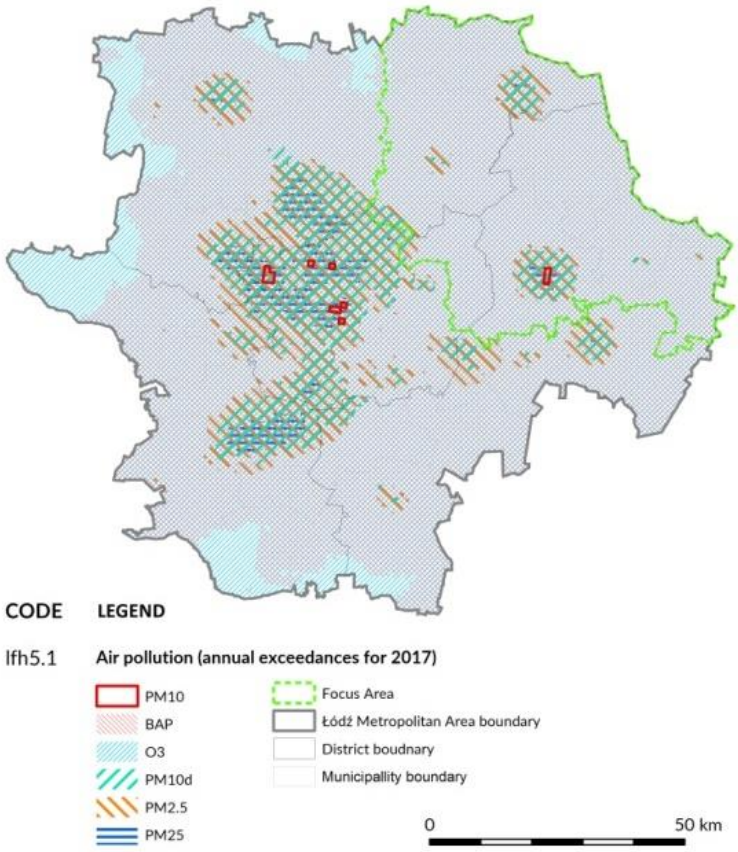


Fig. 15. Air specific. *Source: WIOŚ.*

Similarly as other metropolitan areas in Poland, the ŁOM is struggling with problems of municipal waste management. The most common issue identified in this regard concerning peri-urban and rural area are illegal waste dumps, located mainly in forests. Public spaces in cities where waste management is often disordered are also being degraded. This is mostly evidenced by insufficient or inadequately arranged space designated for waste management.

Wastelands have been identified in the Łódź Metropolitan Area. However, the most important from developmental point of view are degraded areas requiring restoration or granting a new function. The process of identifying degraded and areas intended to be revitalized takes place at communal level as part of the Local Revitalization Programs. These areas are delimited based upon social factors (obligatory factor) as well as economic, environmental, spatial-functional and technical characteristics. Specific issues are identified by stakeholders (apart from local authorities, these include entrepreneurs, residents, investors, etc.). Local Revitalization Programs enable delimitation of degraded areas on a local level in a comprehensive manner. Delimitation is conducted by means of social participation, implementing statistical methods. The process itself is of a bottom-up nature, ensuring identification of significant issues occurring in a given territory.

Delimitation of degraded areas within ŁOM is carried out with respect to two accuracy levels. In the analysed areas there have been identified sites strongly affected by pressure of transport infrastructure and settlement exerted upon the natural environment. Pollution of the latter, in particular concerning water and air conditions has been an important issue raised in the 2020 Development Strategy for the ŁOM. These factors are mentioned among the developmental barriers of the examined territory. Another factor in this regard, which was discussed before comprises lack of supervision over expansion of settlement, which is reflected in the degradation of aesthetic and consequently also functional order. At the local level, degraded and areas being revitalized have been assigned. Delimitation is based upon a series of analyses of a high detail level with the participation of local communities. These areas are mapped on the 1: 5000 scale maps. By means of such cartographic support, funds shall be allocated for the purpose of revitalization projects indicated by the stakeholders.

2.2.7. Development strategy and waste sensitivity towards circularity

The state of the natural environment and condition of the anthropogenic space is an important element embodied in the development strategy at the national and regional level. The query conducted for this purpose regarding strategic documents at mentioned levels allowed to identify important issues from development policy viewpoint. Objectives pertaining to developing a low-carbon economy, waste management and - as a result - improving life quality can be found in 11 national level strategic documents. The most important include: transition towards low-carbon economy, development of "green" cities, improvement of waste management including increasing recycling level, enhancing the use of natural resources and raw materials, development of eco-innovative technologies and establishing green-collared jobs. All objectives should be, according to the provisions of the National Strategy for Regional Development 2010: Regions, Cities, Rural areas implemented respecting the principle of territorial cohesion. Both urban areas and rural areas play an important role in the strategic planning for developing the low-carbon economy. A synthetic approach towards the vision of developing waste management and - more generally improving the state of natural environment - can be found in the Strategy for Energy Security and the Environment (perspective to 2020). Provisions included in this document assume i.a. rational use of waste, taking benefit from waste for energy purposes, supporting green technologies, promoting pro-environmental attitude and establishing green-collared jobs.

The Łódzkie Voivodeship bases strategic planning in the field of waste management and circular economy upon two principal documents: the Regional Development Strategy and the Regional Innovation Strategy. First of them, compiled in each of the 16 regions considers objectives related to improving the state of the environment and the development of waste management. On the other hand, the Regional Innovation Strategy of the Łódkie Voivodeship, unlike other administrative regions, places particular emphasis on discussed issues. Two smart specializations related to waste management and circular economy have been therein formally designated: Advanced Construction

Materials and Energy (including Renewable Energy Sources). Both specializations focus on developing eco-technologies, recycling and research in the field of implementing green technology in construction, energy and waste management. These issues are included in 29 so-called specialized areas of smart specializations, vast majority of which concerns waste management technology. Mentioned specializations closely relate to the dynamic growth of construction industry and associated issues of construction and demolition waste as well as the energy sector, considered strategic to this region. Ambitions arising from these provisions are reflected in actions undertaken by enterprises located in Łódź, i.a. in the field of bio-economy. An example is the Łódź-based company "Biotechnika" which began to develop technology for bio-ethanol and biogas production, generated from waste derived from the processing of sugar beet and potatoes. This is one of the cases for practical implementation of circular economy in the production of energy resources from agricultural waste and is closely related to identified regional smart specialization. Both the energy and the agricultural sectors are involved in the development process related to this kind of technology. Expansion of the bio-economy is particularly important for the region due to the use of bio-waste.

Stakeholder survey – The case of Łódź

One of the main tasks of 'WP3.3 – Social Analysis' is to develop a Primer Socio-cultural Analysis (PSCA) in order to inquire the possible impacts of socio-cultural context on waste and resource management. As all policies, among them waste and resource management related policies, are embedded into a complex social and cultural environment [as these policy mechanisms are targeting and addressing certain smaller or more comprehensive groups of people, while these policies are also implemented by individuals (among them decision makers, stakeholders, beneficiaries, etc.)], then it would be a mistake to neglect that the socio-cultural context might influence the sustainability (efficiency, progressivity, innovativeness, etc.) of waste and resource management activities. SSCA-1 (the first phase of Secondary Socio-cultural Analysis) of WP3.3 actually found out that – on a macro social level – there are relevant differences among the EU member states respective to waste-conscious behaviour (WCB) of individual subjects (see: Deliverable 3.2). SSCA-1 also presented that in the case of Poland there are significant regional differences respective to the WCB scores. In line with this, PSCA aims to map out relevant stakeholders' perceptions about the institutional conditions (financial, regulation-, infrastructure-, policy-, strategy-related aspects) and socio-cultural fundaments of sustainable waste and resource management. Although the comparative PSCA investigation embracing all case study areas will be published in Deliverable 3.8, it is interesting to draw up the first results of the stakeholder surveys by each cases. In the following, the case of Łódź is summarized briefly. Some basic methodological information in advance: the relevant stakeholders were identified by the Polish consortium partner; they were interviewed in their first language via online by a closed, structured survey.

The institutional block of the Łódź stakeholder survey

The first block of the survey has 5 thematic scopes: financial issues, regulation and laws, implementation, infrastructure and technologies, and learning/knowledge-transfer. The general question posed to the interviewees was the following: "*On a 0 to 10 scale, where 0 is 'absolutely not important' and 10 is 'absolutely important', how would you perceive the relevance of the following factors for a sustainable waste/resource management?*"

Table 1. 'Institutional block – Financial issues section' of the Łódź stakeholder survey

Financial issues	**Mean v.**	**N=**
Stable financial background of the responsible provider to secure EU standard quality waste services for every customer	6.5	12
To continuously aim for additional financial resources (e.g. private investments, government subsidies, etc.) for waste sector	6.1	12
To reduce the loss-making waste services and improve the profitable ones even if this intervention has social costs/potentially negative impacts	7.0	8
To reduce the loss-making waste services and improve the profitable ones even if this intervention has environmental costs/potentially negative impacts	7.0	9
To provide the same quality services for every customer even if securing accessibility is reducing profitability	7.1	12

Source: Authors' own elaboration based on primer survey data

Table 2. 'Institutional block – Regulation and laws section' of the Łódź stakeholder survey

Regulations and laws	**Mean v.**	**N=**
Comprehensive and executable regulations on waste/resource management	7.8	13
To explicitly formalize in different (national, regional, local, organizational, etc.) level regulations all the waste/resource management-related issues and practices	8.0	13
To leave room for implementation based on the local context	7.8	13

Source: Authors' own elaboration based on primer survey data

Table 3. 'Institutional block – Implementation section' of the Łódź stakeholder survey

Implementation	**Mean v.**	**N=**
To benchmark by a multi-level monitoring system waste/resource management service providers according to outputs/costs indicators	7.0	11
Strict fines on violating customers	7.4	13
To leave grace period before fines on violating customers become due	6.5	12
Promotion campaigns to encourage participation in and acceptance of waste/resource management	8.6	13

Source: Authors' own elaboration based on primer survey data

Table 4. 'Institutional block – Infrastructure and technologies section' of the Łódź stakeholder survey

Infrastructure and technologies	**Mean v.**	**N=**
Using eco-innovative and smart technologies to improve waste/resource management even if these developments are increasing the costs of services	6.5	13
Using eco-innovative and smart technologies to improve waste/resource management even if these developments are challenging the acceptability of services	6.9	13
Using eco-innovative and smart technologies to improve waste/resource management even if these developments are challenging the equal accessibility of services	5.8	13

Source: Authors' own elaboration based on primer survey data

Table 5. 'Institutional block – Learning/knowledge-transfer section' of the Łódź stakeholder survey

Learning/knowledge-transfer	**Mean v.**	**N=**
Waste/resource management service providers should continuously study best practices	7.5	13
Waste/resource management service providers should continuously learn from webinars (online presentations about best practices and innovative solutions)	6.8	13
Instead of developing local innovations, waste/resource management service providers should adapt an existing model of best practices if it seems a cheaper solution	6.2	13
Waste/resource management service providers should cooperate in developing and sharing eco-innovative solutions	7.3	13

Source: Authors' own elaboration based on primer survey data

Regarding to the financial issues of the institutional block it is worth to note that the stakeholders do not perceive that aiming for additional financial resources from the providers' side is so relevant, yet they understand profitability and the reduction/cutting down of loss-making services even in case of possible social or environmental costs/risks as quite important. It seems that for the respondents securing equal quality services to all customers is a more crucial constrain to profitability than certain social/environmental costs/risks. About the legal issues the interviewees mostly agree that it is relevant to organize waste/resource management sector and its competencies by comprehensive, formalized and executable regulations, even though limited room for manoeuvres in the local context should be respected. About implementation, both benchmarking by a multi-level monitoring system and strict fines on violating customers are considered as relevant, while the role of promotion campaigns is understood as even more important. Using eco-innovative and smart technologies in cases of increasing costs or challenges to accessibility and acceptability is not perceived as so relevant by the respondents. From the learning/knowledge transfer section of the survey it is worth to mention that the interviewees consider continuous study about best practices and joint partnerships in developing/sharing eco-innovative solutions as important.

The socio-cultural block of the Łódź stakeholder survey

The second block of the questionnaire aimed to inquire how the stakeholders perceive the relevancy of certain social and cultural features to waste and resource management. The question posed to the respondents was the following one: "*As some research highlights, the social and cultural milieu of a collective entity (society or smaller community, social group) – through the generally accepted and respected social values, norms and attitudes – could influence the effectiveness of public policies. Based on this argument, we are now interested in how you perceive the relevance of the following social and cultural features and attitudes for a sustainable waste/resource management? The scale refers to the same values: 0 to 10, where 0 is 'absolutely not important' and 10 is 'absolutely important'*."

Table 6. 'Socio-cultural block' of the Łódź stakeholder survey

Social and cultural environment	**Mean v.**	**N=**
A collective feeling of unity arising from common responsibilities, interests and objectives	6.1	15
A bond of social togetherness based on an informal agreement that everybody should have the same opportunities	4.9	14
Social cohesion based on commonly respected principles that everybody is entitled to basic individual rights and needs	5.8	14
Social unitedness founded on the idea of advancing public interests	6.5	12
Willingness for doing, making, undertaking something by one's own accord in the name of collective goals	6.9	14
Acting on behalf of the community without force or coercion to promote public interests	6.0	14
Supporting others by free choice	6.8	12
Willingness to make changes in one's own life and lifestyle	7.6	14
Openness for new challenges	7.5	13
Searching for new opportunities	7.3	13
Ability to cope with individual failures	7.0	14
Being critical on one's own customs and habits	6.3	12
Confidence in the possibility that things could be better	6.8	13
Faith in the achievability of progressive reforms	6.8	13
Optimistic beliefs that wrongs are repairable	6.9	12
To believe that generally people are honest in dealing with others	6.7	12
To believe that generally people are helpful	6.3	13

To believe that generally people are taking into consideration common norms before they doing actions or making decisions	6.3	12
Willingness to participate in activities promoting public interests	6.8	14
Joining civil organizations and/or social movements	5.5	13
Protesting against things (decisions, actions, outcomes) that are contradicting or preventing the facilitation of public interests	7.6	13
To respect the individual opinion and approach of others	7.3	12
Being open for discussion with everybody	7.6	13

Source: Authors' own elaboration based on primer survey data

Regarding to the social and cultural conditions of developing/maintaining a sustainable waste/resource management, it should be noted, in general, that the Polish stakeholders have mixed perceptions. While openness for discussions, respect for individual understandings, objection of/protestation against processes/acts that hamper the facilitation of public interests, and individual risk-taking attitudes and unconventionality are considered as relevant social/cultural contributions, other aspects, such as cohesion and togetherness, trusting atmosphere, and joining civil organizations are understood as rather not important. At the same time, stakeholders' perceive the relevancy of aspects like collective responsibility, reflexivity, optimism and progression as moderate.

Pairwise comparison block of the Łódź stakeholder survey

The last block of the questionnaire used the method of pairwise comparison in order to find out from two theoretically interlinked options which one is preferred by the stakeholders from the perspective of relevancy to waste and resource management. The question posed to the respondents was the following: "*Finally, we are interested in how you perceive the relevance of the following factors compare to each other for a sustainable waste/resource management? 1 means you completely agree with the statement on the left; and 10 means you completely agree with the statement on the right. If your answer would fall between 1 and 10, pick up the number that rightly reflects on your perception.*"

Table 7. 'Pairwise comparison block' of the Łódź stakeholder survey

Pairwise Comparison	**Scale v.**	**Mean v.**	**N=**
1a) Waste/resource management should be funded by private financial resources	*1–5*	6.9	14
1b) Waste/resource management should be funded by public financial resources	*6–10*		
2a) Waste/resource management should be regulated by local level regulations	*1–5*	6.4	13

2b) Waste/resource management should be regulated by national level regulations	*6–10*		
3a) Waste/resource management should be regulated by local level regulations	*1–5*	5.8	14
3b) Waste/resource management should be regulated by EU level regulations	*6–10*		
4a) Waste/resource management should be regulated by national level regulations	*1–5*	5.5	13
4b) Waste/resource management should be regulated by EU level regulations	*6–10*		
5a) Multi-level strategies on waste/resource management should be formulated in bottom-up sense	*1–5*	4.8	13
5b) Multi-level strategies on waste/resource management should be formulated in top-down sense	*6–10*		
6a) In waste/resource management related decision makings, political actors should take the lead	*1–5*	9.0	12
6b) In waste/resource management related decision makings, non-political actors should take the lead	*6–10*		
7a) Waste/resource management related strategies and policies should be discussed by a narrow coalition of actors	*1–5*	8.3	13
7b) Waste/resource management related strategies and policies should be discussed by a wide coalition of actors	*6–10*		
8a) Waste/resource management related strategies and policies should be developed by a narrow coalition of decision makers	*1–5*	8.6	14
8b) Waste/resource management related strategies and policies should be developed by a wide coalition of decision makers	*6–10*		
9a) Waste/resource management policies should offer solutions to imminent challenges	*1–5*	8.6	13
9b) Waste/resource management policies should aim for long-term solutions	*6–10*		

Source: Authors' own elaboration based on primer survey data

Finally, some general notes about the pairwise section of the survey: the respondents are preferring the idea of waste/resource management is funded by public compare to private financial resources; they are slightly in favor of EU level regulations compare to national legal frameworks; they clearly believe that in waste/resource management related decision makings non-political actors should take the lead, while the sector-related strategies should be developed and discussed by a wide collation of actors. The interviewees also think that waste/resource management should aim for long-term solutions.

3. Material Flow Analysis

3.1 Introduction

The main key flow in Łódź peri-urban area are municipal solid waste. Most emphasis would be placed on the composition of MSW, the process towards a more selective waste system, and the extraction of biodegradable waste from the MSW.

The new regulations in waste management came into force practically from 2013, when the Waste Act was introduced (of 14 December 2012). Overall, the entire waste management system has been reformed. According to the Act, municipal wastes should be collected selectively and communal self-governments are responsible for compliance with the principles adopted by the Act. Local self-government authorities are therefore responsible for managing processes related to local waste management; they also make the most important decisions as to the forms and methods of their implementation.

Waste is a by-product of human activity, introduced into the environment in slight or large quantities, including the primal product, but unsuitable in the place and time at which it was created (Universal Encyclopedia 1999). According to the Waste Act of December 12, 2012[2], waste is "any substance or object, the holder of which gets rid of, is going to get rid of or is obligated to get rid of." Waste is therefore any material, raw material or final product, which is not employed, has no designated purpose and is not used for a specific purpose (Lipińska 2016). Waste is then considered as any substance or object which the holder discards or intends to discard or is obligated to discard. On the other hand, the waste producer is understood as any person whose activity or existence results in the generation of waste (initial waste producer) and anyone who performs pre-treatment, mixing or other activities causing change in the nature or composition of this waste.

Waste is classified based on various criteria. The grounds for each classification are carefully set norms of physico-chemical, biological, technological and economic nature such as: source of origin, state of matter, raw material criterion, chemical composition, toxicity, harmfulness to people and the environment, suitability for further use. The general classification, taking into account the origin of the waste, their nature and properties, divides the waste into: municipal, industrial, liquid and hazardous (Lipińska 2016).

The main sources of waste generation are: industry, municipal sector and agriculture. Industrial waste is generated in production processes (e.g. from the mining industry, as a result of wastewater treatment, emission of gases into the atmosphere). Municipal waste is solid and liquid waste that arise in households, public utilities (trade, services, handicrafts) and municipal services (e.g. street cleaning and maintenance of green areas). Hazardous waste is generated as a result of direct or indirect impact of aggressive substances, which can negatively affect living organisms. Hazardous waste may be toxic, harmful, carcinogenic, flammable, etc.

[2] OJ EU of 2013 pos. 21

In Poland, according to the Regulation of the Minister for the Environment of 9 December 2014, the waste catalogue is distinguished by 20 groups of waste, separated based upon the source of waste. The regulation specifies a waste catalogue with division of waste into groups, subgroups and types.

Tab. 8. Waste categories by source

Group code	Description of waste group
01	waste generated by exploration, extraction, physical and chemical processing of ores and other minerals
02	waste generated by agriculture, horticulture, hydroponic crops, fishery, forestry, hunting and food processing
03	waste generated by wood processing and production of panels and furniture, wood pulp, paper and cardboard
04	waste generated by leather, fur and textile industry
05	waste generated by oil refining, purification of natural gas and pyrolytic coal treatment
06	waste generated by production, preparation, marketing and use of inorganic chemistry products
07	waste generated by production, preparation, marketing and use of organic chemistry products
08	waste generated by production, preparation, marketing and use of protective coatings (paints, varnishes, ceramic enamels), putty, adhesives, sealants and printing ink
09	waste generated by photographic industry and photographic services
10	waste generated by thermal processes
11	waste generated by chemical treatment and coating of metal surfaces and other materials and hydrometallurgy of non-ferrous metals
12	waste generated by shaping and physical and mechanical surface treatment of metals and plastics
13	waste oils and liquid fuel waste (excluding edible oils and groups 05, 12 and 19)
14	waste from organic solvents, coolants and propellants (excluding groups 07 and 08)
15	packaging waste; absorbents, wiping cloths, filter materials and protective clothing not included in other groups
16	waste not included in other groups
17	waste generated by construction, renovation and dismantling of construction works and road infrastructure (including soil and land from contaminated areas)
18	medical and veterinary waste (excluding kitchen and restaurant waste not related to health or veterinary care)
19	waste generated by installations and devices used for waste management, sewage treatment plants and treatment of drinking water and water for industrial purposes
20	municipal waste including selectively collected fractions

Source: Regulation of the Minister for the Environment of 9 December 2014 regarding waste catalogue

Municipal waste is waste generated in households and retail trade, enterprises, office buildings and educational institutions as well as medical care and public administration of similar nature and composition to waste produced in households. However, it should be noted that in 2017 more than 85% of the total municipal waste mass was generated by households.

The amount and morphological composition of municipal waste depends to a large extent upon the place of their formation, particularly on social wealth and related level of product consumption, but also on time of year. It should be mentioned that the amount of municipal waste collected per one inhabitant per year is strongly correlated with the economic status of individual regions of the country. As presented in the general analysis in prior chapters, the region of Łódź is not one of the most economically developed in Poland. This is evidenced by the mass of collected municipal waste *per capita* - the value for the region is 10% lower than Poland's average. Slightly higher values were observed in the suburban area of Łódź, however definitely the highest in the city itself.

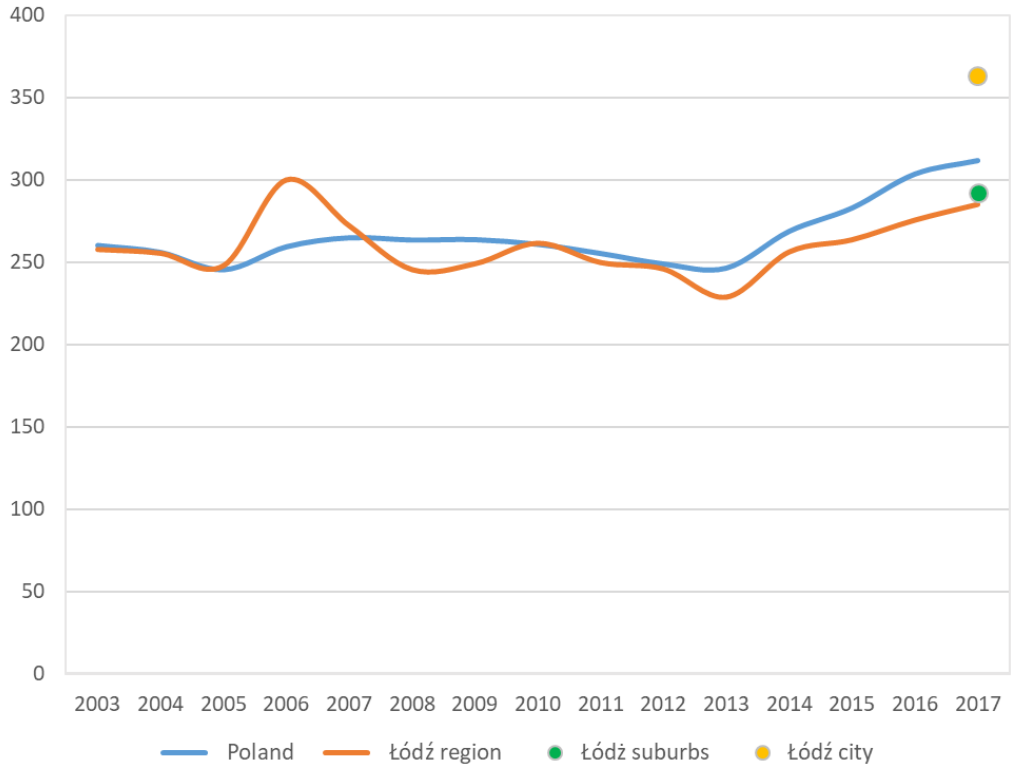


Fig. 16. Mass of generated municipal waste (kg) *per capita* in Poland, Łódź region, Łódź suburban area and the city of Łódź in 2003-2017.

Source: own elaboration based on data from Central Statistical Office of Poland.

