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Analysis of industrial waste management in Poland

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ABSTRACT

The following study addresses the subject of waste management. It pertains to the specificity of waste impact on the environment, including their proper definition and classification. The study focused particularly on industrial waste, their division and the management system. Data on industrial waste in Poland in recent years were analyzed, with particular reference to 2017.

Keywords: waste management system, waste classification, industrial waste, analysis of industrial waste

1. INTRODUCTION

With the development of civilization and technological progress, the diversity of waste increases, and the biological, chemical and physical properties of waste differ even more from natural raw materials. The number of waste generated increases in proportion to the increase in the number of population and the scale of consumption. Waste is a key problem both for the natural environment as well as human life and health due to the ever-increasing mass of their production. Environmental hazards arise where larger amounts of solid or liquid waste are accumulated. These wastes introduce dangerous substances into the environment, which are increasingly difficult to decompose. In soils there are increasing concentrations of heavy metals and pesticides, and in ground and surface waters, the content of organic substances. To avoid

or reduce the negative impact of waste on the environment, you need to manage them rationally. [1]

The problem of waste and its associated hazards are an increasingly noticeable challenge in the field of environmental protection. Technological progress and applicable legal regulations - these are just some of the factors that can reduce the amount of waste generated and contribute to the re-use of secondary raw materials. [2]

Waste can have various origins: besides agricultural and municipal waste, there are also industrial wastes. The latter result from the implementation of technological production processes and together with household waste from the areas of industrial plants. Industrial waste is the solid and liquid substances produced in production processes, as well as useless objects from technological operations. They arise as a result of economic activity and therefore their production cannot be completely avoided. These include, for example, waste from the power industry, metallurgy, mining, but also those created in car workshops or construction companies. [3]

2. WASTE CHARACTERISTICS AND CLASSIFICATION

Waste is an inseparable element of human life and economic activity. With the development of technology, their quantity, variety and composition increase. Waste poses a threat to the environment and to all living beings, which is why their proper management is very important. [4]

A waste is defined as a useless substance, substance or object resulting from the process or use. In the latest law on waste, wastes are defined as any substances that the holder discards or intends to get rid of. [5]

Waste generated in all economic sectors is subject to some deliberate divisions. The classification of waste generated depends on many factors. The waste is generally divided into: municipal waste, hazardous waste, industrial waste. [6]

In addition to municipal or industrial, various types of waste such as waste can be distinguished: [7]

- dangerous - these are waste substances and objects that contain hazardous substances, threaten the environment, and life or health of people. An example of hazardous waste is used synthetic engine oil;
- indifferent - these are wastes that do not change physical, chemical or biological, which have no harmful effects on the environment, health or life of people. These are, for example, concrete waste, brick rubble, excavation soil, ceramic waste, etc.;
- multi-material - waste consisting of many different materials (at least two), which can not be separated in a simple way by mechanical method. Multi-material waste is cartons, e.g. juices or milk;
- bulky waste - they are waste, the large size of which makes it impossible to put them in a container. You can include: wardrobes, beds, mattresses, bicycles, rugs, etc.;
- used electrical and electronic equipment - this group of waste includes, for example, used printers, computers, televisions, as well as their components, etc.;
- green waste - these are waste resulting from the care of green areas, cemeteries along with waste from marketplaces, eg it is mowed grass, branches, other parts of plants. Green waste is suitable for composting;

- biodegradable (or bio-waste) - this is a broader concept than green waste - it is green waste, kitchen waste, food waste and sewage sludge that can be composted, for example, meal residues;
- mining waste - produced as a result of mining and processing of minerals and ores, mining waste (rocks originating from mining operations), processing waste (process separated from rock material), secondary wastes (created in the processes of manufacturing commercial products) can be distinguished.

Waste classification may be different and depends on the criterion adopted, namely: the source of their formation, composition and physico-chemical and biological properties, mass production and their usefulness, environmental damage.

The most commonly used divisions of generated waste are: [8]

- classification due to the degree of environmental burden;
 - inert waste,
 - hazardous waste,
- classification due to physical and chemical properties;
 - solid waste,
 - liquid waste,
 - gas wastes,
- classification based on the place of manufacture;
 - industrial waste,
 - municipal waste,
- classification due to the manner of development;
 - waste destined for recovery,
 - waste destined for disposal,
 - waste destined for storage.

