



# Disposal of asbestos and products containing asbestos in Poland

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## Abstract

The paper makes analyses and evaluation of work progress in asbestos inventory, as well as removal asbestos and asbestos products in Poland in regional scale (i.e., the voivodeships—the state reported until 30th June 2017). Factors, both the ones which caused asbestos ‘presence’ in Poland related with historical conditioning (i.e., various level of asbestos implementation in economy, building, industry, etc.), but also strictly economic factors, observed in the country after First and Second World War and which at present influence quantity of asbestos removed, were discussed. It was clearly observed in the light of research that quantity of asbestos and asbestos-derived products is significantly much higher in eastern and central regions of Poland, which is a consequence of historical–economic conditions. Moreover, it was indicated that the goals included in ‘The Program for Asbestos Abatement in Poland for 2009–2032’ have not been implemented with expected results. Slow rate of asbestos and products containing asbestos removal in the country makes us suppose that the goals of ‘The Program for Asbestos Abatement in Poland for 2009–2032’ will not be completed successfully.

**Keywords** Asbestos · Asbestos cement (eternit) · Neutralization · Hazardous waste · Waste management

## Introduction

Asbestos is a general trade and legal definition for a group of fibrous silicate minerals with crystalline structure and by definition have lengths  $> 5 \mu\text{m}$  and aspect (length/diameter) ratios of three or greater [1]. Its commercial use started in 2nd half of 19th c, together with the development of demand for insulation for the burgeoning steam technology [1]. Its production and use zenith in Europe, North America and Australia was reported during the 60 s, 70 s and 80 s of twentieth century [2, 3]. Together with common asbestos exploitation, the material releasing to the air took place, which resulted in negative influence on human health as well as on other components of natural environment.

Asbestos, due to its properties, i.e., high tensile strength, poor thermal conductivity, sound absorbing properties and relative chemical resistance [4] became very popular

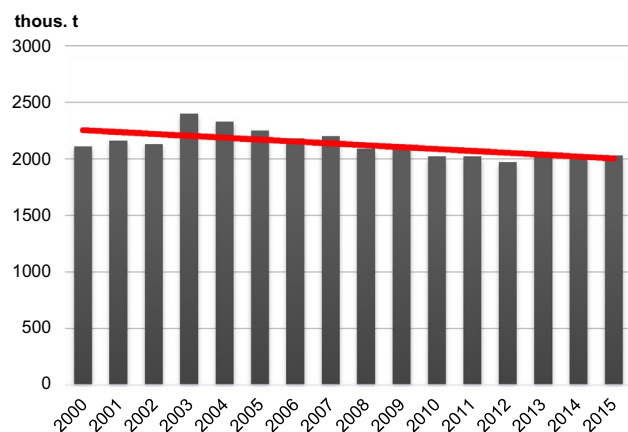
material not only in industry, but also in products of everyday life. Its common use in building (asbestos-cement tiles and pipes), in power engineering (high chimneys, where dilatations are filled with asbestos ropes, heating routes insulation—asbestos-cement coats), in transport industry (engine thermal insulations of motor vehicles and exhaust manifolds), in chemical industry (asbestos membranes used in electrolytic chlorine production), in military sector, in textile industry (incombustible textiles used by firemen), but also in other branches of national economy, made asbestos the cause of many negative phenomena and processes [5–10].

It is difficult to state univocally the scale of asbestos mining and exploitation. Vogel [11] estimates that world mining until 2000 reached about 174 million t (ton) of asbestos (while from 2000 to 2015 annual asbestos production reached about 2 million t—Fig. 1), with significant participation of the past block of socialistic countries, including Poland with a relatively high ratio. Social-economic development dynamism of socialistic countries, where asbestos was commonly used for industrial and building purposes made this material very popular and it was also imported to Poland (mainly in the period between the 70 s until the 90 s of twentieth century, when the Act was passed on 19th June 1997, banning implementation of products containing asbestos), what does not mean, of course, that it had