The nature and overall mass of generated waste is also strongly determined by the land use and predominating type of area (urban, rural) in which these are produced,

population density, type of housing (single- or multi-family), number of tourists, public facilities as well as type, size and number of commercial entities, small industries or services. For instance, in Poland, the differences between particular types of areas are especially noticeable in respect to "paper and cardboard" faction – there is a gradual decline in the share of this fraction along the axis "big cities - small towns - rural areas", on the contrary considering "kitchen and garden waste" - a progressive increase may be observed along the axis "big cities - small towns - rural areas" and "finest fraction - below 10 mm", where the share of this type of waste increases in rural areas in relation to the amount observed in cities.

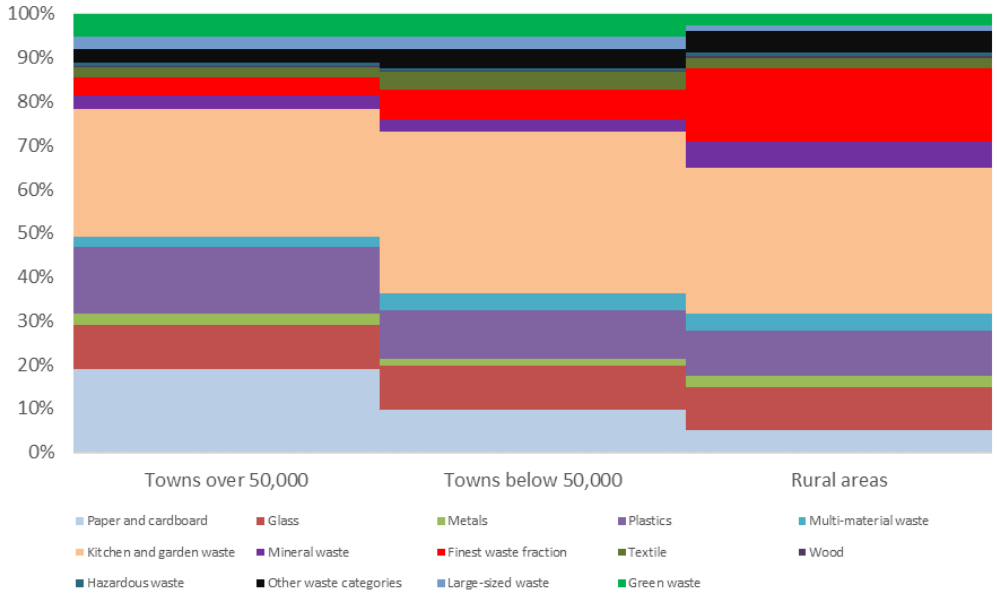


Fig. 16. Morphological composition of municipal waste generated in large cities (over 50,000 inhabitants), small cities (below 50,000) and rural areas of Poland in 2010. *Source: Jędrczak (2010).*

Similar results were obtained in 2015 as an outcome of a study conducted by the General Directorate for Environmental Protection in 20 installations for mechanical and biological waste treatment.

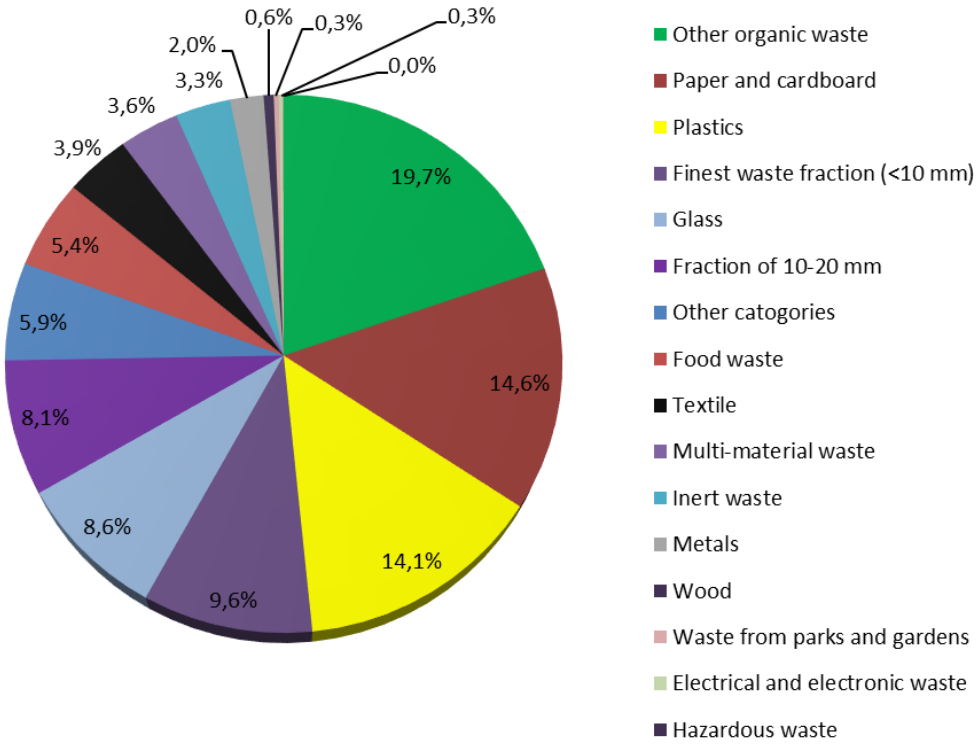


Fig. 17. Morphological composition of mixed municipal waste in 2015.

Source: Jędrczak, den Boer (2015).

The waste management system imposes division of Poland's territory into 123 regions of waste management, under which modern facilities were established, i.e. Regional Municipal Waste Treatment Plants (RIPOK) whose construction is assumed to develop an effective waste management system. Regional Municipal Waste Treatment Plants in accordance with the principle of regionalization are responsible for ingesting specific groups of waste from the region in which the waste was generated. In order to ensure a constant inflow of waste stream, following one of the basic principles of waste management, the so-called "Proximity principle" highlighting the need to treat and/or dispose waste in reasonable *proximity* to their point of generation. This means that the waste is processed at the place where it is produced and, if this is impossible, it is transferred to the nearest place where it can be processed, however bearing in mind, that it is forbidden to transport it outside the region of origin. The Łódzkie Voivodeship is divided into four waste management regions.

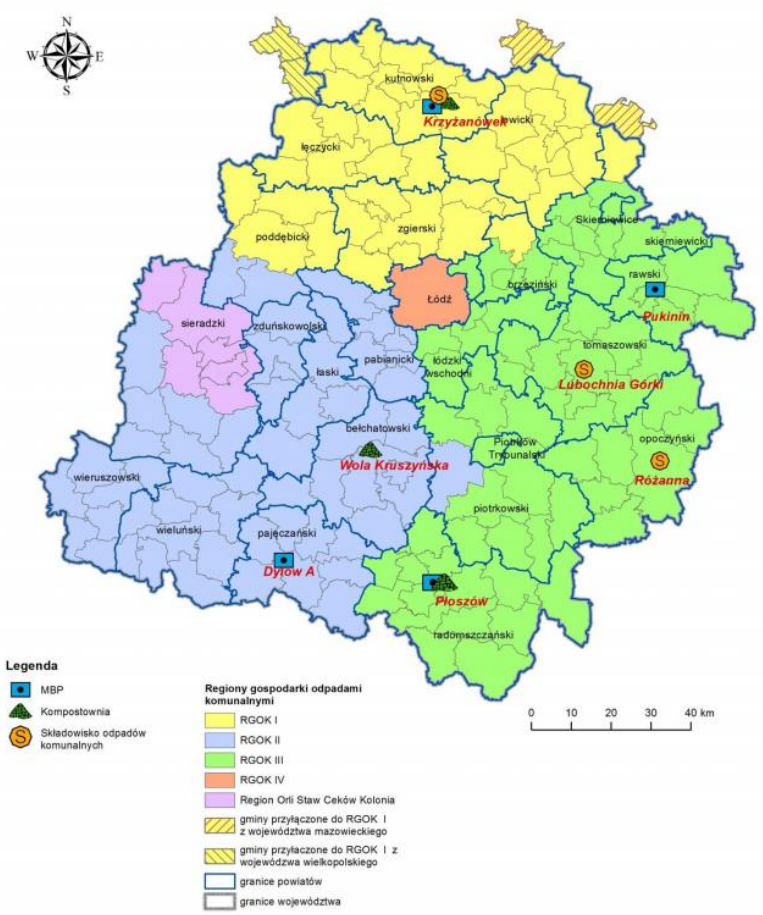


Fig. 18. Division of the Łódzkie Voivodeship into municipal waste management regions and register of installations for processing mixed municipal waste.

Source: Plan gospodarki odpadami dla województwa łódzkiego… (2016).

After the introduction of the new Waste Management Act in 2013, a number of indicators illustrating society's approach towards waste and changes concerning treatment of collected waste have improved. First of all, the change involving taking over responsibility in the field of waste collection by local authorities has resulted that currently all residents are encompassed by compulsory municipal waste collection, while in 2012 this indicator for the entire Łódzkie Voivodeship amounted to 75%. Concurrently, the number of illegal waste dumps i.e. places not intended for landfill has decreased significantly (from 234 in 2008 to 136 in 2016) along with their area (130,000 m^2 in 2008 to 53,000 m^2 in 2016). At the same time, educational campaigns and financial incentives have led to considerable increase in the share of waste collected selectively "at source", i.e. in households, from a few percent a decade ago to over 27% today. With the introduction of obligatory collection of household waste, their participation in the total mass increased from around 60% in the pre-implementation period (prior to 2013) to 85% today. Moreover, the methods for further collection and processing of gathered municipal waste have also changed significantly. As recently as in 2007, almost all collected mixed municipal waste was deposited in landfills, whereas today this share decreased to 40%.

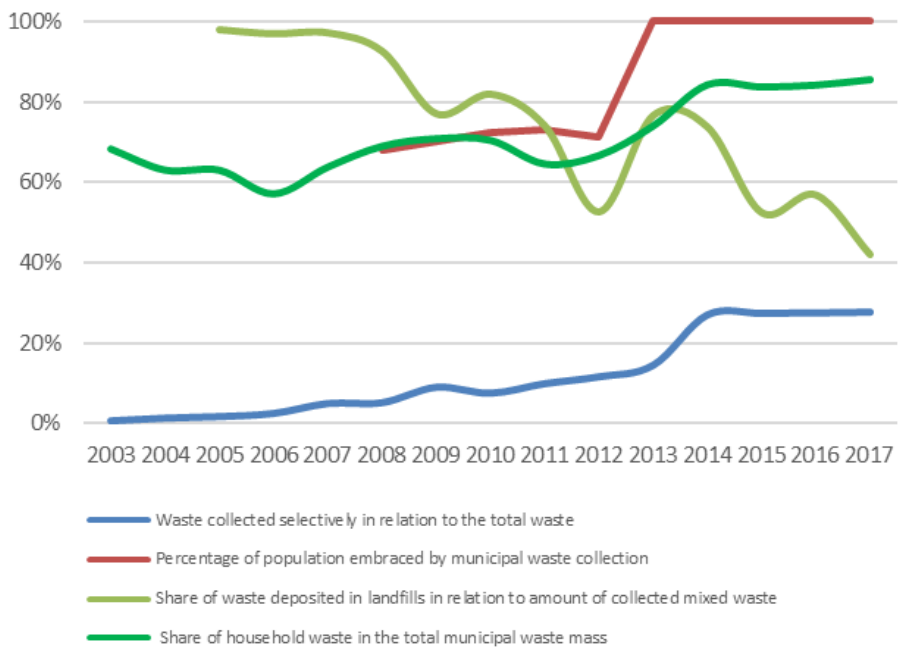


Fig. 19. Change in the values of selected indicators concerning waste management in the Łódzkie Voivodeship.

Source: Own study based on data derived from the Central Statistical Office of Poland.

On the other hand, it should be emphasized that the share of all municipal waste (not only mixed waste) utilized in landfills remains at distinctly higher level in the region of Łódź in relation to Poland's average.

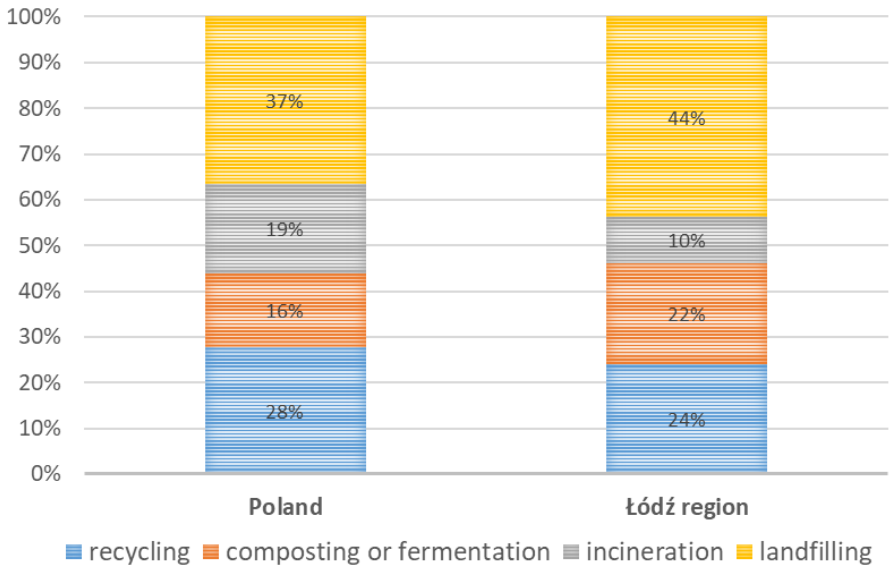


Fig. 20. Municipal waste collected by treatment operations in Poland and the region of Łódź, 2016.

Source: Own study based on data derived from the Central Statistical Office of Poland.

Municipal waste continue to be the key challenge in the field of waste management both in Poland, the region of Łódź and its agglomeration - this has been evidenced not only by various strategic documents, research or field studies, but also by participants of conducted PULL workshops under the REPAiR project. Therefore, for the purpose of this analysis, Municipal Solid Waste will act as the basic type of examined waste.

3.2 Step 1: Determination of material scope

In order to determine the material scope, i.e. the range of materials that will be subjected to the study, (waste) material(s) and their relevant application(s) have to be selected and defined. This selection is based on the interests of stakeholders, which in turn originate from local challenges and "personal" values and also required to ensure that there were traceable and justifiable reasons for the selection of the waste materials.

The table below summarizes the structure of waste collected in 2016 in the communes of the Łódź Metropolitan Area (ŁOM). The analysis of presented data unambiguously proves domination of mixed municipal waste - up to 71.8% of the total mass. Packaging and biodegradable waste comprise a marginal share in this regard.

Table 9. Structure of municipal solid waste by fraction in Łódź Aggl. Area in 2016.

Waste subgroup		Waste fraction	
Packaging waste	11.2%	of which:	
		150106 Mixed packaging waste	8.4%
		150107 Glass packaging	1.5%
Municipal wastes including selectively collected fractions	88.1%	of which:	
		200301 Unsorted (mixed) municipal waste	71.8%
		2001xx Non-biodegradable municipal waste segregated and collected selectively	4.6%
		200201 Biodegradable waste (green waste from gardens and parks)	4.3%
		200108 Biodegradable kitchen waste	3,4%
		200307 Large-sized waste	2.4%
Waste from construction, renovation and dismantling of construction works and road infrastructure (including soil from contaminated areas)	0.7%		

Source: own elaboration based on municipal reports.

Such state of affairs can be partially explained by provisions included in the *Waste Management Plan for the Łódzkie Voivodeship for the years 2016-2022* and the *National Waste Management Plan 2022*, in which crucial issues in the field of municipal waste management, including food waste and other biodegradable waste were considered as follows:

- insufficient pro-environmental social awareness regarding selective collection of municipal waste;
- excessive share of mixed municipal waste in the overall municipal waste flow, especially considering the context of provisions concerning implementation of circular economy;
- lack of adequate cooperation between private and public sectors in terms of waste management system;
- insufficient quality of collected waste;
- lack of operating monitoring system for municipal waste management;
- no statutory minimal fee for waste management;
- insufficient share of waste collected selectively at source, which results in inadequate progress in subjecting waste to recycling processes;
- confined supervision of communal authorities over proper treatment of municipal waste caused by the selection of a joint tender for collection and management of waste;
- excessively high share of municipal waste subjected to storing in relation to the generated waste;
- incidences of storing mixed municipal waste without being processed;
- excessively low market prices of certain secondary raw materials, therefore obtained funds do not allow for lowering the fee rate;
- lack of valid research in the field of municipal waste management, including analysis concerning morphological composition of waste as well as physical and chemical properties of waste.

The method for collecting waste in the Łódź agglomeration (and majority of places in Poland) fosters the dominance of mixed waste. The pictures below illustrate common waste collection sites - a tenement house in the centre of Łódź, residential area in Głowno, a bus stop, a park – in all these places containers for single type of waste prevail.

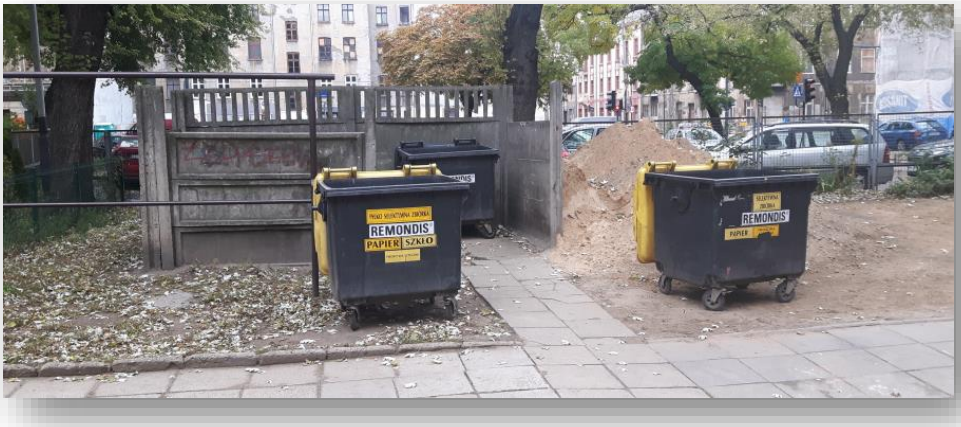

REMONDIS
PAPIER SZKŁO
REMONDIS

Photo 3. Selected places for municipal waste collection in the city of Łódź and its vicinity.

Author: K. Czapiewski.

Taking into account assumptions of the REPAiR project (see Deliverable 3.1) = selecting the appropriate type of waste, which will be subjected to a detailed analysis become a necessity. Considering statements of the User Board members, PULL workshops' participants and bearing in mind challenges facing the Łódź agglomeration in the field of proper waste management, it was decided to conduct the material flow analysis concerning- **biodegradable municipal waste** regarding the Vegetable, Fruit and Garden (VFG waste) fraction. The selected scope of study may serve as a good example in light of the need to solving issues resulting from the necessity to reduce the vast amount of waste collected in a non-selective manner. Biodegradable waste is entirely in line with the ideas of a circular economy. Moreover, it is crucial the mass of accumulated waste in this category (VFG waste) from households is sufficient to allow statistical analysis of flows. As indicated above, one of the most important challenges facing waste management in the Łódź Metropolitan Area (and Poland as a whole) is a more accurate recognition concerning morphological composition of generated waste. Therefore, currently in research conducted in Łódź agglomeration, it has been decided to focus on a broader conceptual category - unfortunately omitting - detailed analyses of specific sub-fractions (such as kitchen waste, plastic bottles for non-alcoholic beverages or coloured glass). Such decision has been motivated by the lack of sufficient segregation on the part of residents in particular, lack of data in a detailed breakdown into waste fractions. In addition, this assumption has also been influenced by inconsistency in municipal waste reports conducted by local authorities. For instance - in one commune data are collected considering fractions 150101, 150102, 150104 and 150105, while in another, of similar size, all data is included under fraction 150106. In addition, the fraction of 150107 was often changed from 200102. At first glance, it may be surprising that faction 200140 "Metals" has not been included in the "Municipal waste collected selectively" category. This results from a specificity of a system for collecting metals in Poland, as in fact these are excluded from waste management and are usually directly transferred to metal collection points, remaining unregistered in the municipal system. In the past, the paper and glass packaging system functioned in a similar manner. The table below contains the definition range for the selected "waste flow".

Table 10. Details of selected waste flow.

Waste group	Municipal Solid Waste
Waste category	Biodegradable municipal waste within Vegetable, Fruit And Garden (VFG waste)
Waste fraction under category	200108 - Biodegradable kitchen waste 200201 - Biodegradable waste (waste from gardens and parks) 200302 - Waste from marketplaces
Involved actors/generators of waste	Households, local self-government, waste management companies
Involved steps in the supply chain	Production, wholesale, retail, consumption, waste treatment

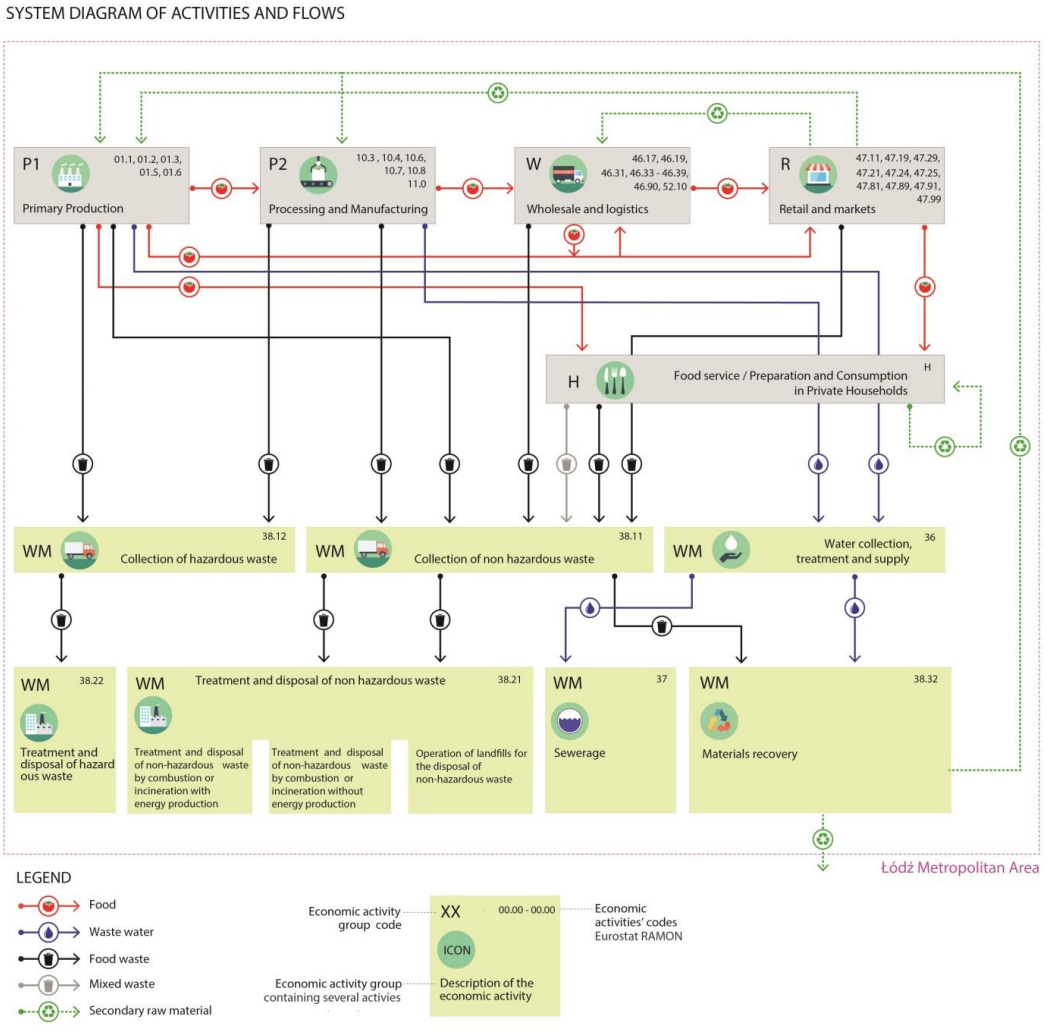
Source: own elaboration based on municipal reports.

3.3 Step 2: Defining the material supply chain

Based on the working definitions applied in this project, a set of NACE codes were selected to represent the examined key waste network, subdivided into Activity Groups (AG) of specific activities, which act as nodes in the waste generation and treatment system. In addition to the AG for economic activities, the AG 'H' which stands for FW production by households was introduced. Therefore, the following AG have been identified:

- P1 - Primary Production - 5 NACE (level 4) codes
- P2 - Processing and manufacturing - 6 NACE (level 4) codes
- W - Wholesale and logistics - 11 NACE (level 4) codes
- R - Retail and markets - 11 NACE (level 4) codes
- H - Food preparation and consumption at households - (not an NACE activity)
- WM - Waste Management - 6 NACE (level 4) codes

The NACE codes selected for the activity groups as well as the interrelations between activity groups are displayed in the comprehensive system diagram in figure below.



3.4 Step 3: Selection of geographical area and spatial scales

As it has been emphasized beforehand, the new regulations that came into force in 2013 have reformed all existing waste management. According to the Act, municipal waste ought to be collected selectively, and communal authorities (self-governments) are responsible for compliance with the principles adopted by the Act. **Local authorities are therefore in charge of managing processes related to local waste management**; they also undertake the most important decisions as to the forms and methods for their implementation. A system of containers for three categories of waste has been commonly introduced: mixed waste, glass and plastic/paper. However, depending on the commune, the number of segregated waste categories varies, ranging from three to six. **Local authorities have decided upon categories of segregated waste.**

Therefore, for the purpose of conducted analyses, the basic reference territorial unit is a municipality (commune). It has been decided to consider all (28) of such units within the Łódź Metropolitan Area – thus the entire region being examined.