3. INDUSTRIAL WASTE

Among waste, special attention should be paid to industrial waste. Industrial waste is a by-product of human activities, arising on the industrial site and undesirable at the place of their creation. These include, among others: oils, packaging, ash slag, mineral waste, metallic waste. [9]

Industrial waste is generated, inter alia, by:

- factories,
- hospitals,
- energy companies,
- steel mills,
- warehouses,
- car workshops,
- construction plants.

Industrial waste, unfortunately, is not indifferent to the environment and pose a threat to all components of the environment, the surface of the earth, the hydrosphere, biosphere and atmosphere. Danger occurs during their manufacture, collection, transport, utilization and storage, therefore in highly developed countries special emphasis is placed on rational waste management as one of the aspects of environmental protection.

The amount and type of industrial waste generated depends on: [10]

- type of raw materials and production technology used,
- technical progress,
- consumption of material goods,
- ecological culture and ethics.

It should be remembered that every undeveloped and unused product, whether it is a raw material, or a final product, acquires the properties of waste. Industrial waste can be: [11]

- Metallic waste
- Mineral wastes
- Packaging
- Lubricants
- Oils
- Ashes
- Metallurgical slag
- Hazardous waste, such as: sulfuric acid, lead concentrates from the converter furnace or waste from lead metallurgy.

4. MANAGEMENT SYSTEMS FOR INDUSTRIAL WASTE

Industrial waste is produced at every step, also by small service companies, warehouses or hospitals, that is why their owners should remember about regular removal of pollution in order to avoid penalties, but above all to protect our environment.

Waste management involves the collection, transport, recovery or disposal of waste. Any waste produced should be directed for reuse. The waste can be used for industrial or non-industrial purposes. The non-industrial use of waste can be used in agriculture for soil fertilization or soil remediation. In the industry, waste can be used as secondary raw material or semi-finished product or material. An important reference for ordering and wise management of waste is the Waste Act. According to it, waste should be managed so as to prevent and limit the amount of waste generated, reduce the negative impact of waste on the environment, ensure the recovery and disposal of waste in line with environmental protection principles. [12]

The management of waste, and in particular industrial ones, belongs to very important and difficult problems that many enterprises face. However, progress in various branches of industry allows for the proper selection of waste, which may lead to their more effective use. Post-production remains a difficult issue for many plants and enterprises due to the growing costs of their development, which means that minimizing their quantity is an economic necessity for many companies. Innovative nature has integrated waste management systems covering, inter alia, - processing, recycling, cleaning processes, utilization and thermal transformation of waste. Such a waste management system is possible thanks to a

comprehensive combination of technological capabilities and machining processes that complement each other. It is very difficult to limit the production of industrial waste because it occurs in almost every industrial plant. It is the duty of each of them to dispose of them, and thus reduce the risks to human health and life and the environment that harmful waste creates. Industrial waste does affect the environment. They are a great threat to all seven elements of the natural environment: geological structure, terrain, climate, water, soil, plants, animals. [13] Danger occurs during the production of industrial waste, collection, transport and disposal.

Therefore, companies offering industrial waste management and their safe disposal are obliged to: [14]

- storage of industrial waste in accordance with the law, that is, storage in appropriate containers marked with special codes,
- dispose of waste in a safe manner,
- having a valid certificate authorizing the receipt of industrial waste from companies,
- issuing to the company an appropriate document confirming the collection of waste,
- re-use of processed raw material for road construction and engineering works.

Each professional company dealing in the collection of industrial waste should operate in accordance with the Polish Environmental Protection Law and the Waste Act. The law on the export of industrial waste is very strict.

Production companies that generate industrial waste in accordance with the law, carry out a policy of managing the generated residues. Designing and modeling of a comprehensive waste management system should consist in aggregation of individual waste flow streams generated within one plant. The individual system implemented in each production enterprise is an element of a larger system (system) that realizes environmental goals. The complex character of the model, taking into account all production sectors, requires systematization according to strictly defined classification criteria. Efficiently functioning waste management systems of many enterprises will be the first stage to create a comprehensive overarching waste management system, eg within the industry, sector or even the country. [15]

Good waste management is an essential element for ensuring the efficient use of natural resources and sustainable economic growth. Therefore, the Waste Act, implementing the Waste Framework Directive, introduced a five-level hierarchy of waste management, in which at the top - the prevention of waste, followed by reuse, recycling, other forms of recovery and ultimately waste treatment was considered as the best practice (e.g. by storage).