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**Fig. 1** World asbestos production. Source: own study based on the data [14]

not been used earlier, after First and Second World War. As Szeszenia–Dąbrowska and Sobala state [12]. Polish territory (according to estimations made in 2002) reported about 15.5 million t of products containing asbestos. Destructive influence on human health of asbestos and asbestos products made majority of the world countries prohibit its usage. As it was mentioned above, Poland also introduced in 1997 the legislation prohibiting using products containing asbestos, introducing them to the market, as well as restrictions on production and purchase. Poland, which became a member of European Union in 2004 is obliged to follow the Union legislation (since 1st January 2005), which prohibits producing and purchasing asbestos products obligatory for all EU countries and complete neutralization of the products and their waste until 2032. Furthermore, Polish government introduced in 2002 a document defining management and course of removing asbestos from the country economy, performed as ‘The Nationwide Program for Asbestos and Asbestos Products Abatement’, which is continued in present ‘Program for Asbestos Abatement in Poland for 2009–2032’ [13]. Completing the goals of the other program (due to relatively long—at least 30 year durability of asbestos-cement boards and other asbestos materials used in building) was prolonged until 2032.

It should be pointed out, that asbestos negative effects on human health is the issue the most often discussed by scientists, politicians and practitioners, both in Poland and the world [12, 15–24]. Pathogenic asbestos impact is the reason of many diseases, such as: asbestosis, idiopathic pulmonary fibrosis, mesothelioma and other types of cancer by inhaling asbestos fibres present in the air [25–28]. These are respirable fibres, invisible to the naked eye, with the diameter of  $< 3 \mu\text{m}$  and length of  $> 5 \mu\text{m}$ , creating asbestos dust [12]. Biological aggressiveness of asbestos dust is related with the level of penetration and quantity of fibres in lower part of a respiratory system.

Due to asbestos harmfulness, both at the mining stage and its use in various products (over 3000), present tendency is to make careful inventories of both processes [29]. In this context, it is vital to register asbestos quantities in particular countries (as one of pathogenic factors), remove and neutralize asbestos products, build and shape social awareness concerning knowledge on asbestos danger, especially, as some countries, like: India and China are still using asbestos as building material [30]. The most important asbestos producers include at present Russia, Brasil, China, and Kazakhstan, where manufacturing the material in 2015 amounted, respectively: 650, 270, 210 and 180 thous. t [31].

The paper goal is to analyze and estimate work progress in asbestos inventory making, removing asbestos products in Poland in regional scale (i.e., voivodeships—the state until 30th June 2017). Factors which contributed to asbestos ‘presence’ in Poland resulting from historical conditions (i.e., various intensity of asbestos use in national economy, building, industry, etc.) and economic problems which Poland had to face after First and Second World War and which are still the consequences of these facts defining quantities of removed and neutralized asbestos at present, are discussed.

The work authoresses try to answer the following questions:

- What was the size and dynamism of changes in asbestos use in Poland in twentieth century?
- What is the scale of listed asbestos quantities in Poland until the half of 2017 and what is its regional diversity?
- Is there any dependence between listed asbestos quantities and the mass still waiting for removal and the level of urbanization (percentage of population inhabiting cities) and if there is any correlation between listed asbestos quantity and still waiting for removal and a number of buildings erected between 1970 and 1988 (when asbestos was commonly used as building and engineering constructive material)?
- How many waste dumps, where asbestos is stored and neutralized, are there in Poland and what is their localization and how much of that harmful material has been disposed (stored) until presence?

## Source material and methods

Basic data source for defining asbestos quantity is derived from information collected by a special organizational group, created by the Ministry of Development for collecting and processing information concerning listing asbestos-containing products, but also monitoring the tasks resulting from ‘The Program of Asbestos Abatement in Poland for 2009–2032’. The group created Asbestos

Base which is still updated. The scale of listed asbestos is performed by filling annual information form in which an owner, manager or property user reports to proper authority (mayor, town president or directly a marshal) locations, where asbestos or products containing asbestos were or are still in use. It should be remarked here that by the end of June 2017 The Asbestos Base included as many as 2472 gminas (communes) (for total of 2478 communes in Poland, what is 99% of that number). Only six communes did not report asbestos presence or local administrative authorities did not report its presence to the Base. Data from Asbestos Base are completed with information obtained by the authoresses during field enquiries made from February until June 2017 in Toruń, Bydgoszcz and Włocławek. These queries indicated that locations defined in The Asbestos Base as places containing asbestos and requiring its urgent removal did not contain asbestos any longer, which shows that data base is not always a reliable source. The observation leads also to conclusion that rural property owners are more disciplined in reporting proper authorities asbestos presence or its removal, while in urban spaces, this negligence often results from lack of information, where the fact of removing asbestos material should be reported. In majority of Polish cities listed asbestos is classified as very urgent to be removed and although it has already been disposed, the facts have not been reported to the Base. Poland uses three levels of urgency in asbestos removal, expressed by three information colors: red, orange and yellow.