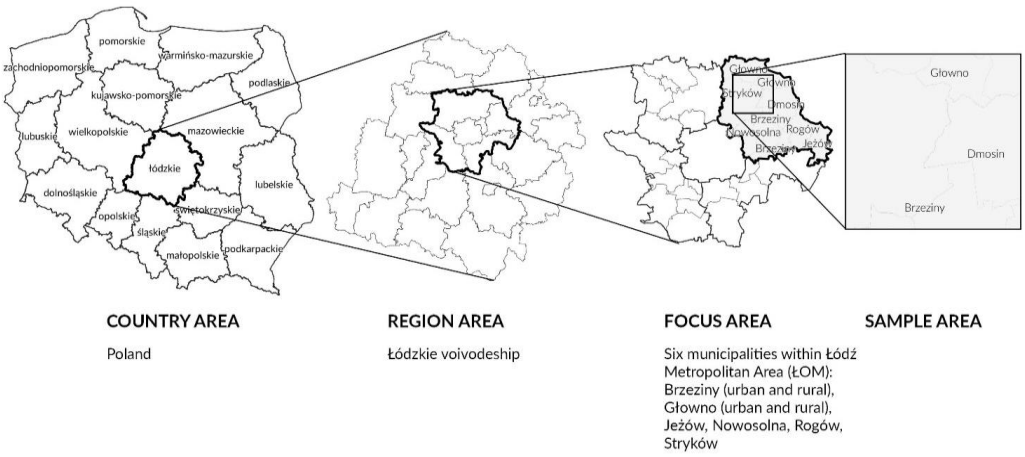


Fig. 21. Country area, Region area, Focus area & Sample area.

Source: own elaboration.

3.5 Step 4: Defining case specific supply chain

A dominant share of municipal solid waste is produced at the household level. For this deliverable, the 2016 statistics are used which show that, in the ŁOM, there are 28 municipalities containing 465,057 households and 1,167,543 inhabitants, of which 690,422 inhabited the Łódź commune, comprising 59.1% of agglomeration. The second largest commune was Pabianice, (population of 65,823) the third one was Zgierz (56,690). The communes of Aleksandrów Łódzki (31,445) and Koluszki (23,639) were also characterized by a relatively high population number. The urban commune of Ozorków was populated by 19,685 inhabitants, while of Konstantynów Łódzki by 18,013 and Głowno by 14,422. The rural commune of Zgierz 13,972; Andrespol by 13, 661, the commune of Stryków 12,565 people, the urban commune of Brzeziny 12,534 people,

and in the commune of Tuszyn 12,332 inhabitants. In the remaining communes of the Łódź agglomeration, the population was below 11,000.

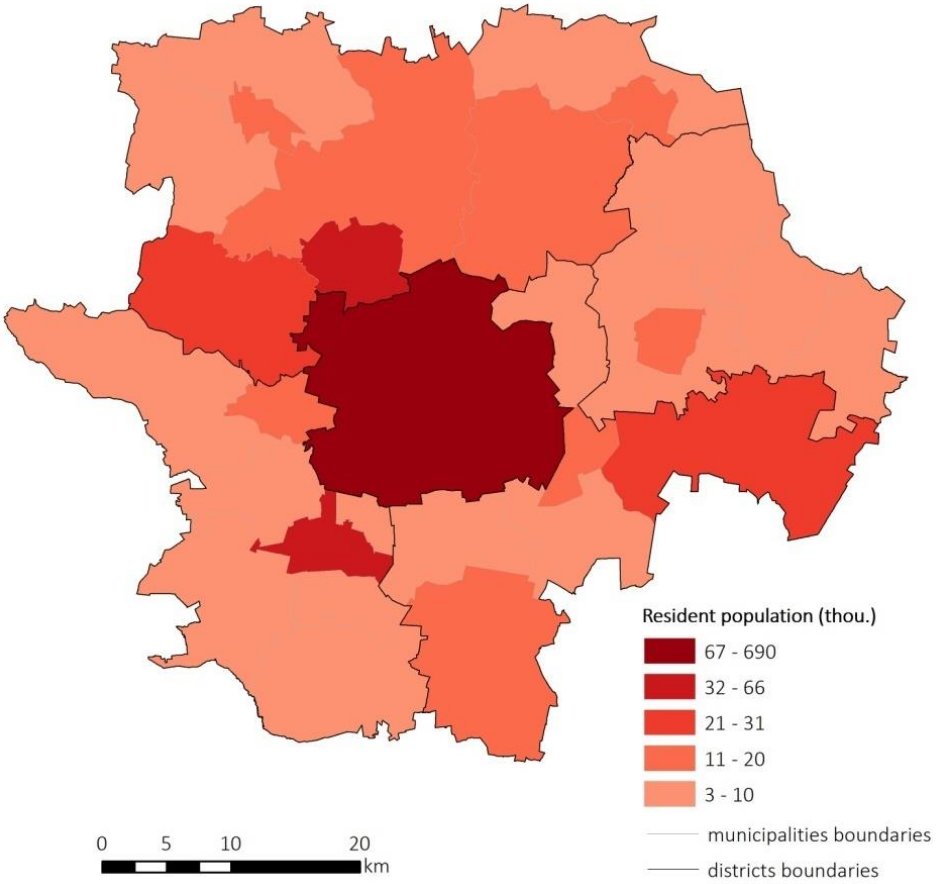


Fig. 22. Population number in communes of the Łódź metropolitan area in 2016

Source: Own study based on data from the Local Data Bank of Poland

The average population density in the Łódź agglomeration area was 421 people/km^2 (as of 2016). The highest population density was found in the following communes: Łódź (2,354 people/km^2), Pabianice (1,995 people/km^2), Zgierz (1,339 people/km^2) and Ozorków (1,273 people/km ^{2}). In the commune of Głowno, there were 727 people/km^2, in the urban commune of Konstantynów Łódzki 661 people/km^2, in Andrespol 585 people/km^2, in Brzeziny 581 people/km^2, in Ksawerów 563 people/km^2, in Aleksandrów Łódzki 270 people/km^2, in Rzgów 151 people/km^2. In the remaining communes of the Łódź agglomeration, the population density was below 150 people/km^2.

The basic spatial socio-demographic and economic structures of the households and population are presented below.

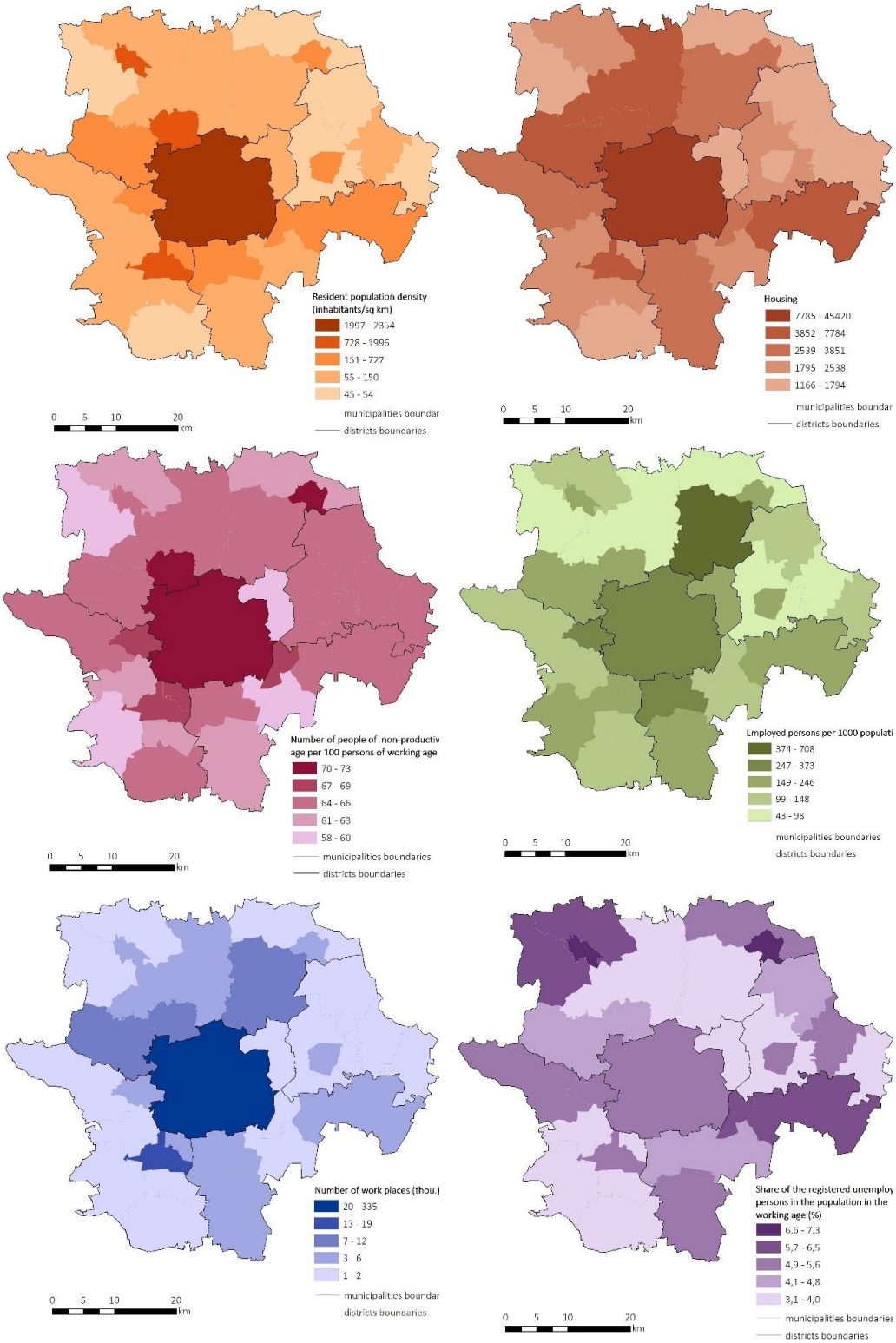


Fig. 23. Selected socio-economic characteristics of households and population in ŁOM, 2016.

Source: Own study based on data derived from the Central Statistical Office of Poland.

3.6 Step 5: Activity-based mass flow modelling

Organization system

The municipal waste management system in Poland is complex. The framework for its functioning is determined by numerous legal acts of the European Union, including i.a Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain directives (the so-called Waste Framework Directive)[3], Directive of the European Parliament and of the Council 2000/76/EC of 4 December 2000 on waste incineration[4], Council Directive 99/31/EC of 26 April 1999 on landfill (the so-called "Landfill Directive")[5], Directive of the European Parliament and Council 2005/20/EC of 9 March 2005 on packaging and packaging waste[6].

Based upon these legal acts, two essential laws are in force in Poland, defining the principles of waste management, i.e. the Act of 14 December 2012 on waste[7] (amended in 2015[8]) and the Act of 13 September 1996 on maintaining cleanliness and order in communes[9] (amended in 2011[10] and 2014[11]).

As it was already mention, the authority responsible for organizing waste management in Poland is the commune (term *municipality* is also commonly used) - the lowest-level self-governing unit (NUTS 5). The commune is obligated to establish collection, transport and management of municipal waste. Specific scope of duties in the field of communal waste management include:

- providing construction, maintenance and operation of own regional installations for municipal waste treatment or share these facilities with other communes;
- involving all property owners in the commune in a municipal waste management system;
- supervising the municipal waste management, including implementation of tasks entrusted to entities collecting municipal waste from property owners;
- establishing separate municipal waste collection covering at least the following waste fractions: paper, metals, plastics, glass and multi-material packaging as well as biodegradable municipal waste, including biodegradable packaging waste;
- establishing points for selective collection of municipal waste;
- ensuring achievement of desired recycling levels, preparation for re-use and recovery by other methods and limiting the mass of biodegradable municipal waste transferred to landfills;

[3] OJ EU L 312 of 22.11.2008
[4] OJ EU L332 of 28.12.2000
[5] OJ EU. L 182 of 16.7.1999
[6] OJ EU L 70/17 of 16.3.2005
[7] OJ EU of 201., pos. 21
[8] OJ EU of 2015 pos. 122
[9] OJ EU of 1996, No. 132, pos. 622
[10] OJ EU of 2011, No 152, pos. 897
[11] OJ EU of 2015, pos. 87

- conducting informative and educational activities in the field of proper municipal waste management, in particular concerning separate collection of municipal waste;
- providing information regarding municipal waste management system on the commune's official website as well as via other customary communication channels.

Municipal authorities, through tender procedure select enterprises responsible for collecting municipal waste from property owners in commune's area and supervise them in the implementation of tasks related to waste management. Enterprises appointed via tender are obliged to collect or collect and dispose municipal waste and transfer it to the regional municipal waste treatment installation (so-called RIPOK). The property owners' duties include participating in waste management expenditure and proper waste segregation. Individuals segregating waste pay a lower fee.

Supervision over communes in the field of investment related to waste management is held by authorities at the voivodeship (province, NUTS 2) level. Voivodship self-governments are obligated to adopt the Voivodeship Waste Management Plans, which include, among others:

- division of voivodship area into municipal waste management regions along with assigning communes included in a given region
- appointing regional installations for municipal waste treatment in individual municipal waste management regions and installations intended for substitute operation of these regions, if the installation located in them has failed or cannot accept waste for other reasons and until launching regional municipal waste treatment installations.

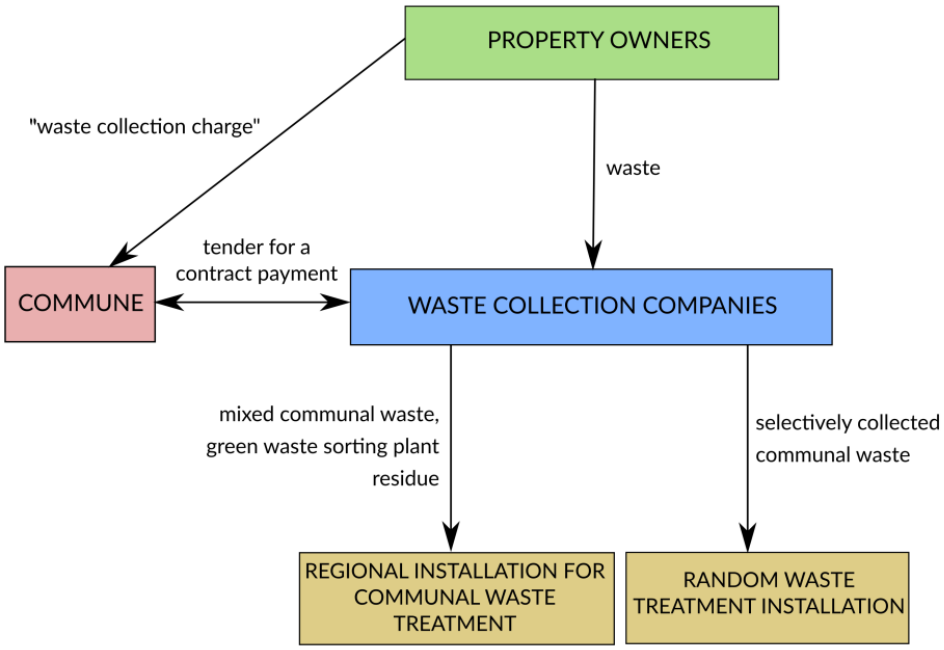


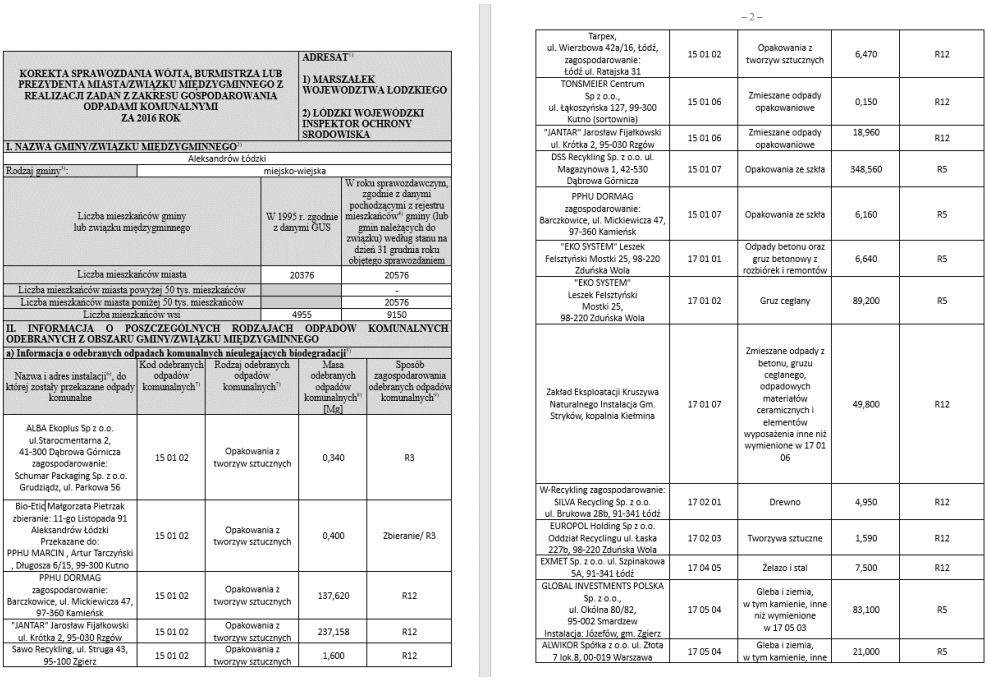
Fig. 24. Municipal waste management system.

Source: own elaboration.

Control over municipal waste landfills, sewage sludge management and compliance with waste management regulations at the voivodeship level is exercised by the Voivodship Inspectorate for Environmental Protection. The Minister of Environment supervises operation of the entire municipal waste management system in Poland, which controls the functioning of waste management by means of the Chief Inspectorate for Environmental Protection.

Reporting

Entities receiving municipal waste from property owners submit a report every six months to the commune head, mayor or town president concerning treatment of municipal waste collected from property owners. On the other hand, entities responsible for operating points for selective municipal waste collection, submit annual reports on collected municipal waste treatment to the head of the municipality, the mayor or the president of the city. The mayor or president is obligated to submit an annual report to the marshal of the voivodeship and voivodeship environmental protection inspector on the implementation of tasks in the field of municipal waste management. Subsequently, marshal of the voivodeship reports completion of assigned tasks to the governmental minister for the environment. On the basis of reports submitted by entities receiving municipal waste from property owners, entities operating selective municipal waste collection points and the annual report regarding implementation of municipal waste management undertakings, a commune head, mayor or city president draw up an analysis of the municipal waste management status. Such a document is compiled annually to verify the technical and organizational capabilities of the commune in the field of municipal waste management. It is open for public use.



KOREKTA SPRAWOZDANIA WOJTA, BURMISTRZA LUB PREZYDENTA MIASTA/ZWIĄZKU MIĘDZYGMINNEGO Z REALIZACJI ZADAŃ Z ZAKRESU GOSPODAROWANIA ODPADAMI KOMUNALNYMI ZA 2016 ROK

ADRESAT[1]

1) MARSZAŁEK WOJEWÓDZTWA ŁÓDZKIEGO

2) ŁÓDZKI WOJEWÓDZKI INSPEKTOR OCHRONY ŚRODOWISKA

I. NAZWA GMINY/ZWIĄZKU MIĘDZYGMINNEGO[2]

Aleksandrów Łódzki

Rodzaj gminy[3]:	miejsko-wiejska	
Liczba mieszkańców gminy lub związku międzygminnego	W 1995 r. zgodnie z danymi GUS	W roku sprawozdawczym, zgodnie z danymi pochodzącymi z rejestru mieszkańców[4] gminy (lub gmin należących do związku) według stanu na dzień 31 grudnia roku objętego sprawozdaniem
Liczba mieszkańców miasta	20376	20576
Liczba mieszkańców miasta powyżej 50 tys. mieszkańców		-
Liczba mieszkańców miasta poniżej 50 tys. mieszkańców		20576
Liczba mieszkańców wsi	4955	9150

II. INFORMACJA O POSZCZEGÓLNYCH RODZAJACH ODPADÓW KOMUNALNYCH ODEBRANYCH Z OBSZARU GMINY/ZWIĄZKU MIĘDZYGMINNEGO

a) Informacja o odebranych odpadach komunalnych nieulegających biodegradacji[1]

Nazwa i adres instalacji[5], do której zostały przekazane odpady komunalne	Kod odebranych odpadów komunalnych[7]	Rodzaj odebranych odpadów komunalnych[7]	Masa odebranych odpadów komunalnych[6] [Mg]	Sposób zagospodarowania odebranych odpadów komunalnych[8]
ALBA Ekoplus Sp z o.o. ul.Starocmentarna 2, 41-300 Dąbrowa Górnicza zagospodarowanie: Schumar Packaging Sp. z o.o. Grudziądz, ul. Parkowa 56	15 01 02	Opakowania z tworzyw sztucznych	0,340	R3
Bio-Etiq Małgorzata Pietrzak zbieranie: 11-go Listopada 91 Aleksandrów Łódzki Przekazane do: PPHU MARCIN , Artur Tarczyński , Długosza 6/15, 99-300 Kutno	15 01 02	Opakowania z tworzyw sztucznych	0,400	Zbieranie/ R3
PPHU DORMAG zagospodarowanie: Barczkowice, ul. Mickiewicza 47, 97-360 Kamieńsk	15 01 02	Opakowania z tworzyw sztucznych	137,620	R12
"JANTAR" Jarosław Fijałkowski ul. Krótka 2, 95-030 Rzgów	15 01 02	Opakowania z tworzyw sztucznych	237,158	R12
Sawo Recykling, ul. Struga 43, 95-100 Zgierz	15 01 02	Opakowania z tworzyw sztucznych	1,600	R12

– 2 –

Tarpex, ul. Wierzbowa 42a/16, Łódź, zagospodarowanie: Łódź ul. Ratajska 31	15 01 02	Opakowania z tworzyw sztucznych	6,470	R12
TONSMEIER Centrum Sp z o.o., ul. Łąkoszyńska 127, 99-300 Kutno (sortownia)	15 01 06	Zmieszane odpady opakowaniowe	0,150	R12
"JANTAR" Jarosław Fijałkowski ul. Krótka 2, 95-030 Rzgów	15 01 06	Zmieszane odpady opakowaniowe	18,960	R12
DSS Recykling Sp. z o.o. ul. Magazynowa 1, 42-530 Dąbrowa Górnicza	15 01 07	Opakowania ze szkła	348,560	R5
PPHU DORMAG zagospodarowanie: Barczkowice, ul. Mickiewicza 47, 97-360 Kamieńsk	15 01 07	Opakowania ze szkła	6,160	R5
"EKO SYSTEM" Leszek Felsztyński Mostki 25, 98-220 Zduńska Wola	17 01 01	Odpady betonu oraz gruz betonowy z rozbiórek i remontów	6,640	R5
"EKO SYSTEM" Leszek Felsztyński Mostki 25, 98-220 Zduńska Wola	17 01 02	Gruz ceglany	89,200	R5
Zakład Eksploatacji Kruszywa Naturalnego Instalacja Gm. Stryków, kopalnia Kiełmina	17 01 07	Zmieszane odpady z betonu, gruzu ceglanego, odpadowych materiałów ceramicznych i elementów wyposażenia inne niż wymienione w 17 01 06	49,800	R12
W-Recykling zagospodarowanie: SILVA Recycling Sp. z o.o. ul. Brukowa 28b, 91-341 Łódź	17 02 01	Drewno	4,950	R12
EUROPOL Holding Sp z o.o. Oddział Recyclingu ul. Łaska 227b, 98-220 Zduńska Wola	17 02 03	Tworzywa sztuczne	1,590	R12
EXMET Sp. z o.o. ul. Szpinakowa 5A, 91-341 Łódź	17 04 05	Żelazo i stal	7,500	R12
GLOBAL INVESTMENTS POLSKA Sp. z o.o., ul. Okólna 80/82, 95-002 Smardzew Instalacja: Józefów, gm. Zgierz	17 05 04	Gleba i ziemia, w tym kamienie, inne niż wymienione w 17 05 03	83,100	R5
ALWIKOR Spółka z o.o. ul. Złota 7 lok.8, 00-019 Warszawa	17 05 04	Gleba i ziemia, w tym kamienie, inne	21,000	R5

Fig. 25. Example of first two pages of annual waste report from commune.

Source: Aleksandrów Łódzki waste report.