5. ANALYSIS FOR THE MANAGEMENT OF INDUSTRIAL WASTE IN POLAND

An inherent feature of human activity is the generation of waste. An important problem for societies is their proper development. Activities are carried out, at the national, regional and local level, aimed at limiting the impact (inconvenience) of waste on the environment and human health and the most effective resource management. The inconvenience of waste to the environment manifests itself primarily in the contamination of water and soil, air pollution, destruction of aesthetic and landscape values and the exclusion from use of agricultural and forestry areas occupied for waste disposal. The main challenge in waste management for the coming years is the transition to a circular economy, which aims to minimize the amount of waste generated and the use of inevitable waste as a resource due to recycling processes.

Assuming a waste site as a criterion for division, a group of municipal waste emerging in inhabited areas and related to the existence of people and industrial waste related to economic activity is distinguished.

The waste producer is understood as any person whose activity or existence results in the generation of waste (the original producer of waste), and anyone who carries out pre-treatment, mixing or other activities causing a change in the nature or composition of this waste. The producer of waste resulting from the provision of services in the field of construction, demolition, renovation of facilities, cleaning of tanks or equipment and cleaning, maintenance and repairs is the entity that provides the service, unless the contract for the provision of services provides otherwise.

In 2017, 126 million tonnes of waste were generated, of which 9.5% was municipal waste (12 million tonnes). The amount of waste generated (excluding municipal waste) from 2000 ranged from 110-130 million tonnes. Generation of 114 million tonnes in 2017 means a decrease of 10% compared to the previous year. The amount of waste generated annually remains at a similar level, with constant GDP growth, which may indicate positive trends in waste management.

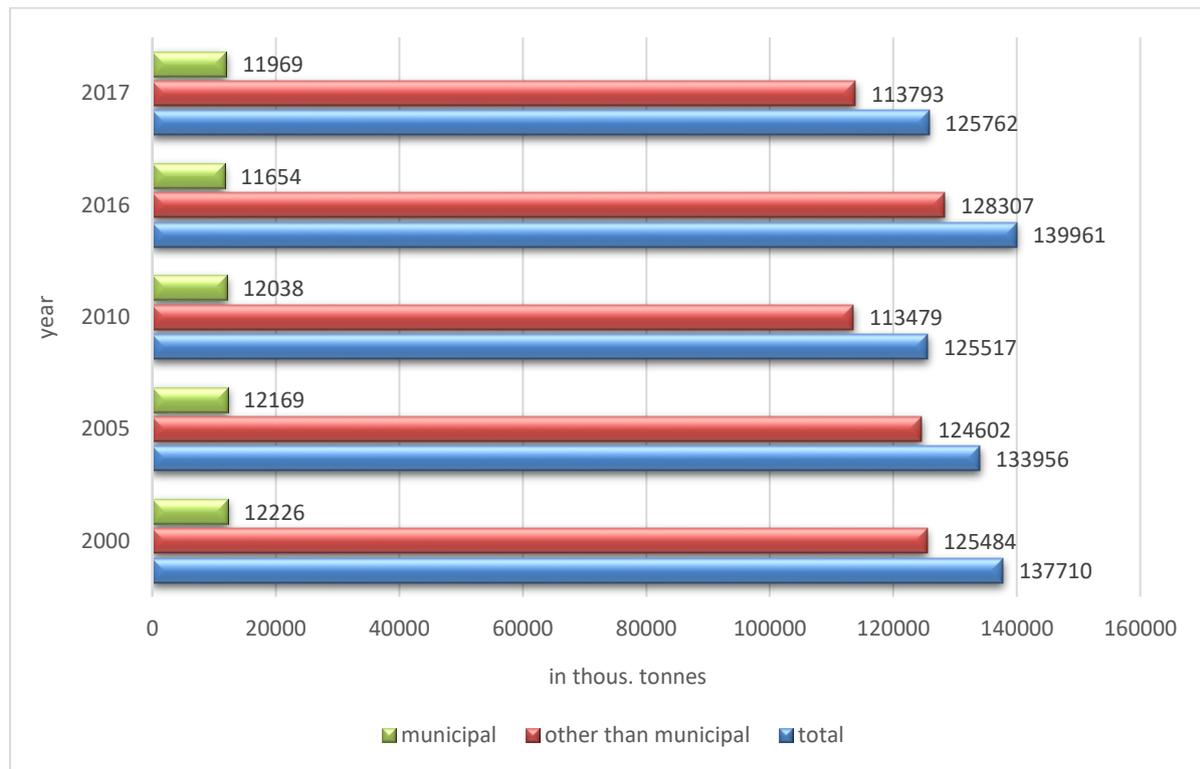


Figure 1. Waste generated during a year.
 [Source: „Environment 2018”, Statistics Poland, Warsaw 2018]

Economic development and the level and patterns of individual consumption are the main factors determining the amount of waste generated. The main source of waste in 2017 was, as in previous years: mining and quarrying (about 56.5% of total waste generated), industrial processing (23.8%) and electricity production and supply (15.4%).