Taking the above circumstances into account (reliability and data accuracy and completion) it should be remarked that as far as asbestos disposal is concerned Asbestos Base reliability is about 70%, what we especially point out, because if we look at all listed asbestos, we have 100% of completion and reliability. Despite the fact that a number depicting asbestos disposal is underestimated (30%), the other 70% is credible and lets us on this ground define directions of further asbestos removal and neutralization (storage) in Poland.

The authoresses use in the elaboration various methods of the obtained results quantification, processing and presentation. To characterize some dependences between quantity of listed asbestos and selected social-economic features (urbanization level, a number of buildings erected between 1970 and 1988, when asbestos was rather commonly used for building and constructive-engineering purposes), correlation coefficients were measured (with statistical significance 0.001%) and coefficient of determination. Furthermore, regression analysis was made, taking into account quantity of listed (designed for disposal) asbestos and percentage of urban populations.

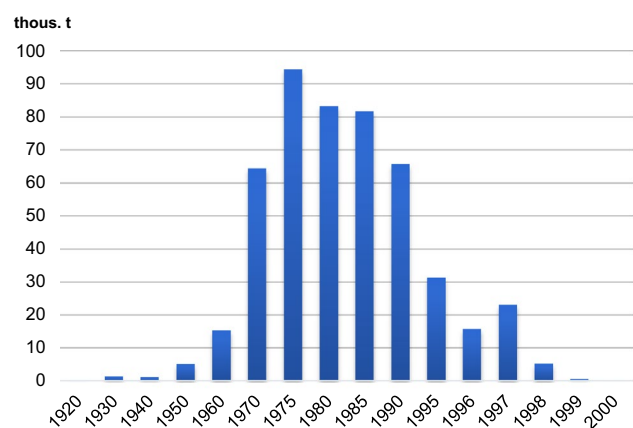
## Results and discussion

### Asbestos and products containing asbestos in Poland—imported problem in socialistic countries

Economy of every country is based on human and natural resources—local or imported, as not all country resources are sufficient for industrial exploitation and use in economy. Social-economic development taking place after First and Second World War, including intense building investment and industrial boom caused increased need and import of asbestos. From 1920 to the 80 s of twentieth century asbestos import to Poland grew systematically (Fig. 2). It must also be remarked that asbestos-cement boards production started in Poland in 1907 and was continued until 1998, when the Act of 19th June 1997 was passed prohibiting usage of products containing asbestos [32].

Poland belonged to the ‘leading’ countries applying asbestos products. First asbestos-concrete boards factory after Kuczumow and Nowak [34] was built in Krakow in 1907, next in Lublin in 1910 and just after Second World War another plants in Lublin, Ogrodzieniec, Wierzbica and Szczucin.

Increased asbestos import to Poland started in the 60 s and lasted until the 90 s of twentieth century (Fig. 2). In the 60 of twentieth century next big factories of asbestos-cement boards were erected in Trzemeszno, Trzebinia, Jarocin and Pruszków. Total of 24 plants using asbestos in their production functioned in Polish territories. The highest rate of asbestos and its products import was observed between 1970 and 1990 (Fig. 2). Average annual asbestos import amounted about 78 thous. t of the product. As it is reported in the research import decrease was observed after 1990 (Fig. 2). Following the data obtained by Łuniewski and Łuniewski



**Fig. 2** Asbestos and products containing asbestos import to Poland between 1920 and 2000. Source: own study based on the data [33]

[35] in the 80 s of twentieth century, 82% of asbestos was used in building and constructing, 12% in chemical industry, 5% in mechanization and 1% in other economy branches, while asbestos usage per one inhabitant was estimated in these years in Poland for 1.7 kg, situating the country in 16 position in the world. It must be remarked here, however, that as Albin et al. [36] points out the highest production intensity was reported in the 70 s of twentieth century, when as much as 85% participation of asbestos usage was designed for asbestos cement and its derivatives.