Waste flow

Generated municipal waste is collected from their producers by receiving companies, appointed by municipal authorities through a tender. Depending on the manner the waste is collected, mixed municipal waste and waste collected selectively are distinguished. Received waste is then directed to installations for municipal waste treatment, where they undergo recovery or disposal processes. In municipal waste treatment installations, the material undergoes a thermal or mechanical-biological transformation. Mixed municipal waste, which comprises the highest percentage of municipal waste received is mainly directed to the installation for mechanical and biological treatment of municipal waste. At that stage, the first process to which waste is subjected is separation of waste material fractions (glass, paper, plastic and metal), which are then sent to the sorting plant for separately collected waste (for cleaning purposes). Mechanical processing of mixed municipal waste consists in isolating specific factions that can be used in material or energy terms as well as a fraction requiring additional biological processing. Fractions intended for further use include i.a. paper, cardboard, ferrous metals, non-ferrous metals, plastic and rubber. Mechanical treatment of mixed municipal waste involves processing of waste for the purpose of preparing for recovery, including recycling or treatment of waste, as a result of which waste intended for disposal is generated. Selectively collected waste (paper, glass, metals, plastics) as well as mixed municipal waste is also directed to the mechanical and biological treatment plant, where it passes through the cleaning process on waste segregation lines and then is recycled. Received green waste and other biodegradable waste collected selectively are transferred to the composting plant. Hazardous waste collected selectively from property owners or collected in points for selective collection of municipal waste are transferred to installations where appropriate recovery and recycling processes are applied, adapted to the given type of waste.

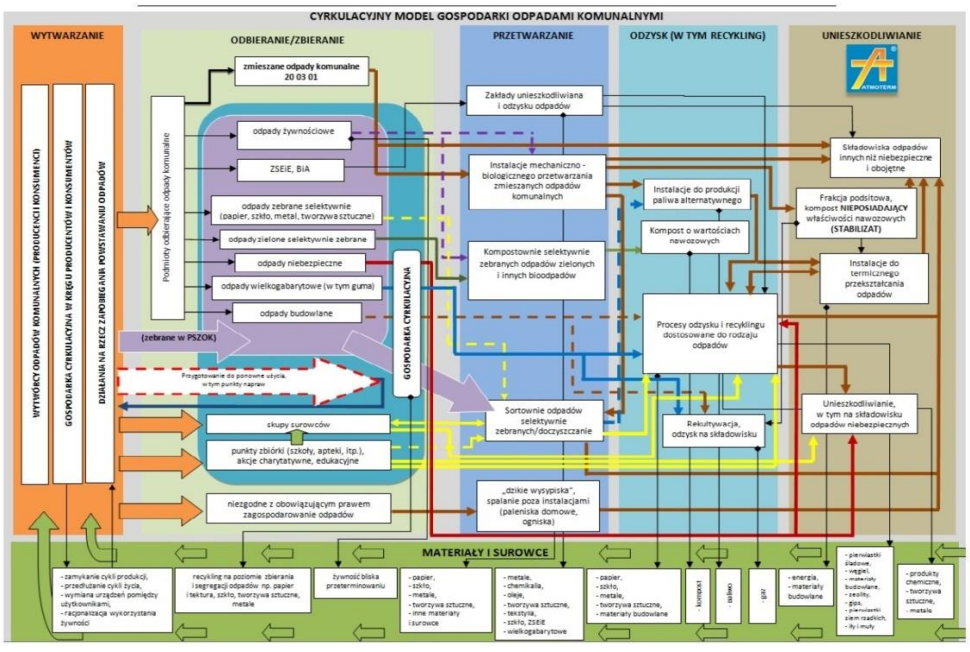


Fig. 26. Model of waste flow. *Source: Plan gospodarki odpadami dla województwa łódzkiego… (2016).*

Municipal solid waste production

Municipal waste is a crucial part of waste management. According to the Waste Act of December 12, 2012 municipal waste is "waste generated in households, excluding end-of-life vehicles, as well as waste not containing hazardous waste originating from other waste generators, which due to their nature or composition are similar to waste generated in households'. Municipal waste is characterized by numerous unfavourable characteristics that cause obstacles in managing them. These include variability in the quantity and quality of waste in the timespan, heterogeneity of morphological and chemical composition, possible sanitary and epidemiological threat, odor nuisance, occurrence of dangerous substances in certain fractions (e.g. heavy metals), as well as presence of hazardous waste (e.g. expired medicines, used batteries, chemicals).

In 2016, a total of 337.3 thous. tons of municipal waste were collected from the Łódź agglomeration. The largest amount of waste was collected from Łódź commune (224.2 thous. tons). These accounted for about 66.5% of the total mass of waste collected from the entire Łódź agglomeration. 22.5 thous. tons were collected from the urban commune of Pabianice, 13.8 thous. tons from Zgierz and 9.2 thous. tones form Aleksandrów Łódzki commune. A relatively high mass of municipal waste was collected from the communes of: Konstantynów Łódzki (7.5 thous. tons), Ozorków (6.4 thous. tons), Andrespol (5.4 thous. tonnes), Koluszki (4.3 thous. tons), Brzeziny (4.2 thous. tons), Stryków (3.7 thous. tons), Rzgów (3.7 thous. tons), Głowno (3.3 thous. tons) and Ksawerów (3.2 thous. tons). From the remaining communes of the Łódź agglomeration, from 0.7 to 2.5 thous. tons of municipal waste were collected. The mass of municipal waste produced by particular communes of course depends on the number of its inhabitants and population density.

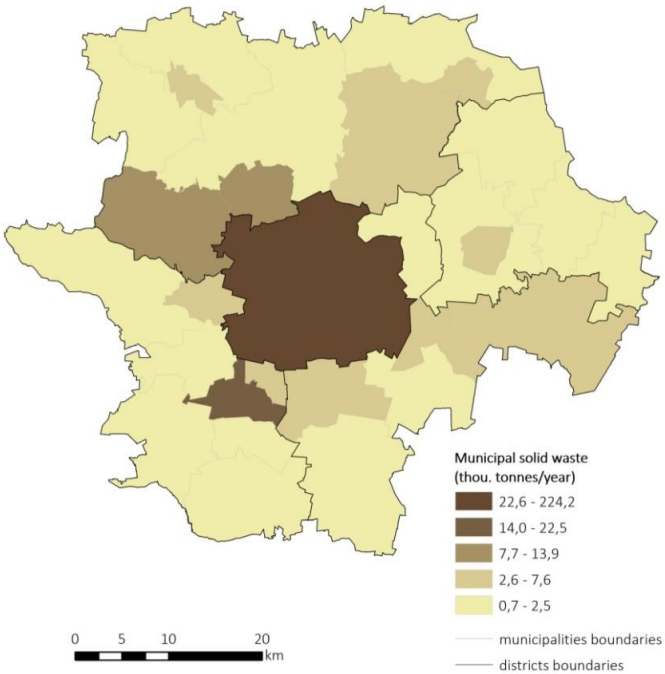


Fig. 27. Mass of municipal waste collected in communes of the ŁOM in 2016.
Source: Own study based on data from communal reports for 2016

Łódź is the largest commune in the Łódź agglomeration in terms of population number and density, and thus consequently comprises the greatest producer of municipal waste within the region. The second largest commune in terms of population number and density as well as overall mass of generated municipal waste is the urban commune of Pabianice, whereas the third one is Zgierz.

The mass of municipal waste collected per 1 inhabitant in the Łódź agglomeration was varied in individual communes. The average mass of municipal waste collected in 2016 per 1 inhabitant was 290 kg. The largest amount of municipal waste per capita was collected in the commune of Ksawerów (425 kg/person), Konstantynów Łódzki (422 kg/person) and Andrespol (401 kg/person). Communes of Łódź, Rzgów, Nowosolna and Brzeziny (330-370 kg/person) were also characterized by a relatively considerable mass of municipal waste per capita. In other communes of the Łódź agglomeration, the mass of municipal waste was significantly lower - below 260 kg/person.

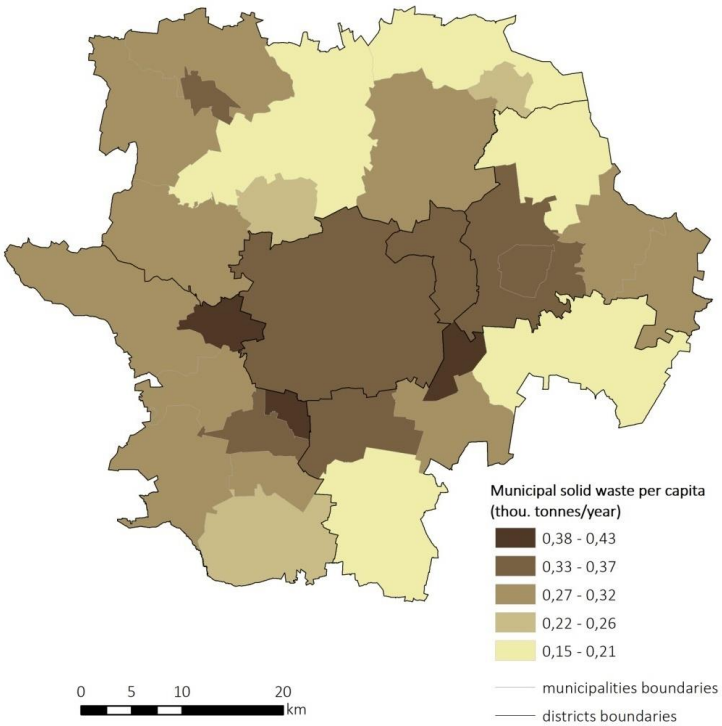


Fig. 28. Mass of collected municipal waste per capita in communes of the ŁOM in 2016.

Source: Own study based on data from communal reports for 2016

Non-biodegradable municipal solid waste production

Non-biodegradable waste is a type of waste that is not decomposed by microorganisms. In 2016, the overall mass of 306,3 thous. tons of such waste was collected in the Łódź agglomeration area. Non-biodegradable waste accounted for approximately 90.8% of the total mass of collected waste generated in the analysed agglomeration. The largest

amount of non-biodegradable municipal waste was collected from the Łódź commune (204.2 thous. tons) comprising for 66.6% of the total mass of non-biodegradable waste collected from the agglomeration. A considerable mass of non-biodegradable municipal waste was also collected from the of urban commune of Pabianice (20.4 thous. tons) and Zgierz (13.3 thous. tons). 8.4 thous. tons of non-biodegradable waste was collected from the Aleksandrów Łódzki commune, 6.3 thous. tons from Konstantynów Łódzki and 5.9 thous. tons from Ozorków. In the remaining communes of the Łódź agglomeration, the overall mass of collected non-biodegradable municipal waste in 2016 ranged from 0.7 to 4.0 thous. tons.

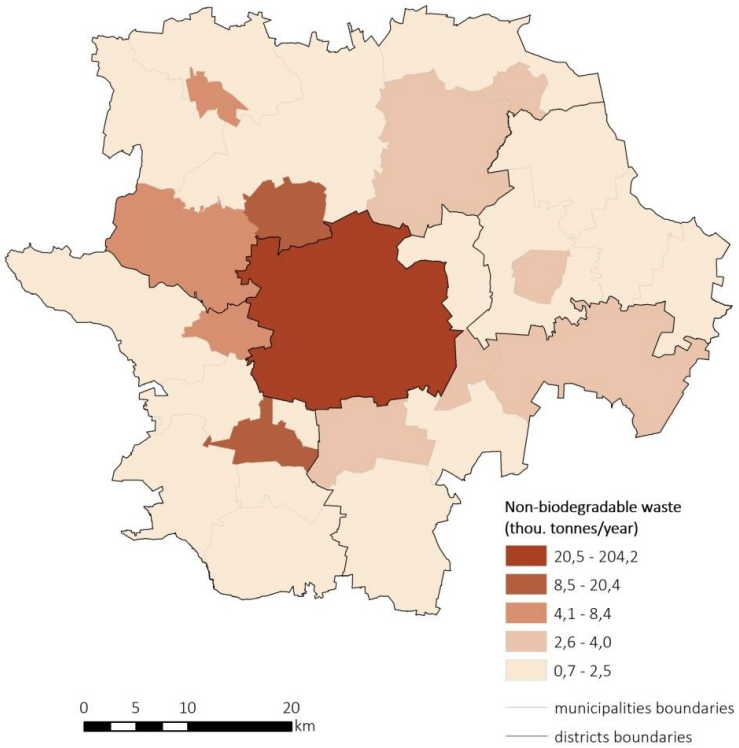


Fig. 29. Mass of non-biodegradable municipal waste collected from communes of the ŁOM in 2016.

Source: Own study based on data from communal reports for 2016

The average mass of non-biodegradable municipal waste per capita was 260 kg. The largest amount of municipal non-biodegradable waste generated by a single inhabitant was collected from the urban commune of Konstantynów Łódzki (353 kg/person), Rzgów (332 kg/person) and Ksawerów (320 kg/person). The mass of non-biodegradable municipal waste collected from the communes of Lutomiersk, Pabianice, Stryków, Brzeziny, Łódź, Rogów, Andrespol, Brójce, Jeżów, Nowosolna and Ozorków ranged from 280 to 310 kg/person. In other communes of examined agglomeration, the average mass of non-biodegradable municipal waste per capita was in 2016 below 270 kg. The largest group of non-biodegradable municipal waste collected comprised non-segregated

municipal waste (waste code 200301), of which 242.35 thous. tons was collected in 2016 from the Łódź agglomeration.

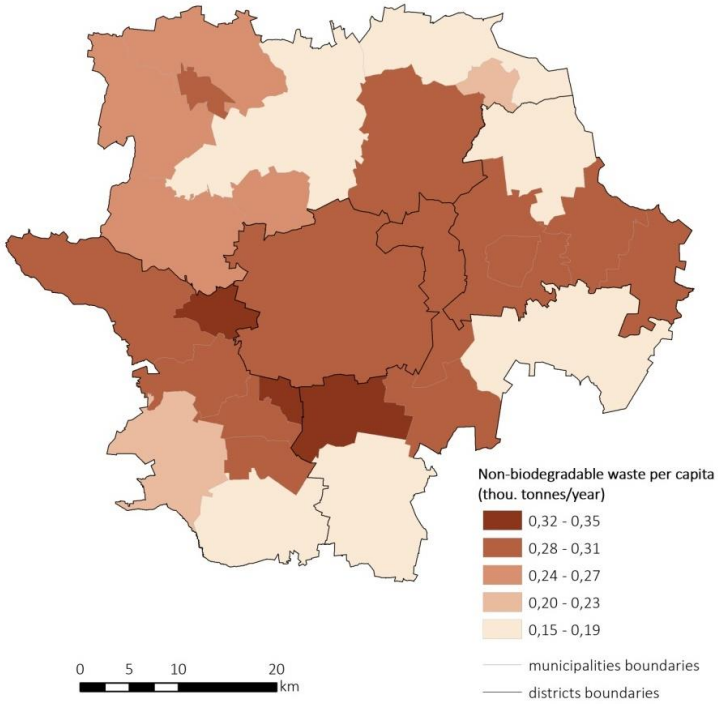


Fig. 30. Mass of non-biodegradable municipal waste per capita in communes of the ŁOM in 2016.

Source: Own study based on data from communal reports for 2016

Biodegradable municipal solid waste production

Biodegradable waste is a type waste that undergoes aerobic or anaerobic decomposition, with participation of microorganisms. Biodegradable municipal waste includes:

- paper and cardboard (including packaging waste),
- clothing made of natural fibres,
- textiles made of natural fibres (including packaging waste),
- edible oils and fats
- wood not containing hazardous substances (including packaging waste),
- biodegradable waste (including biodegradable kitchen waste),
- waste generated at marketplaces.

In 2016 as much as 30.98 thous. tons of biodegradable waste was collected from the Łódź agglomeration. These accounted for 9.2% of the total mass of municipal waste collected in this area. The largest amount of biodegradable municipal waste was collected from the Łódź commune (20 tons). Approximately 2.1 thous. tons was gathered

in the urban commune of Pabianice, 1.5 thous. tons from Andrespol and 1.2 thous. tons from Konstantynów Łódzki commune. The remaining communes collected less than 0.9 thousand. tons of biodegradable waste.

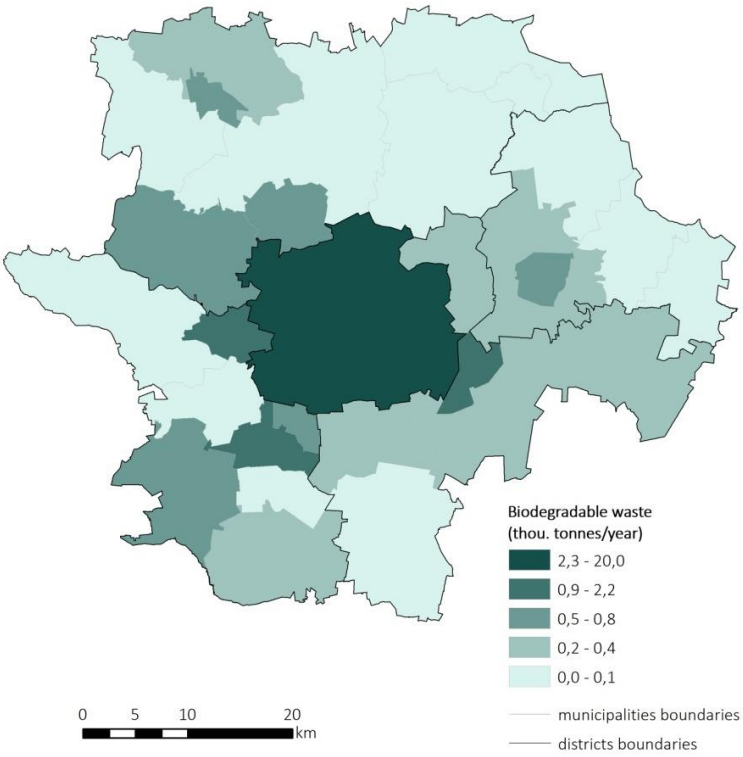


Fig. 31. Mass of biodegradable municipal waste collected from communes of the ŁOM in 2016.

Source: Own study based on data from communal reports for 2016

The average mass of municipal biodegradable waste per capita collected in 2016 was 30 kg. The largest amount of municipal biodegradable waste per 1 inhabitant was collected in the commune of Andrespol (112 kg/person) and Ksawerów (109 kg/person). The commune of Nowosolna (78 kg/person), Konstantynów Łódzki (69 kg/person), Dłutów (63 kg/person) and Dobroń (62 kg/person) also had a relatively high mass of biodegradable waste per capita. In other communes of the Łódź agglomeration area, the mass of biodegradable municipal waste was below 42 kg per inhabitant. The largest group of biodegradable municipal waste collected comprised waste generated by gardens and parks (waste code 200201) and kitchen waste (waste code 200108).

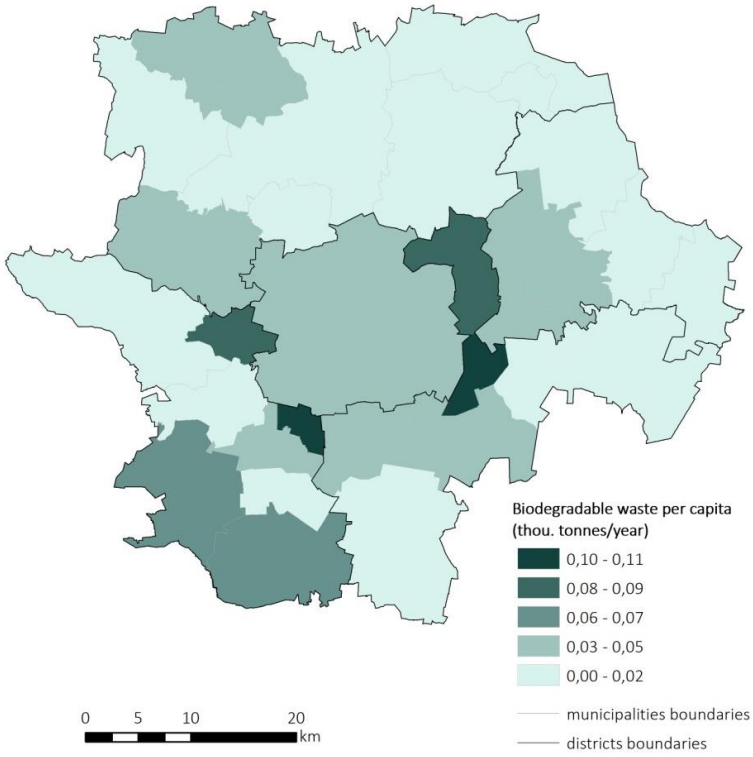


Fig. 32. Mass of biodegradable municipal waste per capita in communes of the ŁOM in 2016.

Source: Own study based on data from communal reports for 2016

Waste intended for re-use and recycling

In 2016, as much as 31.6 thous. tons of municipal waste from the Łódź agglomeration area were reused and recycled. The largest amount of waste for re-use and recycling was generated in the commune of Łódź (17.5 thous. tonnes). About 2.4 thous. tons of municipal waste were prepared for re-use and recycling in the urban commune of Pabianice, while about 2.0 thous. tons in Zgierz. Municipal waste intended for the same purpose in communes of Aleksandrów Łódzki, Konstantynów Łódzki, Koluszki and of Głowno ranged from 0.8 to 1.5 thous. tonnes. In other communes of examined agglomeration, less than 0.8 thous. tons were directed for reuse and recycling.

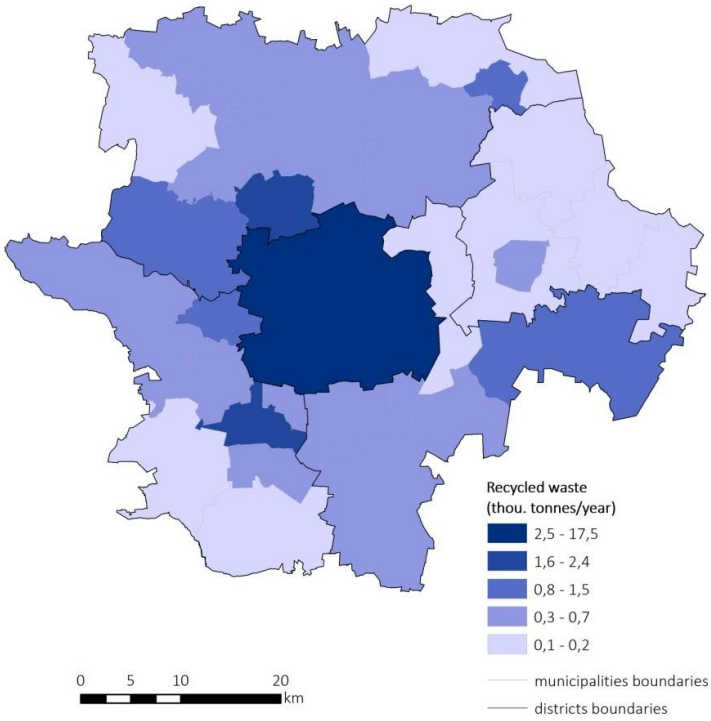


Fig. 33. Mass of municipal waste intended for re-use and recycling in communes of the ŁOM in 2016.

Source: Own study based on data from communal reports for 2016

In the structure of municipal waste intended for re-use and recycling, the largest group comprised glass packaging (waste code 150107). In 2016, 12.6 thous. tons of them were re-used. About 4.2 thous. tons of paper and cardboard packaging were re-used and recycled (waste code 150101), about 4.1 thous. tonnes of plastic packaging (waste code 150102) and around 3.2 thous. tons of mixed waste from concrete, brick rubble, waste ceramic materials and elements of equipment (waste code 170107). The mass of individual types of municipal waste from the Łódź agglomeration area intended for re-use and recycling is presented in the table below.

Tab. 11. Type and mass of municipal waste collected in the ŁOM in 2016 intended for re-use and recycled

Waste subgroup	Waste code	Type of waste	Mass of collected waste (tons)
Packaging waste	150101	Paper and cardboard packaging	4268.89
	150102	Plastic packaging	4090.09
	150103	Wooden packaging	9.35
	150104	Metal packaging	1647.59
	150105	Multi-material packaging	83.65

	150106	Mixed packaging waste	122.74
	150107	Glass packaging	12648.62
Waste from construction, renovation and dismantling of construction works and road infrastructure (including soil from contaminated areas)	170101	Concrete waste and debris from demolition and renovation	1633.26
	170102	Brick rubble	166.25
	170107	Mixed waste of concrete. brick rubble. waste ceramic materials and equipment other than mentioned in 17 01 06	3239.67
	170201	Wood	26.61
	170202	Glass	21.61
	170203	Plastics	29.29
	170405	Iron and steel	27.17
	170604	Insulation material other than mentioned in 17 06 01 and 17 06 03	2.66
	170904	Mixed construction. renovation and disassembly waste other than mentioned in 17 09 01. 17 09 02 and 17 09 03	1507.26
Waste from installations and devices for waste management, sewage treatment plants and treatment of drinking water and water for industrial purposes	191201	Paper and cardboard	1304.40
	191202	Ferrous metals	449.19
	191203	Non-ferrous metals	11.36
Municipal waste including selectively collected fractions	200101	Paper and cardboard	9.37
	200102	Glass	113.24
	200139	Plastics	197.49
	200140	Metals	0.64
	200199	Other non-specified fractions collected selectively	74.54
Total			**31684.94**

Source: Own study based on data from communal reports for 2016

The average paper, metal, plastics and glass recycling level in the Łódź agglomeration amounted to 28.8%. The highest recycling rate of these materials in 2016 was achieved by the Rzgów commune (68.2%), rural commune of Ozorków (62.0%) and the commune of Brójce (51.8%). In communes of Rogów, Lutomiersk, Koluszki, Tuszyn, Ksawerów, Stryków and urban commune of Brzeziny, the recycling level of paper, metal, plastics and glass ranged from 30.8 to 38.4%. In other communes of the Łódź agglomeration area, this figure was below 30%.