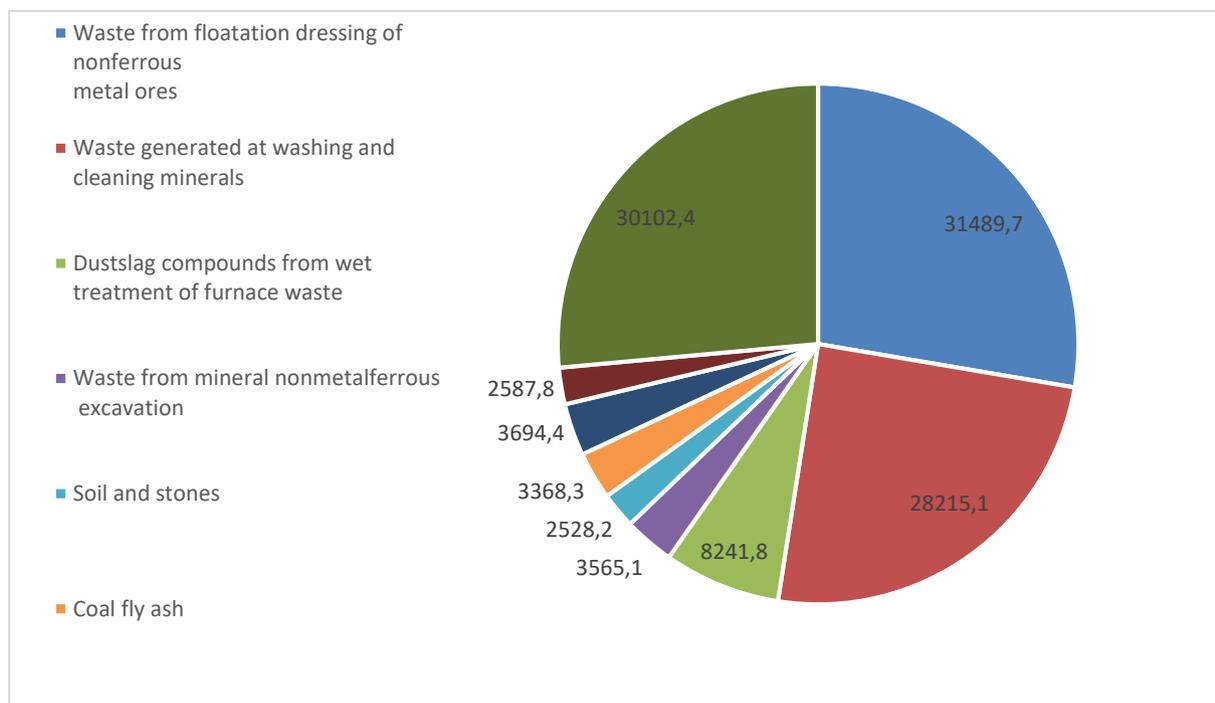


Figure 2. Structure of waste generated by waste type in 2017.

[Source: „Environment 2018”, Statistics Poland, Warsaw 2018]

Out of the total amount of waste generated in 2017, 49% of waste was recovered, 42% was disposed of via storage, and 4% were otherwise disposed of. Data on industrial wastes include the first 19 waste catalog groups and come from units (plants) producing during the year a total of more than 1 thousand tons of waste, excluding municipal waste, or having 1 million tons and more of accumulated waste. The largest share in the amount of waste generated in 2017 was the waste generated during the exploration, extraction, physical and chemical processing of ores and other minerals (58%) and waste from thermal processes (22%).

The largest amount of waste was generated, similarly as in previous years, in the Lower Silesian and Silesian voivodships (where the mining industry is located), the least in the Lubusz, Subcarpathia and Warmian-Masurian voivodships. In most provinces, the amount of waste generated decreased compared to the previous year. The largest decrease was recorded in the Lodz Voivodship - by 4 million tonnes (36%), Świętokrzyskie by 3 million tonnes (38%), and Silesia by 2 million tonnes (6%). In five provinces there was an increase in generated waste, of which two were a significant increase: in the Lesser Poland voivodship by over 800,000. tonnes (18%), Podlachian by over 400,000 tonnes (63%). Despite the introduction of a five-level hierarchy of waste management in Polish law, a large part of waste from business operations is still stored. The largest storage areas are located in the voivodships, in which the largest amounts of waste are generated, i.e. in the Dolnośląskie, Śląskie, Małopolskie and Łódzkie voivodships. In 2017, only 18.2 ha (0.2% of the existing storage areas) were reclaimed. Reclaimed landfill sites should be understood as areas where the operation has been completed and on which work has been carried out to give or restore them utility values by, among others proper shape of the relief, improvement of physical and chemical properties and regulation of water relations.