It is worth mentioning that in global scale asbestos production in the years of its highest popularity, i.e., in the 70 s and 80 s balanced between 4.3 and 4.7 million t annually [4]. Countries like: China, India, Brazil, Argentina, Russia, Kazakhstan, Canada and Zimbabwe were the biggest asbestos and asbestos products manufacturers in 2014. The data reports that in 2014 Canada and Zimbabwe gave up asbestos production, Chile Russia increased it to 1.1 million t of asbestos annually (which is more than a half of total world production) [35].

It must be emphasized once again that Poland introduced relatively early (in 1997) the restrictions for using asbestos and asbestos products and regulations concerning asbestos removal from the country space. It was rather new initiative, whereas USA, for example, limited asbestos production and use in 2002, and EU itself passed respective restrictions as late as in 2005. It should be addend that Denmark was the first country to ban using asbestos for thermal, acoustic insulation, waterproofing (1972) [31]. It also should be remembered that legislation introduced in a number of countries concerning the problem varied, e.g., Croatia in 1993 (bans crocidolite and amosite), in 1996 Slovenia bans production and trade of asbestos products, in 1998 Czech Republic bans the import of asbestos, in 2001 Latvia bans asbestos (exemption for asbestos products already installed, which must, however, be labelled), while Hungary bans amphibolite asbestos products, in 2003 and asbestos-cement products [37]. At present, following the International Ban Asbestos Secretariat production and use of asbestos and asbestos products is banned in 65 countries of the world [31].

### State, structure and regional diversity of asbestos products in Poland

It was estimated for Poland that in 2002 there were 15.5 million t of asbestos products, including: 14,866 thous. y of asbestos-cement boards (1,351,500 thous. m<sup>2</sup>), 600 thous. t of asbestos-cement pipes and other products [38]. Quantity of pure fibred asbestos import is possible to estimate—after 1945 2 million Mg of asbestos was brought to Poland (Fig. 2). On the other hand, it is not possible to obtain the information in case of many other products containing asbestos, because they are often included in smaller import

of machinery and other appliances. By 30th June 2017 about 6 million t of asbestos products were listed, including 90% in hands of private persons and only 10% of these products in hands of juridical persons.

Analyzing structure of asbestos products in Poland it should be indicated that 88% are in form of corrugated sheets, 8% flat sheets, 2% pipes and asbestos-cement connectors and 2% other asbestos objects [39]. Corrugated panels predominate in asbestos products structure in all voivodeships (Table 1), with the highest quantity in Masovian voivodeship (Table 1).

The research pointed out that central and eastern Poland regions report the highest number of listed asbestos products, what is a result of certain historical–economic conditioning and reflects to some degree development level of different parts of Poland being under partition by the year 1918. For instance—in relatively poorly developed part under Russian partition roofs covers were of low quality, with predominant thatch, straw, wooden shakes (what ecological awareness!). Therefore, after Second World War that region reported asbestos-cement (eternit) roofs ‘explosion’, what was a great progress for those times (1960–1990) and a great problem for present period. After Bański and Wesółowska [42] we could observe in the 60 s of twentieth century in Lublin region a tendency for replacing old wooden plank or thatched roofs with asbestos-cement roofs.

Present study indicated that there is significant dependence between quantity of listed asbestos and derived products (designed for removal) and a number of buildings from 1970 to 1988, when asbestos was commonly applied for building and engineering purposes (Fig. 3). Value for Pearson correlation coefficient was  $r = 0.429$  ( $p = 0.001$ ).