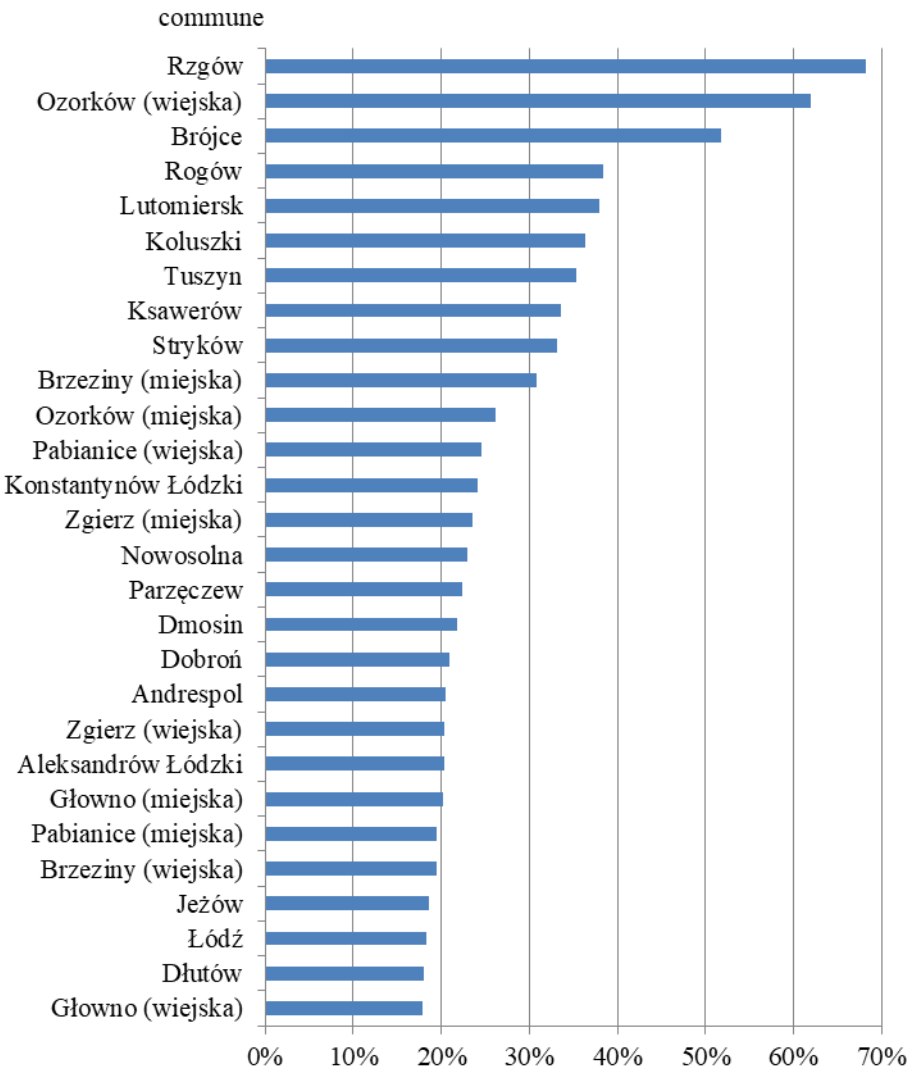


Fig. 34. Paper, metal, plastics and glass recycling level in communes of the ŁOM in 2016.

Source: Own study based on data from communal reports for 2016

Installations for municipal waste collection

In 2016, municipal waste from the Łódź agglomeration area was collected by 82 installations located in 13 voivodeships of Poland. About 99% of municipal waste mass produced in the Łódź agglomeration was collected by installations operating in the field of waste collection in the Łódzkie Voivodeship. The remaining 1% of the total municipal waste mass produced in the agglomeration was collected by installations located outside of this voivodeship.

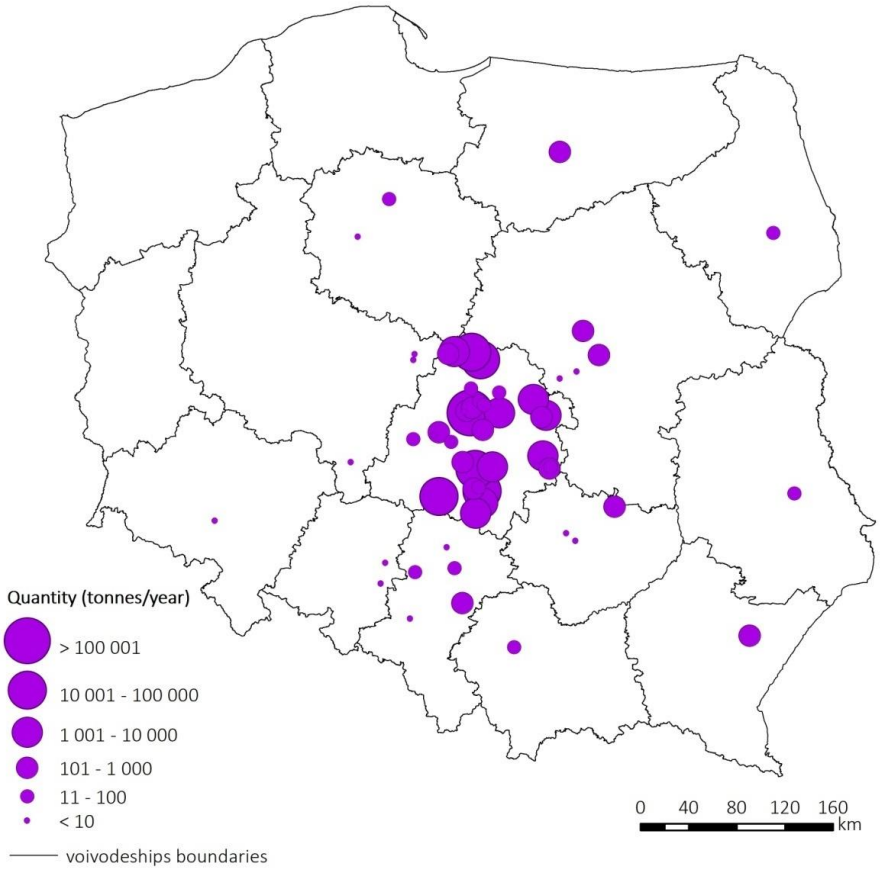


Fig. 35. Overall mass of municipal waste collected from the ŁOM by individual installations in 2016.

Source: Own study based on data from communal reports for 2016.

Approximately 53% of municipal waste collected in the Łódź agglomeration was gathered by installations operating within its area. The largest number of municipal waste was collected by installations operating in the area of Łódź, accounting for 51.5% of the total mass of municipal waste collected from the agglomeration area. As much as 13.7% of the municipal waste mass from the Łódź agglomeration was collected by installations in Kamieńsk (Radomsko County, Łódzkie Voivodeship), 8.4% by installation in Krzyżanówek (Kutno County, Łódzkie Voivodeship), 7.5% by installation in Bełchatów (Bełchatów County) , Łódzkie Voivodeship), 4.2% by installation in Kutno (Kutno County, Łódzkie Voivodeship), 3.5% by installation in Dylów (Pajęczno County, Łódzkie Voivodeship), 2.9% by installation in Pukinin (Rawa County, Łódzkie Voivodeship), and 1.4% by installation in Franki (Kutno County, Łódzkie Voivodeship). About 6,9% of municipal waste from the Łódź agglomeration area was gathered by other installations. The table below presents the mass of municipal waste collected from the Łódź agglomeration area by individual installations dealing with municipal waste collection.

Tab. 12. Mass of municipal waste collected from the ŁOM by individual installations.

Name and address of installation	Mass of non-biodegradable municipal waste (tons)	Mass of biodegradable municipal waste (tons)	Total mass of municipal waste (tons)
Bio-Etic Małgorzata Pietrzak 11-go Listopada 91 Aleksandrów Łódzki	0.40	0.00	0.40
PHU „TRANS-SUR", ul. Zgierska 57, 95-070 Aleksandrów Łódzki	0.00	2.75	2.75
EKO-REGION Sp. Z o.o. Zakład w Bełchatowie ul. Przemysłowa 14, 97-400 Bełchatów	25207.84	0.00	25207.84
Kompostownia i sortownia odpadów ul. Łódzka 35, 95-060 Brzeziny	3587.39	533.71	4121.10
Zakład Utylizacji Odpadów Medycznych ul. I Romanowskiej 2 85-796 Bydgoszcz	4.08	0.00	4.08
P.H.U. "NATURA" Marek Michałowski Serocka 11 85-552 Bydgoszcz	0.21	0.00	0.21
Eko Harpoon - Recykling Sp. z o.o., 05-152 Czosnów, Cząstków Mazowiecki 129	684.87	52.86	737.73
IRCHEM Sp. z o.o Sp. K ul. Bór 182 42-202 Częstochowa	1.51	0.00	1.51
Przedsiębiorstwo JASTA Sp. Z o.o. Spółka Komandytowa Danielów 5 97-360 Kamieńsk	0.00	25.50	25.50
ALBA Ekoplus Sp z o.o. ul. Starocmentarna 2, 41-300 Dąbrowa Górnicza	0.34	21.06	21.40
DSS Recykling Sp. z o.o. ul. Magazynowa 1, 42-530 Dąbrowa Górnicza	348.56	0.00	348.56
Zakład w Dylowie A, Dylów A, 98-330 Pajęczno	8396.86	3536.89	11933.75
Składowisko odpadów, sortownia odpadów zmieszanych Franki, gm. Krośniewice	4841.15	0.00	4841.15
Trans Południe Sp. Z o.o. 39-200 Dębica Podgrodzie 8B	0.72	0.00	0.72
Ferrostal Łabędy Sp. z o.o., 44-109 Gliwice, ul. Zawadzkiego 47	2.34	0.00	2.34
P.P.H. MIRBEZ EXPORT-IMPORT HURT-DETAL ul. Limanowskiego 13, 95-015 Głowno	4.33	2.00	6.33
PPHU MIRBEX Mirosław Piórkowski ul. Dworska 5 95-015 Głowno	0.00	16.82	16.82

AP-LOGIC Sp. z o.o., Gorczyn 71, 98-100 Łask	94.72	0.00	94.72
Terra Recykling Sp. Z o.o. Sp. Komandytowa ul. Traugutta 42 05-825 Grodzisk Maz.	5.17	0.00	5.17
Zakład Utylizacji Odpadów Komunalnych w Hryniewiczach, Hryniewicze 16-061 Juchnowiec Kościelny	42.89	1.52	44.40
Eko-Region Sp. Z o.o. 97-400 Bełchatów ul. Bawełniana 18, instalacja w Julkowie gm. Skierniewice	2628.04	1468.50	4096.54
FB SERWIS Kamieńsk Sp. Z o.o. ul. Wieluńska 50, 97-360 Kamieńska	40372.61	5656.17	46028.78
AMEST Kamieńsk Sp. Z o.o. ul. Wieluńska 50 97-360 Kamieńsk	29.90	0.00	29.90
Przedsiębiorstwo Gospodarki Odpadami MB Recykling Sp. Z o.o. ul. Głowackiego 4a/25 25-368 Kielce	0.99	0.00	0.99
Zakład Eksploatacji Kruszywa Naturalnego Instalacja Gm. Stryków, kopalnia Kiełmina	49.80	0.00	49.80
Packprofit Sp. Z o.o. ul. Zakładowa 3 47-110 Kolonowskie	0.00	9.45	9.45
Coster Elektro Odpady, 62-600 Koło, Chojny 51/3	2.84	0.00	2.84
KON-WIT RECYKLING S.C. ul. Częstochowska 70A 42-350 Koziegłowy	16.01	0.00	16.01
ZGK Organizacja Odzysku i Biosystem S.A. ul. Wodna 4 30-556 Kraków	27.21	0.00	27.21
Kraśnica 86e, gm. Opoczno	988.41	173.01	1161.42
Zakład Zagospodarowania Odpadów w Krzyżanówku, Krzyżanówek 99-314 Krzyżanów	24978.11	3260.07	28238.18
Tonsmeier Centrum Sp. Z o.o. Sortownia ul. Łąkoszyńska 127 99-300 Kutno	13519.35	1713.50	15232.86
Zakład Uzdatniania Stłuczki Szklanej ul. Klonowa 58 42-700 Lubieniec	49.53	0.00	49.53
Trans- Gum Marek Tykwiński ul. Bolka Świdnickiego 11/7 92-414 Łódź	4.50	0.00	4.50
SILVA Recycling Sp. z o.o. ul. Brukowa 28b, 91-341 Łódź	4.95	0.00	4.95
EL-Recykling Ireneusz Szablewski, Heleny 3/5, 93-404 Łódź	3.60	0.00	3.60
Remondis Electrorecykling Sp. Z o.o. ul. Pryncypalna 132/134 93-373 Łódź	11.92	0.00	11.92
REMONDIS Sp. Z o.o. Sortownia Odpadów ul. Swojska 4 91-342 Łódź	56764.89	469.58	57234.47

EXMET Sp. z o.o. ul. Szpinakowa 5A, 91-341 Łódź	7.50	0.00	7.50
MPO- Łódź Sp. Z o.o. ul. Zamiejska 1, 92-468 Łódź, sortownia odpadów komunalnych	105720.52	4466.04	110186.56
Malex Zakład Utylizacji Odpadów 91-169 Łódź ul. Wernera 23	0.01	0.00	0.01
Tarpex, ul. Wierzbowa 42a/16, Łódź	6.47	0.00	6.47
Zakład Gospodarowania Odpadami ul. Sanitariuszek 70/72 93-460 Łódź	0.00	6224.09	6224.09
Składowisko odpadów komunalnych w Modlnej	35.77	0.00	35.77
EKO SYSTEM Leszek Felsztyński Mostki 25, 98-220 Zduńska Wola	148.84	0.00	148.84
Krynicki Recykling S.A. ul. Iwaszkiewicza 48/23 10-089 Olsztyn	369.59	0.00	369.59
Przedsiębiorstwo Gospodarki Komunalnej Sp. Z o.o. w Opocznie 26-300 Opoczno ul. Krótka 1, instalacja Różanna	147.68	0.00	147.68
Komsort Sp. z o.o. ul. Nowogrodzka 31, 00-511 Warszawa Instalacja: Ossowice gmina Cielądz	320.10	0.00	320.10
EKO-REGION Sp. Z o.o. Zakład w Ostrzeszowie ul. Ceglarska 1 63-500 Ostrzeszów	0.04	0.00	0.04
Krynicki Recykling Spółka Akcyjna Zakład Uzdatniania Stłuczki Szklanej Pełkinie 136A 37-511 Wólka Pełkińska	315.30	0.00	315.30
Elektrociepłownia BARTOS Sp. Z o.o. ul. Czarnowska 56 C 26-065 Piekoszów	0.00	9.85	9.85
JUKO Sp. Z o.o. ul. Topolowa 1 Instalacja mechanicznego przetwarzania odpadów w Piotrkowie Trybunalskim ul. 1-go Maja 25	130.40	4.90	135.30
Zakład Usług Komunalnych HAK Stanisław Burczyński 97-300 Piotrków Tryb. Ul. Próchnika 25, instalacja 97-300 Piotrków Tryb. Ul. Wolska	1460.64	329.71	1790.35
Firma Handlowo-Usługowa DEREWENDA Henryk Derewenda, 97-300 Piotrków Trybunalski, ul. Topolowa 1	66.59	0.00	66.59
Zakład Unieszkodliwiania Odpadów Komunalnych Płoszów ul. Jeżynowa 40, 97-500 Radomsko	3537.94	273.53	3811.47
Coster Elektro Odpady Powiercie Kolonia 75/7, Powiercie Kolonia 62-600 Koło	2.86	0.00	2.86

Zakład Gospodarki Odpadami AQUARIUM Sp. Z o.o. Pukinin 140 96-200 Rawa Mazowiecka	8160.24	1638.11	9798.35
PPHU DORMAG ul. Stara droga 68, 95-500 Radomsko	680.66	102.27	782.93
EKO CENTRUM Radomsko ul. Reymonta 62 97-500 Radomsko	17.54	0.00	17.54
Ekostan Sp. Z o.o. ul. Południowa 20 Rawa Maz.	247.45	0.00	247.45
Zakład Robót Sanitarnych SANATOR Sp. Z o.o. Rąbień ul. Pańska 68/70 95-070 Aleksandrów Łódzki	722.85	0.00	722.85
EKO HARPOON- Recykling Sp. Z o.o. ul. Cementowa 20 22-170 Rejowiec Fabryczny	42.81	4.67	47.48
Zakład Unieszkodliwiania Odpadów Różanna gm. Opoczno PGK Sp. Z o.o. Opoczno, Różanna	21.48	0.00	21.48
FB SERWIS Składowisko Odpadów Ruszczyn, Ruszczyn	241.50	0.00	241.50
JANTAR Jarosław Fijałkowski ul.Krótka 2, 95-030 Rzgów	911.06	20.28	931.34
MK-RECYKLING Maciej Kosowski, Polna 11/35, 98-200 Sieradz	52.10	0.00	52.10
Vinderen Sp. Z o.o. Zakład Produkcyjny Sławno ul. Leśna 4 26-332 Sławno	3.20	0.00	3.20
GLOBAL INVESTMENTS POLSKA Sp. z o.o., ul. Okólna 80/82, 95-002 Smardzew Instalacja: Józefów, gm. Zgierz	83.10	0.00	83.10
Centrum Odzysku i Recyklingu w Starachowicach ul. Elaboracji 1, 22-215 Wąchock	0.00	110.37	110.37
TKM Recykling Polska Sp. Z o.o. Strzegom ul. Wojska Polskiego 75, 58-150 Strzegom	6.19	0.00	6.19
SILVA SPÓŁKA Z.O.O Silva Recycling oddział w Strzelcach Opolskich ul. 1 maja 52 47-100 Strzelce Opolskie	3.40	0.00	3.40
Świecie Recykling Sp. Z o.o. ul. Bydgoska 1 86-100 Świecie	0.00	18.07	18.07
MG Recykling S.C. Wąchocki, Marcin Wyderka ul.Kasprowicza 88/60, 01-949 Warszawa	137.04	0.25	137.29
REMONDIS Electrorecycling Sp. z o.o. ul. Zawodzie 16, 02-981 Warszawa	1.31	0.00	1.31
ALWIKOR Spółka z o.o. ul. Złota 7 lok.8, 00-019 Warszawa	21.00	0.00	21.00
WPT Polska Sp. Z o.o. Sp. Komandytowa ul. Sienna 73 00-833 Warszawa	0.00	16.85	16.85

TWK-ZAG SP. Z O.O. Wola Łaska 71 98-100 Łask	8.40	0.00	8.40
EKO-REGION Sp. Z o.o. Zakład w Woli Kruszyńskiej, Wola Kruszyńska 97-400 Bełchatów	0.00	692.26	692.26
EUROPOL Holding Sp z o.o. Oddział Recyclingu ul. Łaska 227b, 98-220 Zduńska Wola	4.15	0.00	4.15
Sawo Recykling, ul. Struga 43, 95-100 Zgierz	1.60	134.28	135.88
Eneris Sp z o.o. Zakład w Zgierzu ul. Boruty 7a, 95-100 Zgierz	0.00	1.08	1.08
EMKA S.A ul. Jaktorowska 15A 96-300 Żyrardów	0.09	0.00	0.09

Source: Own study based on data from communal reports for 2016

In 2016, non-biodegradable municipal waste was collected by 71 installations operating in the field of municipal waste collection. About 99% of the non-biodegradable municipal waste mass was collected by installations operating in the Łódzkie Voivodeship, whereas about 1% by external installations. The majority of municipal non-biodegradable waste (54.8% of mass) was collected by installations operating in the Łódź agglomeration area. The largest mass of non-biodegradable municipal waste was collected by installations in Łódź (53.6% of the non-biodegradable waste mass). About 13.3% of non-biodegradable municipal waste from the Łódź agglomeration was collected by installations in Kamieńsk (Radomsko County, Łódzkie Voivodeship), 8.2% by installation in Bełchatów (Bełchatów County Łódzkie Voivodeship), 8.1% by installation in Krzyżanówek (Kutno County, Łódzkie Voivodeship), 4.4% by installation in Kutno (Kutno County, Łódzkie Voivodeship), 2.7% by installation in Dylów (Pajęczno County, Łódzkie Voivodeship), 2.6% by installation in Pukinin (Rawa County, Łódzkie Voivodeship) and 1.6% by installation in Franki (Kutno County, Łódzkie Voivodeship). The remaining 5.5% of non-biodegradable municipal waste was collected by other installations.

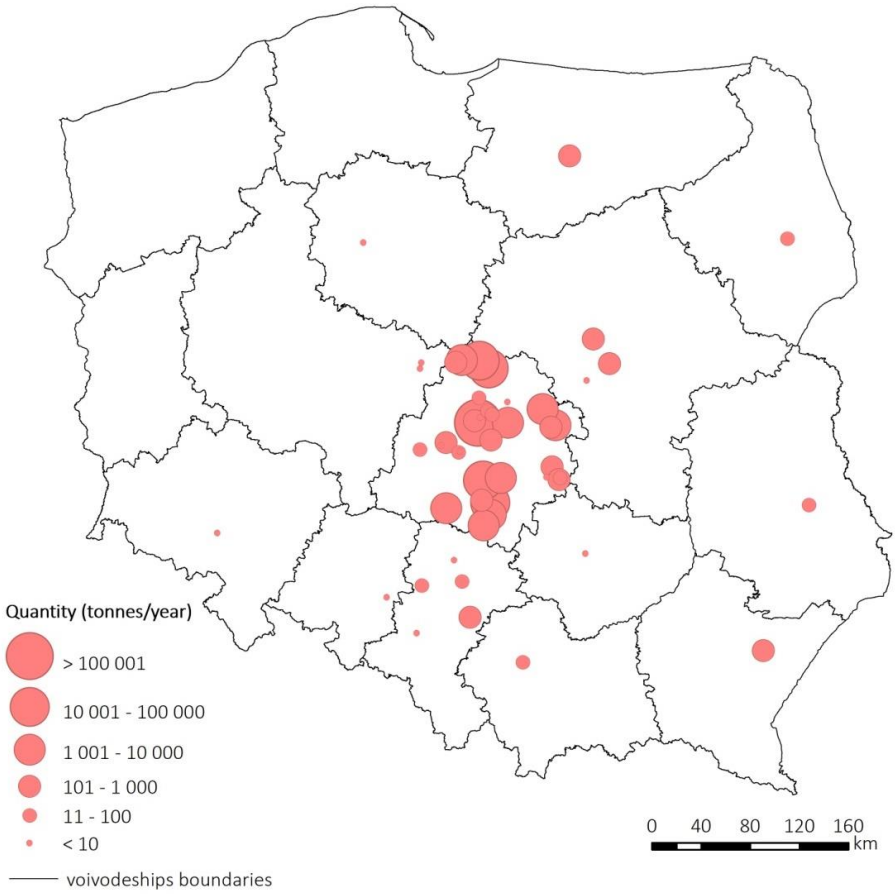


Fig. 35. Mass of non-biodegradable municipal waste collected from the Łódź Metropolitan Area by individual installations in 2016

Source: Own study based on data from communal reports for 2016

Municipal biodegradable waste was in 2016 collected from the agglomeration area by 33 installations. Approximately 99% of the biodegradable municipal waste mass was collected by installations operating in the Łódzkie Voivodeship. The remaining 1% was collected by installations located in the Kujawsko-Pomorskie, Mazowieckie, Podlaskie, Lubelskie, Świętokrzyskie, Śląskie and Opolskie Voivodeships. About 38.3% of biodegradable municipal waste was collected by installations operating in the Łódź agglomeration area. The largest mass of biodegradable municipal waste was collected by installations in Łódź (36.0% of this type of waste collected from entire agglomeration). About 18.3% of the biodegradable municipal waste was collected by the installations in Kamieńsk (Radomsko County, Łódzkie Voivodeship), 11.4% by installations in Dylów (Pajęczański County, Łódzkie Voivodeship), 10.5% by installations in Krzyżanówek (Kutno County, Łódzkie Voivodeship), 5.4% by installations in Kutno (Kutno County, Łódzkie Voivodeship), 5.3% by installations in Pukinin (Rawa County, Łódzkie Voivodeship), and 4.7% by installations in Julków (Skierniewice County, Łódzkie Voivodeship). The remaining 8.4% of biodegradable municipal waste was collected by other installations.