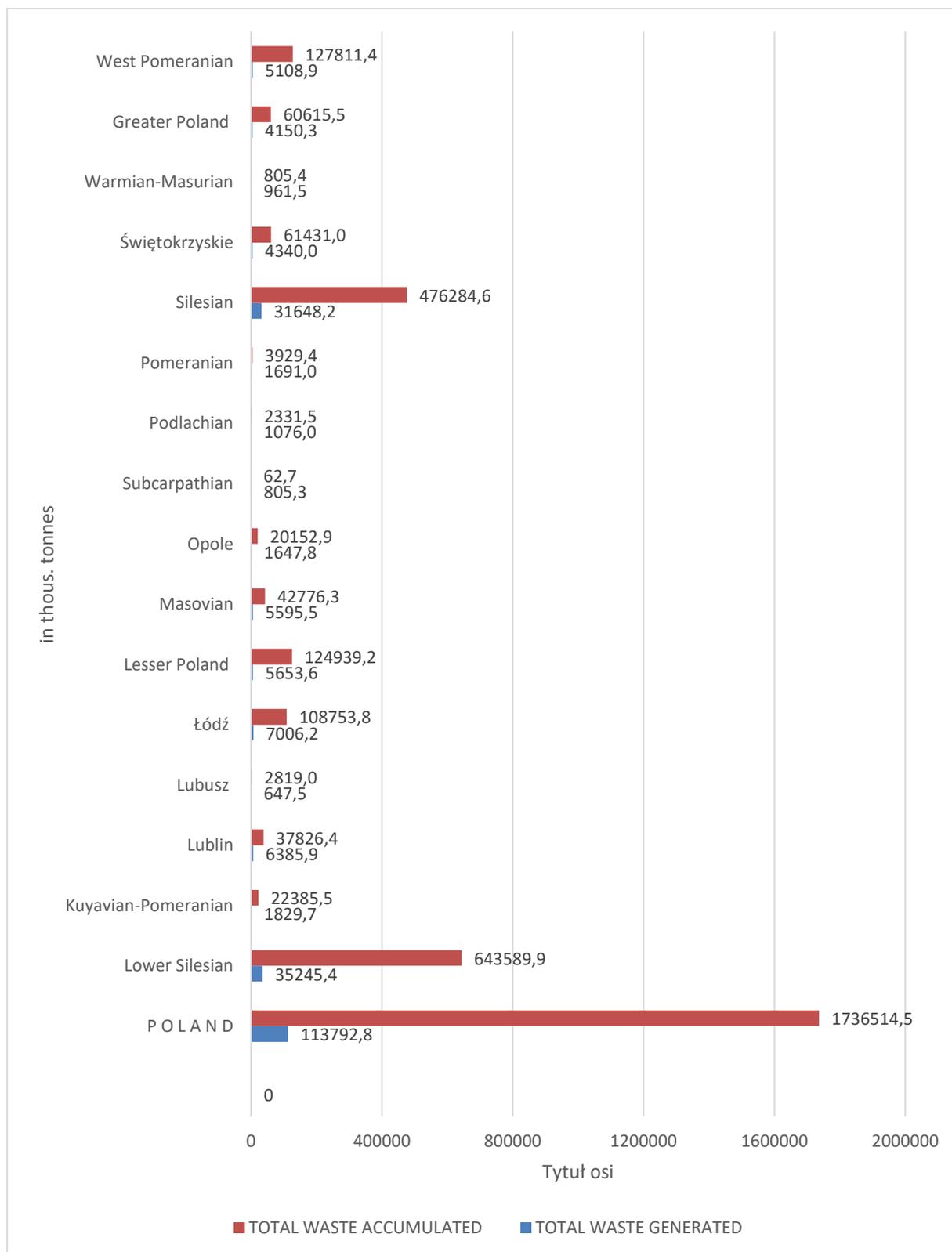


Figure 3. Waste (Excluding municipal waste) generated by voivodships in 2017
 [Source: „Environment 2018”, Statistics Poland, Warsaw 2018]

Table 1. Waste generated and landfilled (accumulated) so far according to section of the Polish Classification of Activities in 2017.