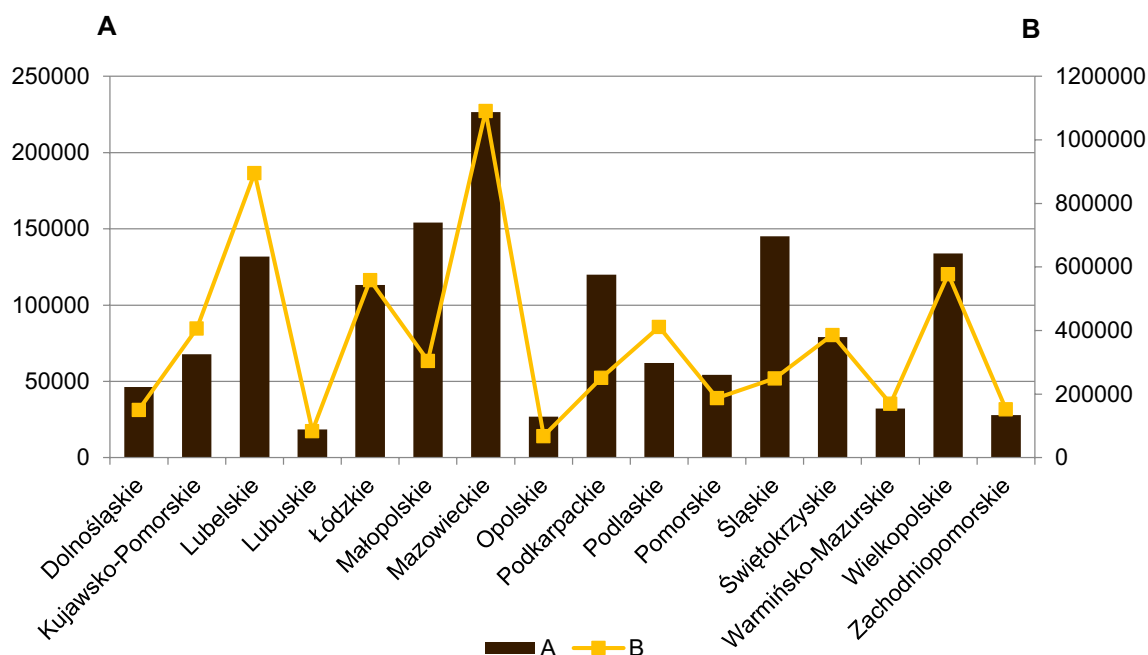
The other reason of increased quantity of asbestos in Eastern Poland is the fact that Lublin region is of a rural character, where percentage of asbestos-cement roof covers can amount even 90% [44]. Rural character is also observed as predominant in Podlasie or Central Poland. High asbestos presence there is confirmed by research of Buczaj et al. [44], where it was established that Lubelski and Warszawski regions report the highest concentration of fibre asbestos structures in the air.

The survey also shows that urbanization level is measured as a ratio of urban population for general population expressed in percentage, what influences on catalogued asbestos quantity and it is confirmed by adjusting curvilinear regression model  $r^2 = 0.3845$  with simultaneous statistical significance model below 0.001 (Fig. 4). This connection is also confirmed by value of Pearson correlation coefficient  $r = -0.505$  ( $p = 0.001$ ), hence—the lower the degree of urbanization is observed (rural areas), the more of listed asbestos and asbestos products.

Taking above discussion into consideration there are some problems arising. First general issue for Poland is

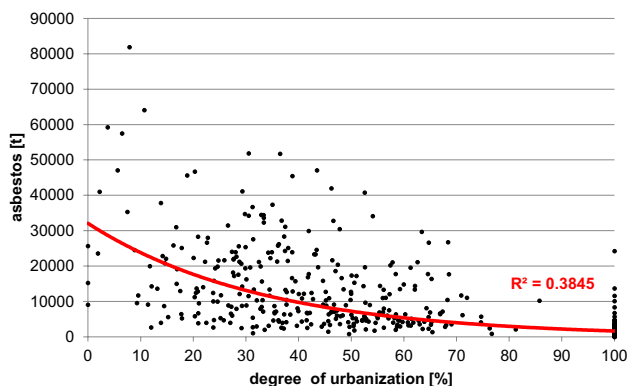
**Table 1** Quantity of asbestos products in ton in Poland listed and designed for removal (state for 30th June 2017) and mass of neutralized waste containing asbestos. Source: own study based on the data [40, 41]