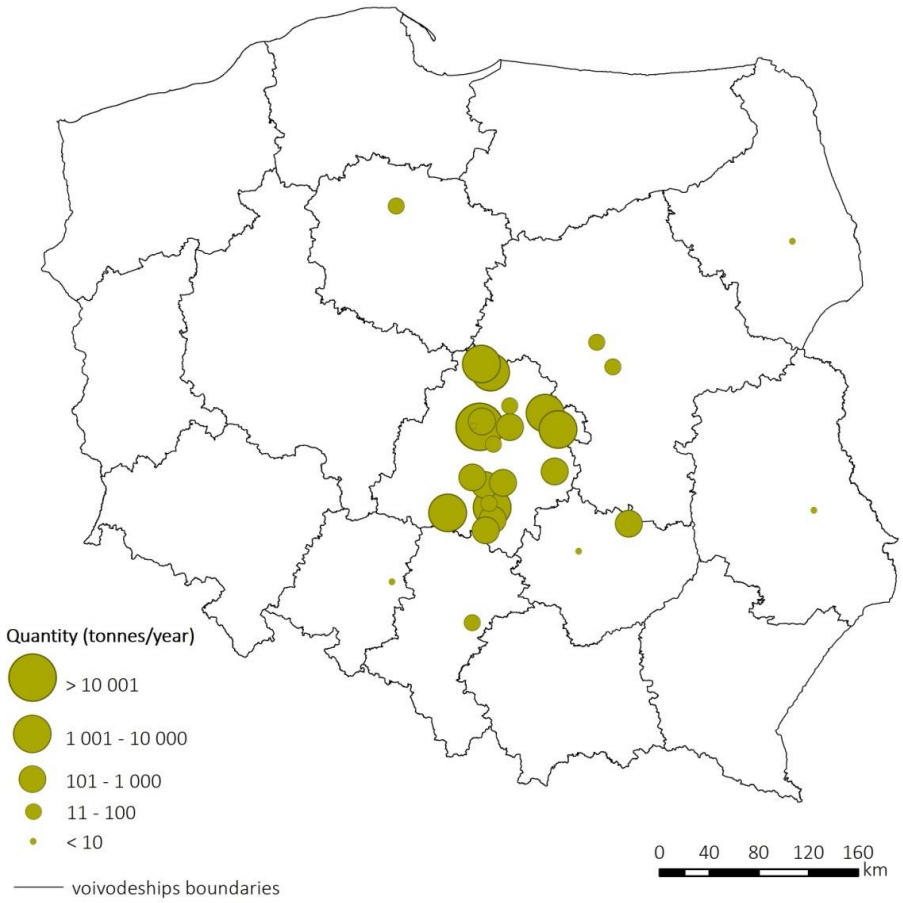


Fig. 36. Mass of biodegradable municipal waste collected from the Łódź Metropolitan Area by individual installations in 2016

Source: Own study based on data from communal reports for 2016

In the area of Łódź agglomeration there are 22 points for selective municipal waste collection. These points operate in most communes of the analysed area. In 2016, a total of around 9 thous. tons of waste were collected at the points for selective municipal waste collection. The largest amount was collected at such points in Łódź, Pabianice, Aleksandrów Łódzki, Zgierz and Głowno.

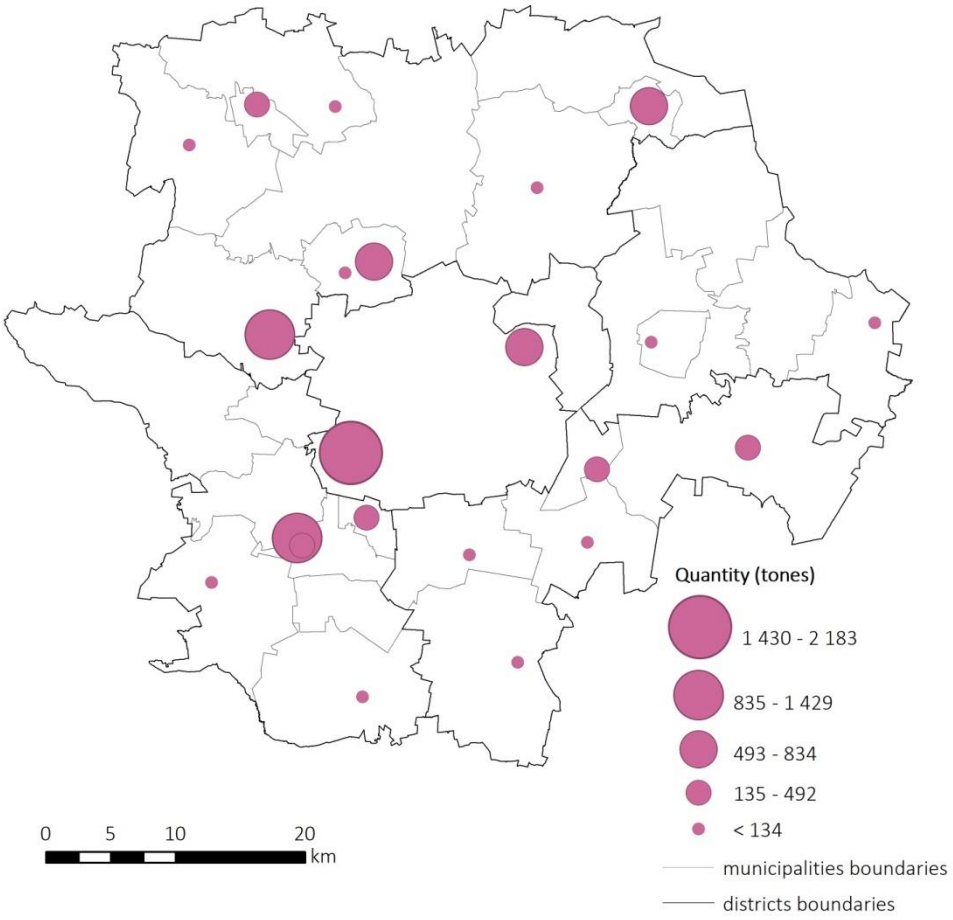


Fig. 37. Mass of municipal waste collected by individual points for selective municipal waste collection in the Łódź Metropolitan Area in 2016.

Source: Own study based on data from communal reports for 2016

Treatment for municipal waste collection

In 2016, municipal waste collected from the Łódź agglomeration area was treated by 80 installations located in 13 voivodeships. Approximately 99% of municipal waste is managed by installations operating in the Łódzkie Voivodeship, while the remaining 1% by external installations. Such a considerable rate of municipal waste management collected from the Łódź agglomeration area by installations operating within the voivodeship results from the provisions of the Waste Act of 14 December 2012. Pursuant to this document, waste is first processed at the place where it was generated. In case when waste cannot be processed at this place, it is transferred to the nearest place where it can be processed. In 2016, more than half of the municipal waste mass (53.3%) was utilized by installations operating in the Łódź agglomeration area.

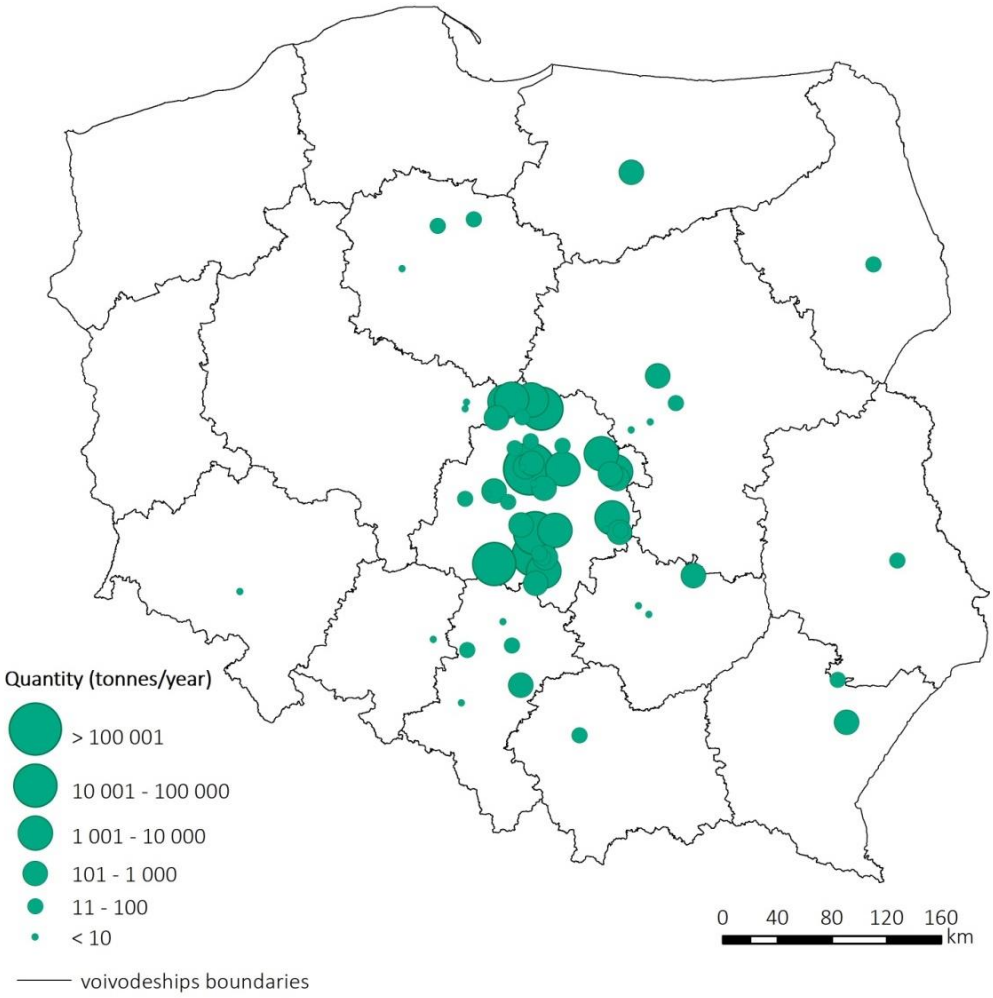


Fig 38. Mass of municipal waste collected from the Łódź Metropolitan Area utilized by individual installations in 2016.

Source: Own study based on data from communal reports for 2016

The largest mass of municipal waste was treated by installations operating in Łódź (51.6%). About 13.3% of the municipal waste generated within the agglomeration is utilized by installation in Ruszczyn (Radomsko County, Łódzkie Voivodeship), 11.2% by installation in Krzyżanówek (Kutno County, Łódzkie Voivodeship), 7.4% by installation in Bełchatów (Bełchatów County, Łódzkie Voivodeship), 3.3% by installation in Dylów (Pajeczno County, Łódzkie Voivodeship), 2.7% installation in Pukinin (Rawa County, Łódzkie Voivodeship), and 1.6% by installation in Kutno (Kutno County, Łódzkie Voivodeship). The remaining 8.9% of the of collected municipal waste mass was utilized by other installations. The overall mass of municipal waste managed in 2016 by individual installations is presented in the table below.

Tab. 13. Mass of municipal waste collected from the area of Łódź Metropolitan Are utilized by individual installations.

Name and address of installation	Mass of non-biodegradable municipal waste (tons)	Mass of biodegradable municipal waste (tons)	Total mass of utilized municipal waste (tons)
PHU „TRANS-SUR", ul. Zgierska 57, 95-070 Aleksandrów Łódzki	0.00	2.75	2.75
Barczkowice, ul. Mickiewicza 47, 97-360 Kamieńsk	197.58	40.00	237.58
EKO-REGION Sp. Z o.o. Zakład w Bełchatowie ul. Przemysłowa 14, 97-400 Bełchatów	22558.43	0.00	22558.43
Kompostownia i sortownia odpadów ul. Łódzka 35, 95-060 Brzeziny	3587.39	533.71	4121.10
Zakład Utylizacji Odpadów Medycznych ul. I Romanowskiej 2 85-796 Bydgoszcz	4.08	0.00	4.08
P.H.U. "NATURA" Marek Michałowski Serocka 11 85-552 Bydgoszcz	0.21	0.00	0.21
EKO HARPOON- Recykling Sp. Z o.o. Cząstków Mazowiecki 128 05-152 Czosnów sortownia odpadów	684.87	52.86	737.73
IRCHEM Sp. z o.o Sp. K ul. Bór 182 42-202 Częstochowa	1.51	0.00	1.51
Przedsiębiorstwo JASTA Sp. Z o.o. Spółka Komandytowa Danielów 5 97-360 Kamieńsk	0.00	25.50	25.50
DSS Recykling Sp. z o.o. ul. Magazynowa 1, 42-530 Dąbrowa Górnicza	348.56	0.00	348.56
Zakład w Dylowie A, Dylów A, 98-330 Pajęczno	10146.85	3796.17	13943.02
Składowisko odpadów, sortownia odpadów zmieszanych Franki, gm. Krośniewice	3177.95	0.00	3177.95
Trans Południe Sp. Z o.o. 39-200 Dębica Podgrodzie 8B	0.72	0.00	0.72
Ferrostal Łabędy Sp. z o.o., 44-109 Gliwice, ul. Zawadzkiego 47	2.34	0.00	2.34
AP-LOGIC Sp. z o.o., Gorczyn 71, 98-100Łask	94.72	0.00	94.72
Magazyn Grabów ul. Ogrodowa 56	132.04	0.00	132.04
Terra Recykling Sp. Z o.o. Sp. Komandytowa ul. Traugutta 42 05-825 Grodzisk Maz.	5.17	0.00	5.17
SchumarPackaging Sp. z o.o. Grudziądz, ul.Parkowa 56	0.34	21.06	21.40
Zakład Utylizacji Odpadów Komunalnych w Hryniewiczach, Hryniewicze 16-061 Juchnowiec Kościelny	42.89	1.52	44.40

Huta szkła O_I Produkcja Polska w Jarosławiu	47.54	0.00	47.54
GLOBAL INVESTMENTS POLSKA Sp. z o.o., ul. Okólna 80/82, 95-002 Smardzew Instalacja: Józefów, gm. Zgierz	83.10	0.00	83.10
Eko-Region Sp. Z o.o. 97-400 Bełchatów ul. Bawełniana 18, instalacja w Julkowie gm. Skierniewice	3225.50	1636.84	4862.34
AMEST Kamieńsk Sp. Z o.o. ul. Wieluńska 50 97-360 Kamieńsk	29.90	0.00	29.90
Przedsiębiorstwo Gospodarki Odpadami MB Recykling Sp. Z o.o. ul. Głowackiego 4a/25 25-368 Kielce	0.99	0.00	0.99
Packprofit Sp. Z o.o. ul. Zakładowa 3 47-110 Kolonowskie	0.00	9.45	9.45
Coster Elektro Odpady, 62-600 Koło, Chojny 51/3	2.84	0.00	2.84
KON- WIT Recykling s.c, Częstochowska 70, 42-350 Koziegłowy	10.78	0.00	10.78
ZGK Organizacja Odzysku i Biosystem S.A. ul. Wodna 4 30-556 Kraków	27.21	0.00	27.21
Ekostan Sp. Z o.o. ul. Południowa 20 Rawa Maz., instalacja Kraśnica 86e gm. Opoczno	1112.77	173.01	1285.78
Zakład Usług Komunalnych w Krośniewicach, ul. Paderewskiego 3, 99-340 Krośniewice	1820.30	0.00	1820.30
Zakład Zagospodarowania Odpadów w Krzyżanówku, Krzyżanówek 99-314 Krzyżanów	34254.19	3801.75	38055.93
Tonsmeier Centrum Sp. Z o.o. Sortownia ul. Łąkoszyńska 127 99-300 Kutno	4086.58	1171.82	5258.40
Zakład Uzdatniania Stłuczki Szklanej ul. Klonowa 58 42-700 Lubieniec	49.53	0.00	49.53
Trans- Gum Marek Tykwiński ul. Bolka Świdnickiego 11/7 92-414 Łódź	4.50	0.00	4.50
SILVA Recycling Sp. z o.o. ul. Brukowa 28b, 91-341 Łódź	8.35	0.00	8.35
EL-Recykling Ireneusz Szablewski, Heleny 3/5, 93-404 Łódź	3.60	0.00	3.60
Remondis Electrorecykling Sp. Z o.o. ul. Pryncypalna 132/134 93-373 Łódź	11.97	0.00	11.97
Łódź ul. Ratajska 31	6.47	0.00	6.47
REMONDIS Sp. Z o.o. Sortownia Odpadów ul. Swojska 4 91-342 Łódź	56764.89	469.58	57234.47
EXMET Sp. z o.o. ul. Szpinakowa 5A, 91-341 Łódź	7.50	0.00	7.50
Malex Zakład Utylizacji Odpadów 91-169 Łódź ul. Wernera 23	0.01	0.00	0.01

MPO Sp. z o.o. ul. Tokarzewskiego 2, 91-842 Łódź Sortownia: ul.Zamiejska 1, 93-468 Łódź	105720.52	4466.04	110186.56
Zakład Gospodarowania Odpadami ul. Sanitariuszek 70/72 93-460 Łódź	0.00	6224.09	6224.09
Składowisko odpadów komunalnych w Modlnej	35.77	0.00	35.77
EKO SYSTEM Leszek Felsztyński Mostki 25, 98-220 Zduńska Wola	198.64	0.00	198.64
Krynicki Recykling S.A. ul. Iwaszkiewicza 48/23 10-089 Olsztyn	322.05	0.00	322.05
Przedsiębiorstwo Gospodarki Komunalnej Sp. Z o.o. w Opocznie 26-300 Opoczno ul. Krótka 1	118.74	0.00	118.74
Komsort Sp. z o.o. ul. Nowogrodzka 31, 00-511 Warszawa Instalacja: Ossowice gmina Cielądz	320.10	0.00	320.10
ALWIKOR Spółka z o.o. ul. Złota 7 lok.8, 00-019 Warszawa zagospodarowanie: Ignacew Rozlazły dz.nr 200, 201, 95-045 Parzęczew	21.00	0.00	21.00
Krynicki Recykling Spółka Akcyjna Zakład Uzdatniania Stłuczki Szklanej Pełkinie 136A 37-511 Wólka Pełkińska	315.30	0.00	315.30
Elektrociepłownia BARTOS Sp. Z o.o. ul. Czarnowska 56 C 26-065 Piekoszów	0.00	9.85	9.85
JUKO Sp. Z o.o. ul. Topolowa 1 Instalacja mechanicznego przetwarzania odpadów w Piotrkowie Trybunalskim ul. 1-go Maja 25	130.40	4.90	135.30
Firma Handlowo-Usługowa DEREWENDA Henryk Derewenda, 97-300 Piotrków Trybunalski, ul. Topolowa 1	66.59	0.00	66.59
Zakład Usług Komunalnych HAK Stanisław Burczyński 97-300 Piotrków Tryb. Ul. Próchnika 25, instalacja 97-300 Piotrków Tryb. Ul. Wolska	1460.64	329.71	1790.35
Zakład Unieszkodliwiania Odpadów Komunalnych Płoszów ul. Jeżynowa 40, 97-500 Radomsko	3537.94	273.53	3811.47
Coster Elektro Odpady Powiercie Kolonia 75/7, Powiercie Kolonia 62-600 Koło	2.86	0.00	2.86
Zakład Gospodarki Odpadami AQUARIUM Sp. Z o.o. Pukinin 140 96-200 Rawa Mazowiecka	8160.24	1638.11	9798.35
MG Recykling S.C. Wąchocki, Wyderka ul. Kasprowicza 88/60, 01-949 zagospodarowanie: PRT-Radomsko ul. Geodetów 8, 97-500 Radomsko	4.69	0.25	4.94
EKO CENTRUM Radomsko ul. Reymonta 62 97-500 Radomsko	17.54	0.00	17.54

PPHU Dormag Henryk Fornalski ul. Stara Droga 68 Radomsko	483.08	0.00	483.08
Ekostan Sp. Z o.o. ul. Południowa 20 Rawa Maz.	123.09	0.00	123.09
Zakład Robót Sanitarnych SANATOR Sp. Z o.o. Rąbień ul. Pańska 68/70 95-070 Aleksandrów Łódzki	722.85	0.00	722.85
EKO HARPOON- Recykling Sp. Z o.o. ul. Cementowa 20 22-170 Rejowiec Fabryczny	42.81	4.67	47.48
Zakład Unieszkodliwiania Odpadów Różanna gm. Opoczno PGK Sp. Z o.o. Opoczno, Różanna	50.42	0.00	50.42
FB SERWIS Składowisko Odpadów Ruszczyn, Ruszczyn	40614.11	5656.17	46270.28
JANTAR Jarosław Fijałkowski ul.Krótka 2, 95-030 Rzgów	911.06	20.28	931.34
MK-RECYKLING Maciej Kosowski, Polna 11/35, 98-200 Sieradz	52.10	0.00	52.10
Vinderen Sp. Z o.o. Zakład Produkcyjny Sławno ul. Leśna 4 26-332 Sławno	3.20	0.00	3.20
Centrum Odzysku i Recyklingu w Starachowicach ul. Elaboracji 1, 22-215 Wąchock	0.00	110.37	110.37
TKM Recykling Polska Sp. Z o.o. Strzegom ul. Wojska Polskiego 75, 58-150 Strzegom	6.19	0.00	6.19
Świecie Recykling Sp. Z o.o. ul. Bydgoska 1 86-100 Świecie	0.00	18.07	18.07
REMONDIS Electrorecycling Sp. z o.o. ul. Zawodzie 16, 02-981 Warszawa	1.26	0.00	1.26
MG Recykling s.c. Grzegorz Wąchocki, Marcin Wydera 01-949 Warszawa	0.36	0.00	0.36
WPT Polska Sp. Z o.o. Sp. Komandytowa ul. Sienna 73 00-833 Warszawa	0.00	16.85	16.85
EKO-REGION Sp. Z o.o. Zakład w Woli Kruszyńskiej, Wola Kruszyńska 97-400 Bełchatów	0.00	264.64	264.64
TWK-ZAG SP. Z O.O. Wola Łaska 71 98-100 Łask	8.40	0.00	8.40
EUROPOL Holding Sp z o.o. Oddział Recyclingu ul. Łaska 227b, 98-220 Zduńska Wola	4.15	0.00	4.15
Sawo Recykling, ul. Struga 43, 95-100 Zgierz	1.60	134.28	135.88
Eneris Sp z o.o. Zakład w Zgierzu ul. Boruty 7a, 95-100 Zgierz	0.00	1.08	1.08
EMKA S.A ul. Jaktorowska 15A 96-300 Żyrardów	0.09	0.00	0.09

Source: Own study based on data from communal reports for 2016

In 2016, non-biodegradable municipal waste was utilized by 70 installations. About 99% of the non-biodegradable municipal waste mass was managed by installations operating in the Łódzkie Voivodeship. Majority of this type of waste (54.8%) was utilized by installations operating in the Łódź agglomeration area. The largest mass of non-biodegradable municipal waste was utilized by installations operating in Łódź, which in 2016 managed to utilize 53.1% of this type of waste collected within agglomeration. About 13.3% of the non-biodegradable municipal waste mass was utilized by installation in Ruszczyn (Radomsko County, Łódzkie Voivodeship), 11.2% by installation in Krzyżanówek (Kutno County, Łódzkie Voivodeship), 7.4% by installation in Bełchatów (Bełchatów County, Łódzkie Voivodeship), 3.3% by installation in Dylów (Pajęczno County, Łódzkie Voivodeship), 2.7% by installation in Pukinin (Rawa County, Łódzkie Voivodeship), and 1.3% by installation in Kutno (Kutno County, Łódzkie Voivodeship). The remaining 7.7% of the non-biodegradable municipal waste was utilized by other installations. Non-biodegradable waste is mainly treated by the R12 system, i.e. dismantling, sorting, crushing, compacting, granulation, drying, crushing, conditioning, repacking, separation, blending or mixing before submission to any of the processes listed in item. R1-R11. Other processes are sporadically used.

In 2016, biodegradable municipal waste was managed by 31 installations. About 99% of the biodegradable municipal waste mass was utilized by installations operating in the Łódzkie Voivodeship. About 38.3% of this type of waste is managed by installations operating in the Łódź agglomeration. The largest mass of biodegradable municipal waste was utilized by installations in Łódź (36.1% of the overall mass). About 18.3% of agglomeration's biodegradable municipal waste was managed by installations in Ruszczyn (Radomsko County, Łódzkie Voivodeship.), 12.3% by installations in Krzyżanówek (Kutno County, Łódzkie Voivodeship.), 12.3% by installations in Dylów (Pajęczno County, Łódzkie Voivodeship.), 5.3% by installations in Pukinin (Rawa County, Łódzkie Voivodeship), 5.3% by installation in Julków (Skierniewice County, Łódzkie Voivodeship), and 3.8% by installations in Kutno (Kutno County, Łódzkie Voivodeship). The remaining 6.6% of biodegradable municipal waste was utilized by other installations. Biodegradable waste is mainly treated by the R3 system, i.e. recycling of waste paper and board; reprocessing and recycling of plastic waste; composting of bio waste and green waste; fermentation of biodegradable waste for biogas production (biogas plants).