Specification	Waste generated during year						Waste landfilled (accumulated)
	grand total	Recovered	disposed		transferred to other recipients	Temporarily stored	
			total	in which landfilling			
	in thousen tonnes						
TOTAL	113793	55842	53411	48395	3313	1227	1736515
Mining and quarrying	62268	23230	38431	38037	323	284	800529
Manufacturing	26167	19706	5345	3420	554	562	268318
Electricity, gas, steam and air conditioning supply	16911	9294	6855	6587	577	186	296756
Water supply; sewerage; waste management and remediation activities	4799	2112	2485	72	66	136	339050
Construction	2895	1061	7	6	1782	45	-
Other sections	753	440	288	272	11	14	31862

[Source: „Environment 2018”, Statistics Poland, Warsaw 2018]

Table 2. Waste landfills (Excluding municipal waste) by voivodshipsa in 2017

VOIVODSHIPS	Plants landfilling Waste (as of 31 December)	Waste landfilled			Area of waste landfill sites	
		total	in tailing ponds	on landfills slag heaps	non-reclaimed (as of the end of the year)	reclaimed during the year
		<i>in thous. tonnes</i>			<i>in ha</i>	
POLAND	70	48125,0	5476,0	42649,0	8376,8	18,2
Lower Silesian	12	30130,1	—	30130,1	2506,4	7,9

Kuyavian-Pomeranian	3	29,5	1,2	28,3	255,4	—
Lublin	2	3029,8	—	3029,8	143,3	—
Lubusz	3	11,8	0,2	11,6	39,9	—
Łódź	3	5473,4	5439,0	34,4	727,6	—
Lesser Poland	9	194,4	—	194,4	749,2	—
Masovian	3	60,7	—	60,7	518,7	—
Opole	4	11,7	2,5	9,2	204,7	—
Subcarpathian	1	2,6	—	2,6	26,0	—
Podlachian	—	0,2	—	0,2	28,8	—
Pomeranian	4	47,0	30,9	16,1	124,5	—
Silesian	8	4064,7	0,0	4064,7	1566,2	10,3
Świętokrzyskie	12	1828,8	2,2	1826,6	295,7	—
Warmian-Masurian	—	0,2	—	0,2	4,6	—
Greater Poland	3	906,9	—	906,9	624,3	—
West Pomeranian	3	2333,2	—	2333,2	561,5	—

[Source: „Environment 2018”, Statistics Poland, Warsaw 2018]

6. CONCLUSIONS

The largest amounts of industrial waste in Poland are produced by industrial processing plants (46.9%) and industries - mining (31.8%) and energy (18.6%). Therefore, in the following voivodships: Śląskie, Dolnośląskie and Małopolskie, where the industries are located - metallurgical, mining, and energy, the largest amount of waste is generated. Industrial waste is generated as a result of various production processes. Over 30% of industrial waste is generated in the production of metals and metal products, including copper, lead, zinc and tin production. The type and amount of waste generated depends both on the production technology used and on the type of raw materials. Health hazards associated with the storage of industrial waste are a consequence of exposure to toxic and harmful substances present in waste. Industrial waste contains many substances from the group of heavy metals, as well as aliphatic, aromatic hydrocarbons and pesticides, which, due to their physicochemical and toxic properties, pose a potential threat to human health and the environment. Uncontrolled storage of industrial waste and improper location, construction and operation of landfills, create opportunities to emit chemical substances contained in accumulated waste, which can be a source of threats to the environment and human health. Due to the amount of exposure to toxic substances present in

industrial wastes, the largest risk populations are people in the area of storage sites and people consuming water contaminated by chemical substances released from industrial waste dumps. Because industrial waste has a negative impact on the environment, it must be managed rationally. An important principle in waste management is the reduction of waste at the source of its generation and selective collection. Firstly, the collected waste should be subject to a recovery process, and only then to the disposal process. Waste recovery aims to use waste in whole or in part. Wastes that could not be recovered are treated for neutralization. Waste can be disposed of by biological, chemical and physical methods. Each of these methods aims to bring waste to a state where it will not pose a threat to the environment. Proper waste management controls waste monitoring. Waste monitoring also collects information on the quantity and quality of waste generated and assesses their impact on the environment. It is also necessary to take public education activities in relation to waste management and control industrial plants that produce waste.

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