Voivodeship	Quantity of asbestos products listed and designed for removal						Mass of neutralized waste containing asbestos				Dynamism of changes in 2011–2013 (2011–100%)		
	Corrugated boards (%)		Flat boards (%)		Asbestos-cement pipes and connectors (%)		Others (%)		Total			Neutralization (t)	
	boards (%)	(%)	(%)	(%)	and connectors (%)	(%)	(%)	t	%	2011		2012	2013
Dolnośląskie	69	25	3	4	3	3	4	108,610	100	3719	7525	6631	78.30
Kujawsko-Pomorskie	93	2	2	3	2	2	3	371,157	100	9876	18,697	21,177	114.43
Lubelskie	88	10	1	1	1	1	1	812,237	100	15,136	16,789	30,605	102.20
Lubuskie	85	6	3	6	3	3	6	57,003	100	5329	4980	4991	-6.34
Łódzkie	93	3	2	2	2	2	2	541,762	100	3031	7808	9607	216.96
Małopolskie	74	23	1	2	1	2	2	244,303	100	28,009	5197	6107	-78.20
Mazowieckie	93	4	2	1	2	2	1	1,000,856	100	193	76	91	-52.85
Opolskie	80	13	5	2	5	2	2	58,618	100	0	0	0	0.00
Podkarpackie	89	10	0	1	0	1	1	220,520	100	832	973	1177	41.47
Podlaskie	96	4	0	0	0	0	0	375,777	100	26	391	2413	9,180.77
Pomorskie	88	2	7	3	7	3	3	168,397	100	721	839	1089	51.04
Śląskie	55	42	1	2	1	2	2	199,250	100	7714	7968	9300	20.56
Świętokrzyskie	93	5	0	1	0	1	1	356,429	100	45,32	47,322	46,366	2.31
Warmińsko-Mazurskie	92	3	3	1	3	1	1	155,983	100	1256	332	64	-94.90
Wielkopolskie	88	2	6	4	6	4	4	524,719	100	9341	5353	3835	-58.94
Zachodniopomorskie	87	2	4	6	4	6	6	108,322	100	2929	1979	2286	-21.95
Total	88	8	2	2	2	2	2	5,303,943	100	133,432	126,229	145,739	9.22



**Fig. 3** Number of buildings from 1970 to 1988 and quantity of listed asbestos in Polish voivodeships. Explanations: **a** Total number of buildings from 1970 to 1988, **b** Total quantity of listed asbestos in

voivodeships in thous. *t* (state: 30th June 2017). Source: own study based on the data [40, 43]



**Fig. 4** Dependence between the urbanization degree and quantity of listed asbestos in Poland (in poviats). Source: own study based on the data [40, 43]

the necessity of making complete inventory of all asbestos products. Until presence (as our survey confirmed) only 1/3 of all asbestos production has been listed in the area of the country. The situation may have resulted from the fact that its presence has not been reported by an owner of a building or other property containing asbestos to respective authority, which consequently follows the material removal or replacing it with other material (the other solution is applied the most often in case of roofs or building fronts), next transport it to specially prepared dumps and secure it, what generates high costs. In some regions of Poland, rural

ones in particular, there is also an aspect of local society protests, as dismantling asbestos insulation, e.g., roofs leads to general house redecoration, what causes extra costs. Older farmer generations are not so eager to exchange functional and cheap roofs (which serve the purpose) to expensive, but healthier new ones, moreover, that they have not experienced any direct pathogenic consequences of asbestos affects on human health. We should emphasize here that stage of latency can last over 30 years and releases asbestos dusts to the air gradually and it intensifies with time. Therefore, the problem of asbestos disposal has become in Poland and other world countries an issue of economic, financial, social and ecological significance.

While pro-health reasons appeal to a society, relatively small number of disease cases caused by asbestos and their limitation to persons directly working with the material causes the situation that asbestosis and other derivatives are commonly treated as exotic diseases, which significantly diminishes understanding the problem essence and threatening danger.

Another issue, difficult to solve is individual economic interest, because not all Polish communes provide equal co-financing the costs of asbestos removal. In case of some of them this aid can amount even 100% of expenses of removing and disposing asbestos, in others there is 80%, and in some cases only from 50 to 20% of the cost. Sum of that allowance can evidence that officials are resourceful and care for common local good. For example, in Bydgoszcz, the sum

of allowance for the process is up to 100% of costs including dismantling, collecting, transport and disposal or storage in a secure location of all waste containing asbestos, but no more than 1000 zł per 1 t of disposed or protected asbestos waste (information obtained basing on field query).