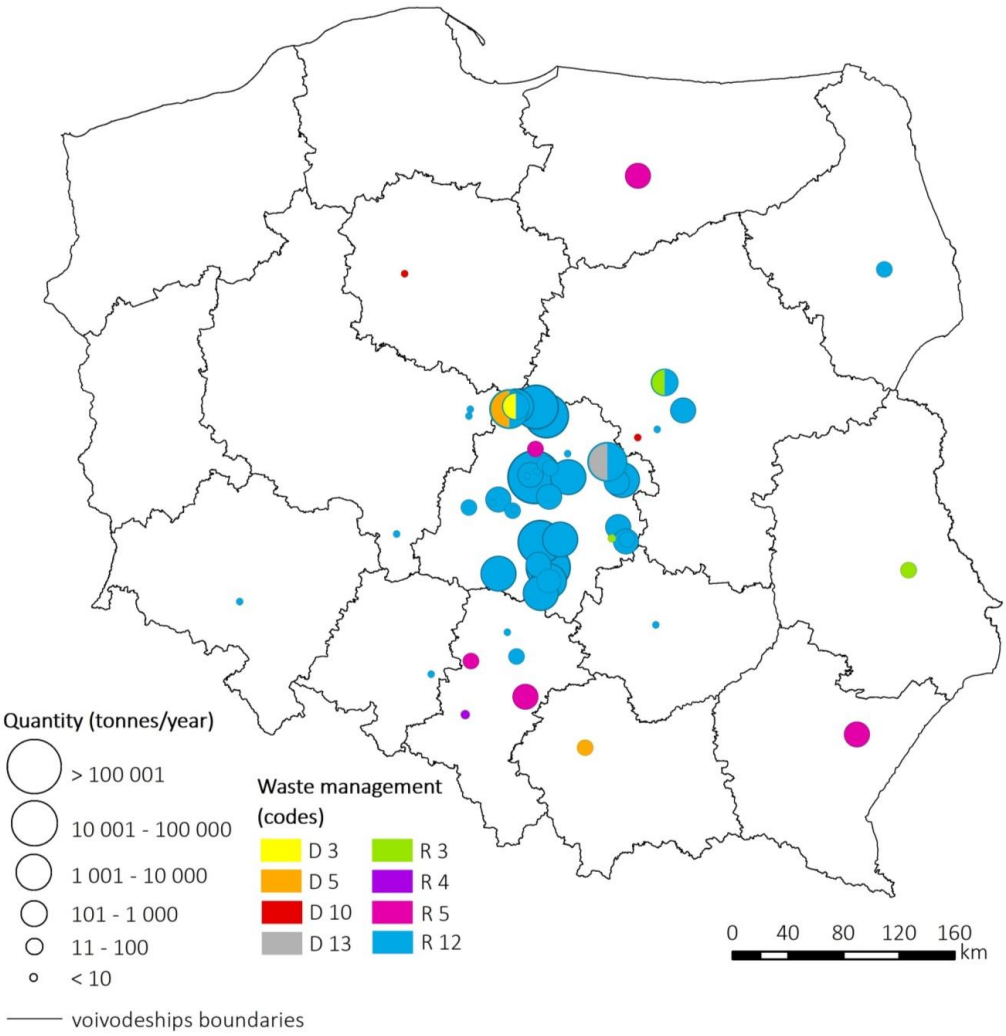


Fig. 39. Mass of non-biodegradable municipal waste collected from the Łódź Metropolitan Area treated by individual installations by forms.

D3 - Deep injection, D5 - Engineered landfill, D10 - Incineration on land, D13 - Blending or mixing prior to submission to any of the operations numbered D1 to D12, R3 - Organic substance recycling/reclamation, R4 - Metal recycling/reclamation, R5 - Inorganic substance recycling/reclamation, R12 - Exchange of waste for submission to any of the operations numbered R1 to R11

Source: Own study based on data from communal reports for 2016

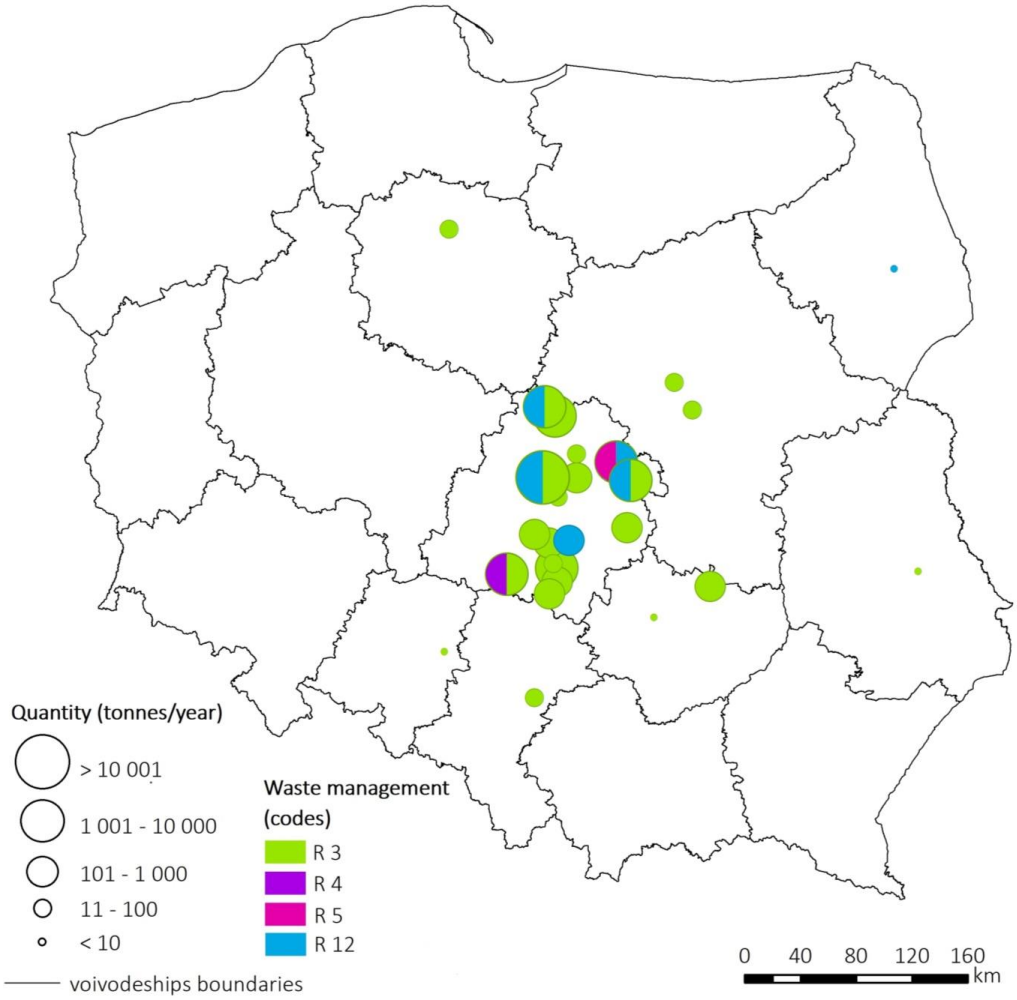


Fig. 40. Mass of biodegradable municipal waste collected from the Łódź Metropolitan Area treated by individual installations by forms.

R3 - Organic substance recycling/reclamation, R4 - Metal recycling/reclamation, R5 - Inorganic substance recycling/reclamation, R12 - Exchange of waste for submission to any of the operations numbered R1 to R11

Source: Own study based on data from communal reports for 2016

Vegetable, Fruit and Garden (VFG) waste flow

In the Vegetable, Fruit and Garden (VFG) waste flow analysis the following three categories of waste have been considered: 200108 (biodegradable kitchen and canteen waste; separately collected fractions as part of municipal solid waste), 200201 (biodegradable waste from garden and park wastes, including cemetery) and 200302 (bio-waste from markets). As over 70% of waste collected in 2016 in the Łódź Metropolitan Area was classified under mixed waste category, it was decided to estimate this value based on nationwide data and information obtained from communal reports on implementation of tasks related to municipal waste management concerning mass of biodegradable waste collected from municipal waste stream within commune's area in the accounting year, transported for storing. As a result of these calculations, the total

VFG waste mass is estimated to be 76.57 thous. tons, which comprises 22% of all municipal waste. It is worth to point out that in the above-mentioned study conducted for Poland, the share of this type of waste varies from 20% to 37% depending on the type of city and the examined period, therefore the estimated value for the Łódź Metropolitan Area seems to be correct. The map below illustrates the VFG waste flows between agglomeration's communes and treatment points - a very distinct geographical regionalization is visible, in terms of spatial proximity. The following maps present VFG flows in detail for each of the 28 communes in the ŁOM.

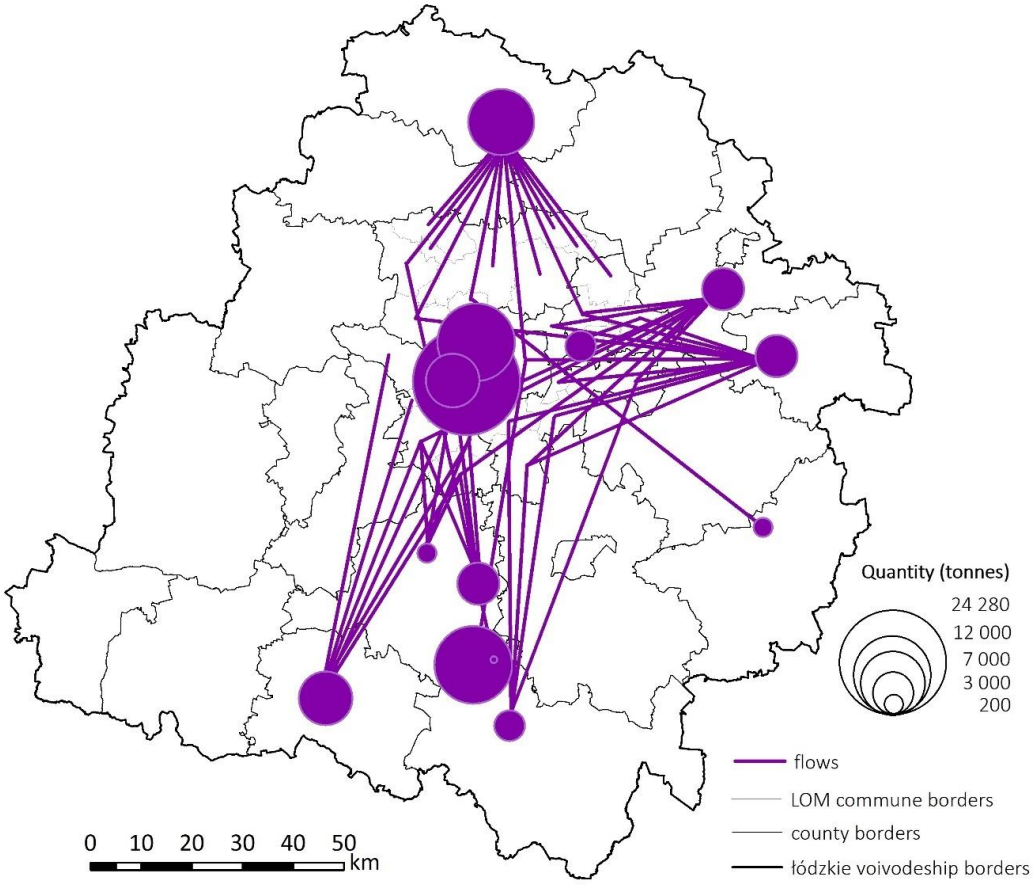
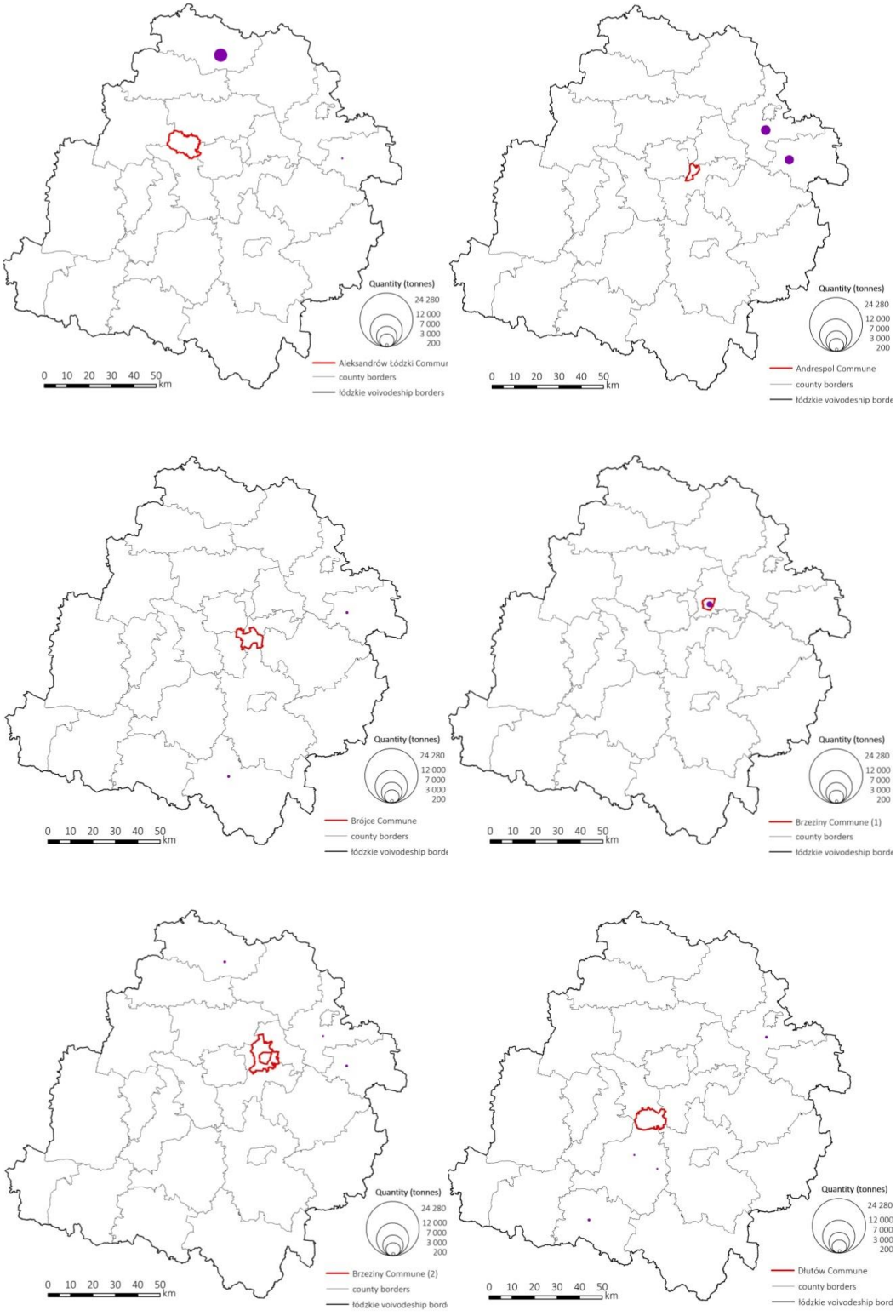
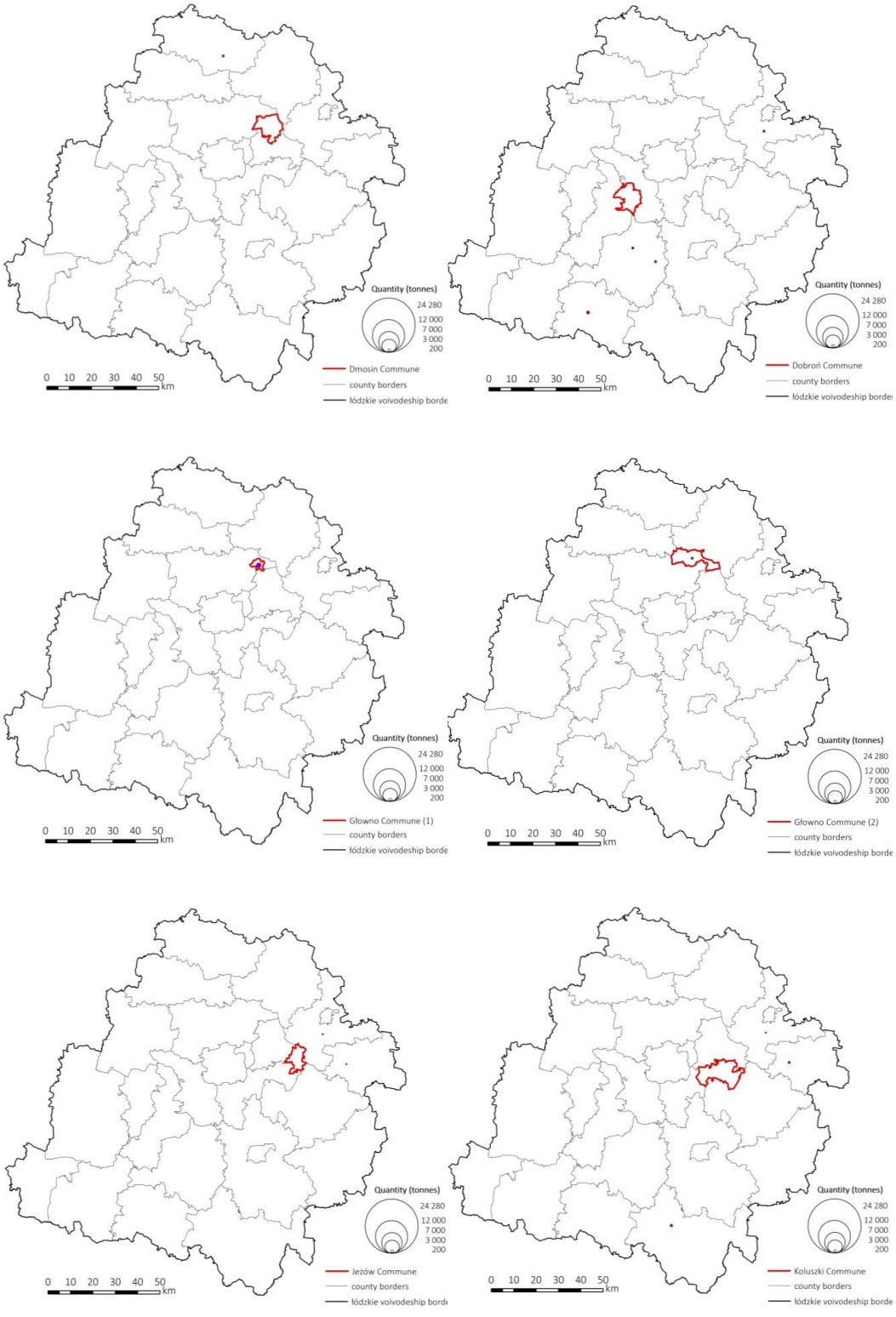
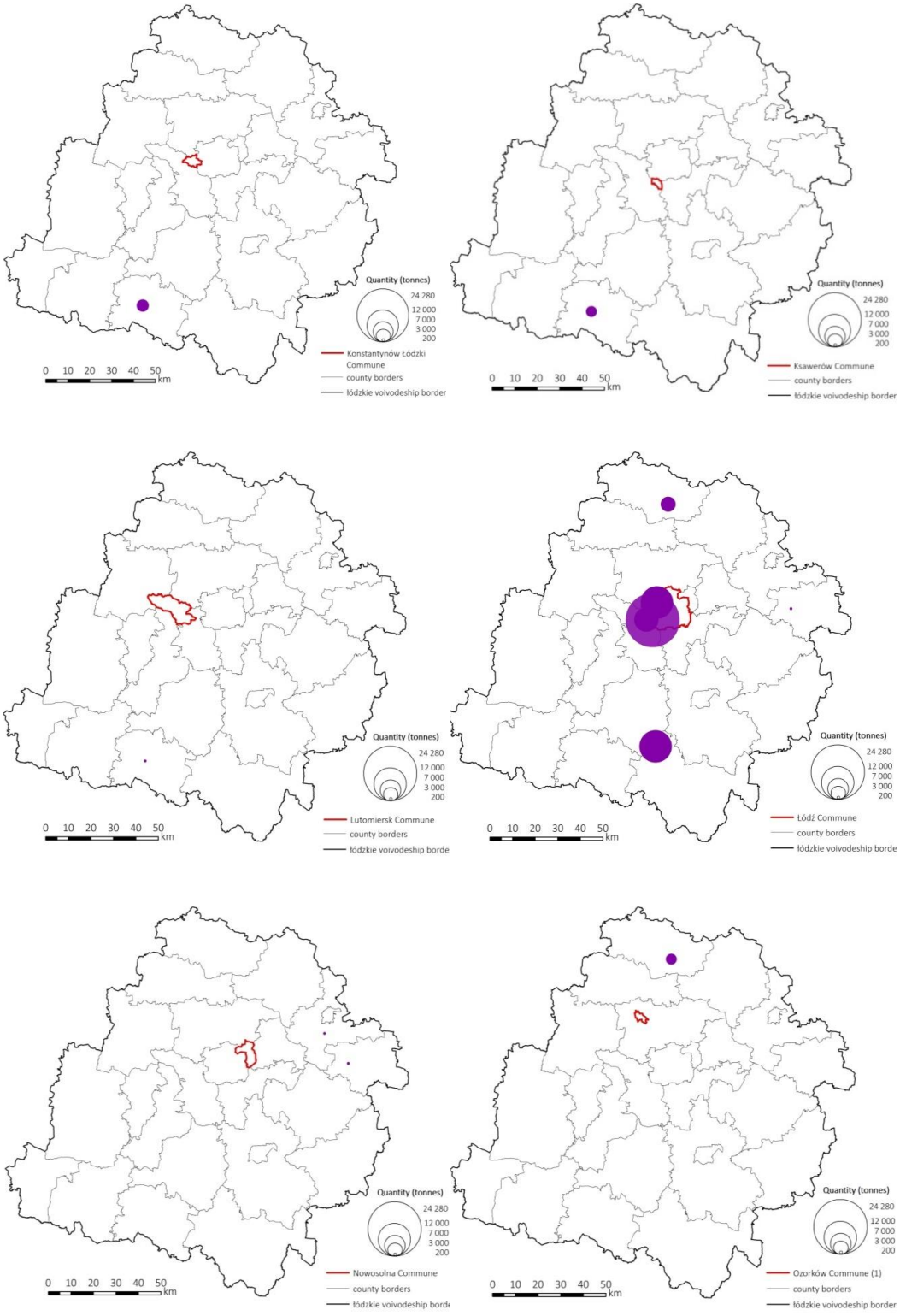


Fig. 41. VFG flows from communes of Łódź Metropolitan Area in 2016.

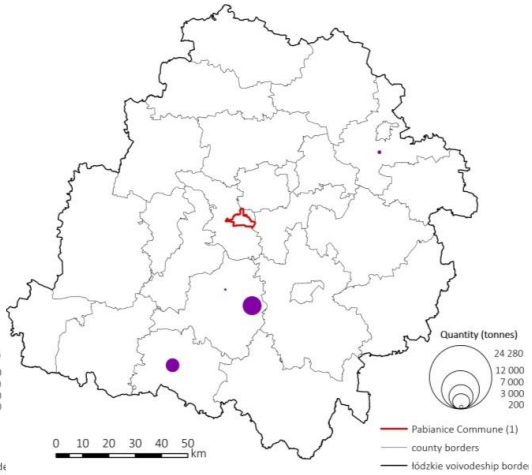
Source: Own study based on data from communal reports for 2016

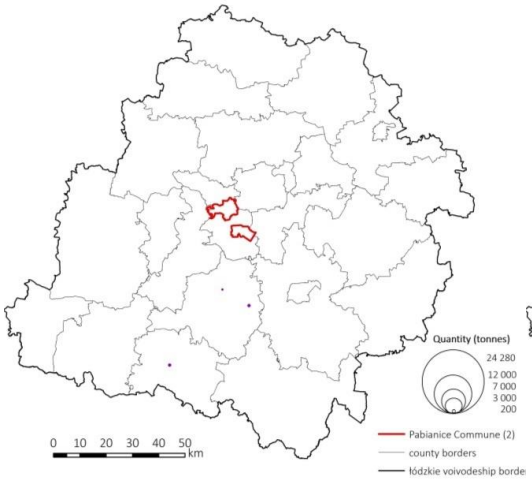

Quantity (tonnes)
24 280
12 000
7 000
3 000
200
0 10 20 30 40 50 km
Aleksandrów Łódzki Commun
county borders
łódzkie voivodeship borders
Andrespol Commune
county borders
łódzkie voivodeship borde
Brójce Commune
county borders
łódzkie voivodeship borde
Brzeziny Commune (1)
county borders
łódzkie voivodeship borde
Brzeziny Commune (2)
county borders
łódzkie voivodeship borde
Dłutów Commune
county borders
łódzkie voivodeship borde

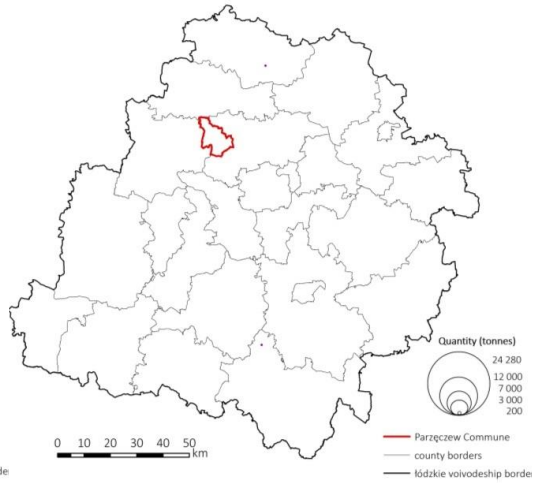

Quantity (tonnes)
24 280
12 000
7 000
3 000
200
0 10 20 30 40 50 km
Dmosin Commune
county borders
łódzkie voivodeship borde
Dobroń Commune
county borders
łódzkie voivodeship borde
Głowno Commune (1)
county borders
łódzkie voivodeship borde
Głowno Commune (2)
county borders
łódzkie voivodeship borde
Jeżów Commune
county borders
łódzkie voivodeship borde
Koluszki Commune
county borders
łódzkie voivodeship borde

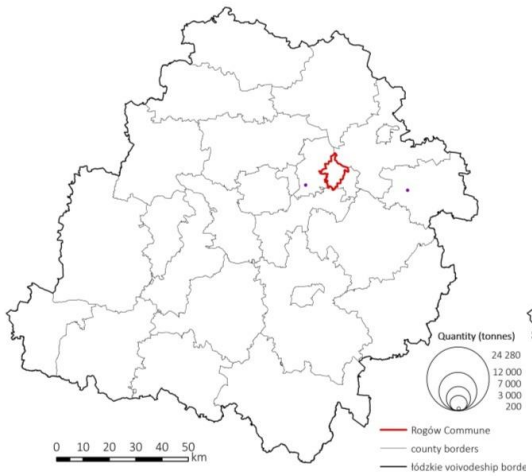

Quantity (tonnes)
24 280
12 000
7 000
3 000
200
0 10 20 30 40 50 km
Konstantynów Łódzki Commune
county borders
łódzkie voivodeship border
Ksawerów Commune
county borders
łódzkie voivodeship border
Lutomiersk Commune
county borders
łódzkie voivodeship borde
Łódź Commune
county borders
łódzkie voivodeship borde
Nowosolna Commune
county borders
łódzkie voivodeship borde
Ozorków Commune (1)
county borders
łódzkie voivodeship border


Quantity (tonnes)
24 280
12 000
7 000
3 000
200
0 10 20 30 40 50 km
Ozorków Commune (2)
county borders
łódzkie voivodeship borde


Quantity (tonnes)
24 280
12 000
7 000
3 000
200
0 10 20 30 40 50 km
Pabianice Commune (1)
county borders
łódzkie voivodeship borde


Quantity (tonnes)
24 280
12 000
7 000
3 000
200
0 10 20 30 40 50 km
Pabianice Commune (2)
county borders
łódzkie voivodeship borde


Quantity (tonnes)
24 280
12 000
7 000
3 000
200
0 10 20 30 40 50 km
Parzęczew Commune
county borders
łódzkie voivodeship borde


Quantity (tonnes)
24 280
12 000
7 000
3 000
200
0 10 20 30 40 50 km
Rogów Commune
county borders
łódzkie voivodeship borde


Quantity (tonnes)
24 280
12 000
7 000
3 000
200
0 10 20 30 40 50 km
Rzgów Commune
county borders
łódzkie voivodeship borde

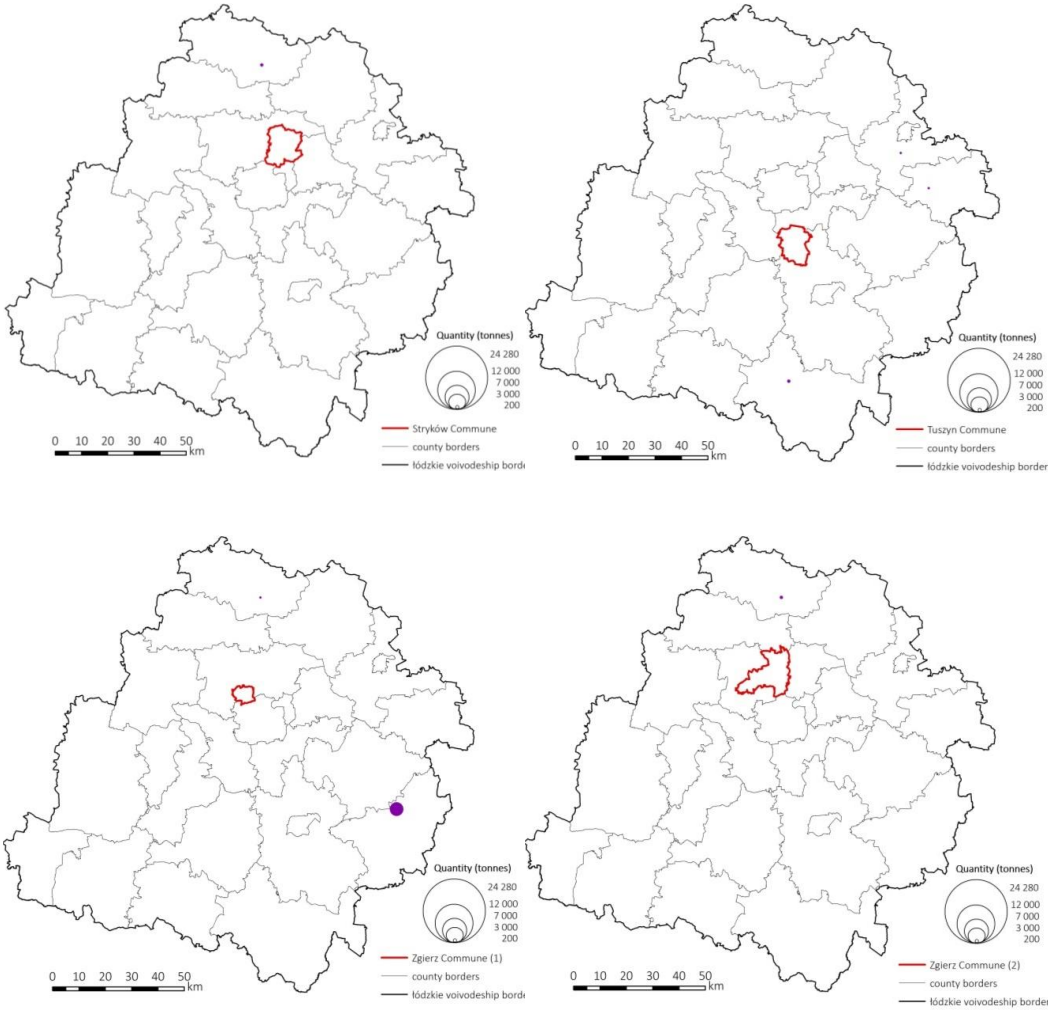


Fig. 42. VFG flows from each of the Łódź Metropolitan Area communes in 2016.

Source: Own study based on data from communal reports for 2016

3.7 Factors disturbing the waste flow

One ought to bear in mind that the waste management system is also characterized by a number of irregularities. From January to the beginning of July 2018, nearly 80 fires broke out in Poland in various waste disposal sites. The police examined 54 of them. 46 fires took place in legal, whereas 12 in illegal landfills. Estimates indicate that out of 76 fires that occurred in 2018, 30 took place in warehouses, 21 in landfills, 11 waste storing sites, 10 broke out in Regional Installations for Municipal Waste Treatment, and 4 in Points for Selective Municipal Waste Collection. On Saturdays and Sundays 30 fires broke out. As it turns out, in 23 cases fire was set deliberately, while in 15 there was a spontaneous combustion and 6 inadvertently made fire. The causes of the remaining fires have not been determined yet. The police diagnosis has registered 1809 waste storing sites of different types in Poland: dumps, landfills, sorting plants and warehouses. 492 of them, according to the police, are particularly at risk of fire.

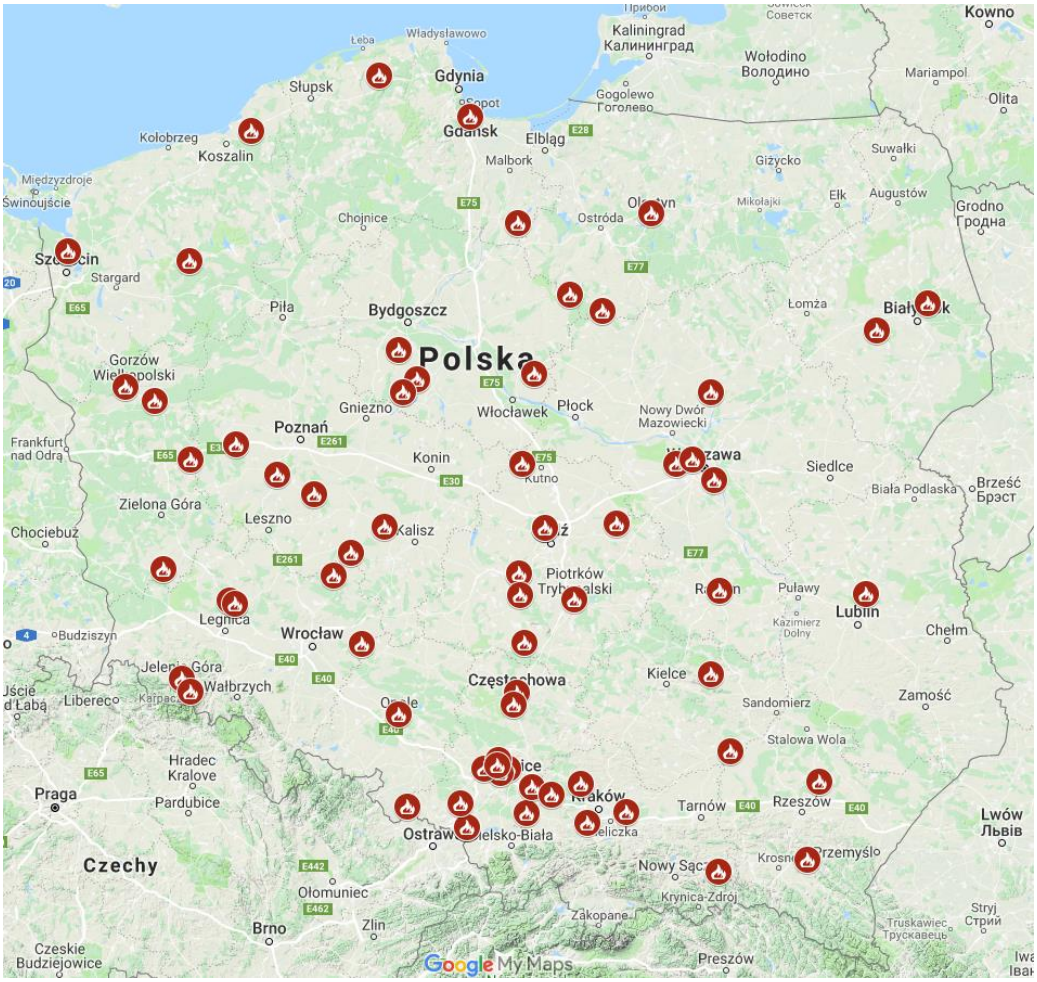


Fig. 43. Registered fires in objects related to waste management in 2018.

Source: www.portalkomunalny.pl; Status: as of 20.06.2018

As confirmed by the National Chamber of Waste Management, there is a so-called “junk mafia” and admits that this is a serious problem because it undermines financial and educational effort undertaken in recent years in Poland in the field of waste management. The aim of such activities is to protect the natural environment by means of proper waste management and increase recycling level. Irregularities on the market and legal loopholes cause that reliable enterprises must compete with prices determined by criminals who, for example, transport waste to landfills and later often set it on fire. The current situation concerning the issue of fires is an aftermath of a long-term lack of a comprehensive and effective approach towards the waste management system regarded as a branch of industry, related to other industries affecting the environment and the national economy. "*We have accounted such absurdities that in some communes the fee for waste collection is 6 PLN per person. Why the competent authorities are not interested in such cases when it is obvious that at this price part of the waste is transported to a gravel pit or burnt? I do not understand the clumsiness of responsible institutions*" (Leszek Świętalski, Secretary General of the Union of Rural Communes of the Republic of Poland).

Photo 4. Fire and the remains of a fire in an illegal landfill in Zgierz near Łódź.

Source: www.portalkomunalny.pl and K. Czapiewski.

The table below contains titles of articles/information from the *Municipal Portal* web-page (www.portalkomunalny.pl) depicting the scale of various irregularities throughout Poland only in the month of October 2018. Obviously, there is a considerably larger number of properly conducted actions in the field of waste management by many companies in comparison to these indicated cases of illegal acts, however, they affect the social perception of waste management in Poland and clearly expose imperfections in the current system.

Tab. 14. Titles of articles from the Municipal Portal web-page in the month of October 2018.

Date	Title (original in Polish)	Title (translation in English)	Link
01.10.2018	*Pożar w zakładzie recyklingu w woj. lubuskim*	Fire at recycling plant in the Lubuskie Voivodeship	https://portalkomunalny.pl/pozar-w-zakladzie-recyklingu-w-woj-lubuskim-381660/
01.10.2018	*Kolejny pożar odpadów w Pyszącej k. Śremu*	Another waste fire in Pyszona near Śrem town	https://portalkomunalny.pl/kolejny-pozar-odpadow-w-pyszacej-k-sremu-381667/
03.10.2018	*Zarzuty za nielegalny import i składowanie odpadów w woj. lubelskim*	Accusation for illegal import and storing of waste in the Lubelskie Vivodeship	https://portalkomunalny.pl/zarzuty-za-import-i-skladowanie-odpadow-w-woj-lubelskim-381820/
05.10.2018	*Policjanci z Piotrkowa zatrzymali mężczyzn nielegalnie wysypujących odpady*	Policemen from Piotrków town detain men illegally dumping waste	https://portalkomunalny.pl/policjanci-z-piotrkowa-zatrzymali-mezczyzn-nielegalnie-wysypujacych-odpady-381979/
09.10.2018	*Zatrzymano nielegalny transport odpadów w woj. kujawsko-pomorskim*	Illegal transport of waste was stopped in the Kujawsko-Pomorskie Voivodeship	https://portalkomunalny.pl/zatrzymano-nielegalny-transport-odpadow-w-woj-kujawsko-pomorskim-382153/
10.10.2018	*Dwa pożary odpadów w woj. łódzkim. To prawdopodobnie podpalenia*	Two waste fires in the Łódzkie Voivodeship. It's probably arson	https://portalkomunalny.pl/dwa-pozary-odpadow-w-woj-lodzkim-to-prawdopodobnie-podpalenia-382229/
10.10.2018	*Bytom wypowiada wojnę mafii śmieciowej*	Bytom town declares war	https://portalkomunalny.pl/bytom-wypowiada-wojne-mafii-smieciowej-382252/

		on 'junk mafia'	
16.10.2018	*Mazowieckie: zatrzymano nielegalny transport 25 ton odpadów*	Mazowieckie Voivodeship: illegal transport of 25 tons of waste was stopped	https://portalkomunalny.pl/mazowieckie-zatrzymano-nielegalny-transport-25-ton-odpadow-382544/
17.10.2018	*Lubuskie: Śledztwo ws. nieodpowiedniego postępowania z odpadami*	Lubuskie Voivodeship: Investigation on inappropriate waste handling	https://portalkomunalny.pl/lubuskie-sledztwo-ws-nieodpowiedniego-postepowania-z-odpadami-382593/
17.10.2018	*Pożar odpadów w Zgierzu. Kto uprzątnie teren?*	Waste fire in Zgierz town. Who will clean up the area?	https://portalkomunalny.pl/pozar-odpadow-w-zgierzu-kto-uprzatnie-teren-382614/
18.20.2018	*CBŚ rozbiło „gang odpadowy". Przywozili odpady z Niemiec do Polski*	Central Bureau of Investigation broke the "waste gang". They brought waste from Germany to Poland	https://portalkomunalny.pl/cbs-rozbilo-gang-odpadowy-przywozili-odpady-z-niemiec-do-polski-382694/
19.10.2018	*W Gliwicach zatrzymano transport toksycznych odpadów*	Transport of toxic waste was stopped in Gliwice town	https://portalkomunalny.pl/w-gliwicach-zatrzymano-transport-toksycznych-odpadow-382733/
22.10.2018	*Pożar odpadów w Pyszącej k. Śremu. To już trzeci w tym roku*	Waste fire in Pysząca near Śrem town. This is already the third time this year	https://portalkomunalny.pl/pozar-odpadow-w-pyszacej-k-sremu-to-juz-trzeci-w-tym-roku-382859/
27.10.2018	*Pysząca: czwarty pożar odpadów w tym roku!*	Pysząca: the forth fire of waste in this year	https://portalkomunalny.pl/pyszaca-czwarty-pozar-odpadow-w-tym-roku-383073/

Source: own elaboration based on www.portalkomunalny.pl.

Photo 5. Illegally disposed waste on large and small scale.

Source: www.portalkomunalny.pl and K. Czapiewski.

An important element is also the fact that waste exports to Poland many times exceed the value of imports. Applied quantity of exported waste was 951 thous. tonnes, while the applied quantity of imported waste from Poland was 154 thous. tonnes. Added to this is the illegal export of waste to Poland, successively recognized by customs services, as indicated by the press information cited above.

Tab. 15. Data on import and export of waste form and to Poland, 2016.

IMPORTS OF WASTE FROM THE EUROPEAN UNION MEMBER STATES TO POLAND IN 2016

KRAJ WYSYŁKI / *COUNTRY OF DISPATCH*	Liczba zakończonych postępowań / *Number of completed proceedings*			Wnioskowana ilość odpadów importowanych w tonach / *Applied quantity of imported waste in tonnes*	
	ogółem / *total*	w tym *of which*: wydane zezwolenia / *issued permissions*	w tym *of which*: wydane sprzeciwy / *issued objections*	ogółem / *total*	w tym na mocy wydanego zezwolenia / *of which based on issued permission*
OGÓŁEM / *GRAND TOTAL*	**198**	**150**	**48**	**951021**	**654535**
W TYM WNIOSKI ZGŁASZAJĄCE IMPORT JEDNEJ GRUPY ODPADÓW / *OF WHICH APPLICATIONS FOR A SINGLE GROUP OF WASTE*					
RAZEM / *TOTAL*	**187**	**144**	**43**	**938527**	**648535**
Austria / *Austria*	7	7	—	46900	46900
Belgia / *Belgium*	4	3	1	1175	925
Chorwacja / *Croatia*	5	4	1	1060	560
Czechy / *Czech Republic*	4	3	1	4450	1500
Cypr / *Cyprus*	1	—	1	3000	—
Dania / *Denmark*	2	1	1	8300	1300
Finlandia / *Finland*	1	—	1	1000	—
Francja / *France*	6	5	1	6750	6650
Grecja / *Greece*	12	12	—	2800	2800
Holandia / *Netherlands*	7	3	4	9250	6400
Irlandia / *Ireland*	3	3	—	600	600
Litwa / *Lithuania*	24	21	3	39352	34160
Niemcy / *Germany*	41	36	5	356000	298500
Słowacja / *Slovakia*	6	2	4	25150	19500
Słowenia / *Slovenia*	3	3	—	12000	12000
Szwecja / *Sweden*	7	7	—	73600	73600
Węgry / *Hungary*	4	4	—	6100	6100
Wielka Brytania / *United Kingdom*	12	4	8	247440	75940
Włochy / *Italy*	38	26	12	93600	61100

EXPORTS OF WASTE FROM POLAND IN 2016

KRAJ ODBIORU / *RECEIVING COUNTRY*	Liczba zakończonych postępowań / *Number of completed proceedings*			Wnioskowana ilość odpadów eksportowanych w tonach / *Applied quantity of waste exported in tonnes*	
	ogółem / *total*	w tym *of which*: wydane zezwolenia / *issued permissions*	w tym *of which*: wydane sprzeciwy / *issued objections*	ogółem / *total*	w tym na mocy wydanego zezwolenia / *of which based on issued permission*
OGÓŁEM / *GRAND TOTAL*	**55**	**50**	**5**	**153927**	**133477**
W TYM WNIOSKI ZGŁASZAJĄCE EKSPORT JEDNEJ GRUPY ODPADÓW / *OF WHICH APPLICATIONS FOR A SINGLE GROUP OF WASTE*					
RAZEM / *TOTAL*	**52**	**47**	**5**	**142887**	**122437**
Austria / *Austria*	2	2	—	10390	10390
Belgia / *Belgium*	5	5	—	2786	2786
Czechy / *Czech Republic*	3	2	1	12692	692
Holandia / *Netherlands*	14	13	1	510	240
Niemcy / *Germany*	19	18	1	106627	98627
Słowenia / *Slovenia*	2	2	—	4000	4000
USA / *USA*	2	2	—	242	242
Wielka Brytania / *United Kingdom*	1	1	—	5000	5000
Włochy / *Italy*	4	2	2	640	460

Source: Ochrona Środowiska (2017).

4. Summary and recommendations

The amount of generated municipal waste should be determined by the change in the EU and national policy implemented by the means of increasing the pressure on preventing and limiting waste generation, developing and promoting "circular economy", as well as raising environmental awareness among the society.

One should strive to reduce the amount of generated waste, increase public awareness concerning their efficient management, including food waste and other biodegradable waste. It is crucial to channel the functioning of waste management system towards the hierarchy of waste handling methods, and above all to diminish the share of mixed municipal waste in the entire waste collection stream. In addition, it is advisable to discontinue storing of selectively biodegradable waste, cease storing of mixed municipal waste without treatment, reduce the number of illegal municipal waste storing sites and establish a monitoring system for municipal waste management. Particularly concerning the latter issue, it should be pointed out that currently there are insufficient activities conducted by communal self-governments associated with monitoring enterprises in the field of collection and management of waste from the commune's area. Today’s legal conditions preclude proper cooperation between the private and public sector in the field of waste management system.

Furthermore, the future of waste management also ought to be considered. It will be necessary to verify the existing and planned capacity of installations conducting processes of mechanical waste treatment. The hierarchy for waste management methods and objectives to be achieved in the perspective of the year 2030 impose the need to significantly reduce the amount of deposited waste and to constrain storage only to previously treated waste.

References

Atlas obszarów wiejskich w Polsce, 2016, IGiPZ PAN, Warszawa.

Banerjee S.B., 2002, *Corporate environmentalism. The construct and its measurement*. Journal of Business Research, 55, pp. 177-191.

Bank Danych Lokalnych, 1995-2018, Główny Urząd Statystyczny, Warszawa.

Bański J., 2017, *Rozwój obszarów wiejskich*, PWE, Warszawa.

Bratanova B., Loghnan S., Gatersleben B., 2012, *The moral circle as a common motivational cause of cross-situational pro-environmentalism*. European Journal of Social Psychology, 42, 539-545.

Encyklopedia powszechna, 1999, PWN, Warszawa.

Geldermans B., Bellstedt C., Formato E., Varju V., Grunhut Z., Cerreta M., Amenta L., Inglese P., van der Leer J., Wandl A., 2017, *D3.1 Introduction to methodology for integrated spatial, material flow and social analyses*, TUDelft.

Geldermans B., Wandl A., Steenmeijer M., Furlan C., Streefland T., Formato E., Cerreta M., Amenta L., Inglese P., Iodice S., Berruti G., Varju V., Grunhut Z., Bodor A., Lovász V., Moticska Z., Tonini D., Taelman S.E., 2018, *D3.3 Process model for the two pilot cases: Amsterdam, the Netherlands & Naples, Italy*, TUDelft & UNINA.

Hillarya R., Thorsenb N., 1999, *Regulatory and self-regulatory measures as routes to promote cleaner production*. Journal of Cleaner Production, 7 (1), pp. 1-11.

Jędrczak A., 2010, *Analiza dotycząca ilości wytwarzanych oraz zagospodarowanych odpadów ulegających biodegradacji*, Zielona Góra.

Jędrczak A., den Boer E., 2015, *Final report on the third stage of expertise aimed at conducting waste management evaluation in 20 installations for mechanical and biological waste treatment*, Zielona Góra.

Kondracki J., 2011, *Geografia regionalna Polski*, Warszawa, PWN.

Kudłak R., 2017, *Drivers of corporate environmentalism: The case of the Polish economy in transition*. Journal of Cleaner Production, 142, pp. 3194-3203.

Lipińska D., 2016, *Gospodarka odpadowa i wodno-ściekowa*, Wydawnictwo Uniwersytetu Łódzkiego, Łódź.

Lyon T.P., Maxwell J.W., 2004, *Corporate environmentalism and Public Policy.* Cambridge: Cambridge University Press.

Neugebauer F., 2012, *EMAS and ISO 14001 in the German industry – complements or substitutes?* Journal of Cleaner Production, 37, pp. 249-256.

Ochrona Środowiska, 2017, Główny Urząd Statystyczny, Warszawa.

Parysek J.J., 2008, *Aglomeracje miejskie w Polsce oraz problemy ich funkcjonowania i rozwoju*, [w:] Wybrane problemy rozwoju i rewitalizacji miast: aspekty poznawcze i praktyczne, Bogucki Wyd. Naukowe, IGSEiGP UAM, Seria Rozwój Regionalny i Polityka Regionalna, nr 5, Poznań.

Plan gospodarki odpadami dla województwa łódzkiego na lata 2016-2022 z uwzględnieniem lat 2023-2028, 2016, Łódź.

Rozporządzenie Ministra Środowiska z dnia 9 grudnia 2014 roku w sprawie katalogu odpadów.

Sprawozdania z 28 gmin (Aleksandrów Łódzki, Andrespol, Brójce, Brzeziny (1), Brzeziny (2), Dłutów, Dmosin, Dobroń, Głowno (1), Głowno (2), Jeżów, Koluszki, Konstantynów Łódzki, Ksawerów, Lutomiersk, Łódź, Nowosolna, Ozorków (1), Ozorków (2), Pabianice (1), Pabianice (2), Parzęczew, Rogów, Rzgów, Stryków, Tuszyn, Zgierz (1), Zgierz (2)) *z realizacji zadań z zakresu gospodarowania odpadami komunalnymi za rok 2016*, 2016, Urzędy Gmin.

Statistical Atlas of Poland, 2018, GUS, Warszawa.

Strategia Rozwoju Łódzkiego Obszaru Metropolitalnego 2020+, Łódź, 2016

Styś T., Foks R., 2014, *Rynek gospodarowania odpadami komunalnymi w Polsce. Perspektywa 2030*, Instytut Sobieskiego, Warszawa.

Ustawa z dnia 13 września 1996 roku o utrzymaniu czystości i porządku w gminach.

Ustawa z dnia 14 grudnia 2012 roku o odpadach.