### Disposal of asbestos products in Poland

At this stage of social-economic world development there are many problems requiring rapid reaction and solution. These are, besides desertification and lack of water, nuclear weapon and terror threats as well as ecological challenges. For a human and other living organisms it is vital to reduce and dispose harmful asbestos products used commonly in the past. We all realize the necessity of their instant neutralization. At present the only acceptable method of waste containing asbestos disposal is its storage in special dumps for hazardous waste or separated sectors of other landfills. It must be remembered, though, that just like general definitions of preventing, diminishing and waste reusing differ in various countries and regions [45, 46], asbestos disposal methods also differ in various parts of the world. The most efficient methods of asbestos disposal are being discussed in scientific centers, in view of the fact that asbestos waste storage seems to be only a temporal solution. Japan, for instance, promotes asbestos waste inertization and its thermal processing [47, 48]. Research on recycling technology for asbestos waste is being in progress, but due to high costs and special laboratory conditions necessary, the methods are not used in practice [49–53]. Tests of Gidarakos et al. [54] and Paglietti et al. [55] who claim that asbestos mines can be used in future as locations of asbestos waste disposal, which in particular is a safe method of environment pollution minimizing, seem to be exceptionally valuable. Asbestos waste belongs to hazardous waste; therefore, its management requires special procedure and strict control. Following legislation obligatory in Poland, programs for environment protection are implemented with its integral element, which is waste management (plans for waste management on country, voivodeships, poviats and communes level).

An owner of a property is obliged to report asbestos products for removal and disposal (storage) to a special territory administration unit, although, as it was remarked earlier, financial factor is the main obstacle, as an owner is responsible for all the costs concerning asbestos removal, e.g., roof of a building—asbestos panels and replace them with new safe material. One of the ways to hasten the removal process and protect the environment from threat caused by improper asbestos waste management is (what has already been mentioned) support from the part of self-government authorities in co-financing these actions (e.g., financial help with removing asbestos, transport and disposal of all the waste produced during dismantling dangerous

construction—rubble and scrap metal in the area of industrial plants or private houses.

Poland has strict legal regulations concerning procedures of dismantling asbestos-cement roof covers, which are included in the Regulation of the Minister of Economy from 14th August 1998 concerning save use and conditions of removing products containing asbestos [56]. In accordance with obligatory executive order removal works must be performed solely by certified firms, equipped with special technical facilities designed for the purpose and qualified staff. There are at present 437 firms functioning in the area of the country for dismantling and transporting asbestos (Fig. 5). These rigorous regulations are designed to reduce negative effects on human health, in particular persons working with the material removal. World evaluations inform that as many as 125 million of people are endangered to harmful asbestos activity in their work places and every year thousands of new cases of asbestos diseases are reported [57].

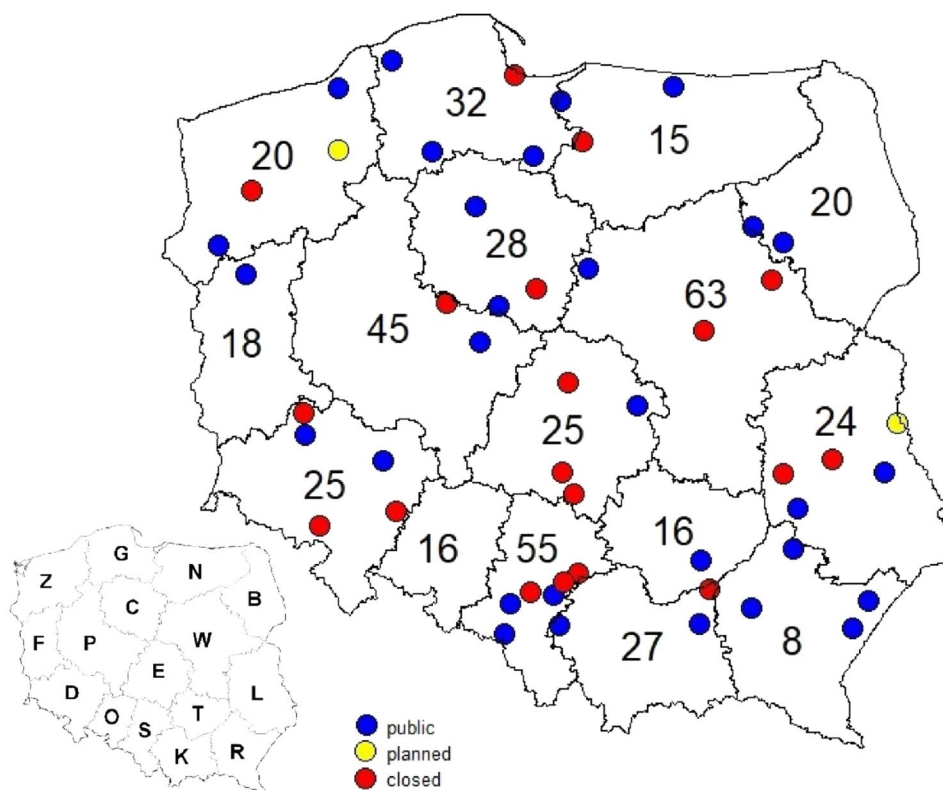
‘The Program for Asbestos Abatement in Poland for 2009–2032’ indicated that Poland according to the state for 31st December 2008 estimated quantity of waste containing asbestos for removal by 2032 amounted about 14.5 million t (15.5 million in 2002) and they mainly consisted of asbestos-cement products, like eternit, so consequently from 2002 to 2008 1.083 million Mg of waste containing asbestos were neutralized. ‘The Program for Asbestos Abatement in Poland for 2009–2032’ assumes that by 2032 the problem of asbestos waste will have been solved definitely, with subsequent process of diminishing—2009–2012 its presence (14.5 million t) decreases of 28% of asbestos waste (4 million t), in 2013–2022 next 35% of waste (5.1 million t), while between 2023 and 2032 of 37% (5.4 million t).

The survey and analyses show that until now the process of removing and neutralizing asbestos (storage) has been performed much more slowly than it was planned. From 2009 until the half of 2017 only 645,206 Mg, i.e., 7.8% of listed asbestos was neutralized, 84% of which was asbestos belonging to private persons and only 16% was natural persons’ property.

Researchers’ duty requires a remark that quantity of asbestos products already stored was in 2009 98,322 t, in 2010 116,457 t, in 2011 133,432 t and in 2012 126,229 t (Table 1); therefore, quantity of removed asbestos forecasted for 2009–2012 was not achieved (!). Between 2009 and 2012 total of 1.557 million Mg of asbestos products (i.e., about 10.9% of all mass of the group planned for neutralization for these years) was neutralized (stored). One fact is alarming that by the end of June 2017 even the quantity planned for 2009–2012 for neutralization had not been completed.

On the other hand, it should be emphasized that quantity of neutralized asbestos products in Poland has been gradually growing in majority of voivodeships (Table 1), although there are regions, like: Warmińsko-Mazurskie,

**Fig. 5** Hazardous waste landfills, where asbestos is neutralized and a number of firms removing asbestos in voivodeships (state from 30th June 2017). Explanations: Voivodeships: B—Podlaskie; C—Kujawsko-Pomorskie; D—Dolnośląskie; E—Łódzkie; F—Lubuskie; G—Pomorskie; K—Małopolskie; L—Lubelskie; N—Warmińsko-Mazurskie; O—Opolskie; P—Wielkopolskie; R—Podkarpackie; S—Śląskie; T—Świętokrzyskie; W—Mazowieckie; Z—Zachodniopomorskie. Source: own study based on the data [40]



Małopolskie, Mazowieckie Zachodniopomorskie, Lubuskie and Wielkopolskie (Table 1), where the process is slowed down. In the last voivodeship mentioned the drop in asbestos products neutralization (storage) was related to the fact that Wielkopolskie voivodeship stopped in 2013 disposal process for material brought from neighboring regions and started transporting most of asbestos waste to other voivodeships. Another interesting fact is that the voivodeship (Mazowieckie), where the highest number of asbestos was listed, relatively small quantities of that waste are neutralized locally, what indicates that it is transported to neighboring regions. It should be noted that Świętokrzyskie voivodeship is the leading region in asbestos waste disposal, which results from, among the others, financial support and efficient work of special disposing firms. The other example—Opolskie voivodeship does not report any localization of that waste landfill, where it is disposed, so it is transported and stored in another voivodeships (Table 1; Fig. 5).

By the end of June 2017 Polish territory had 34 public hazardous waste landfills functioning, which also neutralized asbestos waste—state for 30th June 2017, located in the following communes: Sianów, Myślibórz, Konin, Bartoszyce, Elbląg, Tuczępy, Świętochłowice, Sosnowiec, Knurów, Jastrzębie-Zdrój, Gdańsk, Chojnice, Kwidzyn, Słupsk, Miastkowo, Zambrów, Pysznica, Radymno, Ostrów, Oleszyce, Sierpc, Bolesław, Tarnów, Oświęcim, Rawa Mazowiecka, Radomsko, Gorzów Wielkopolski, Chełm,

Krańnik (two), Pruszcz, Piotrków Kujawski, Polkowice, Trzebnica). Pomorskie and Podkarpackie voivodeships have four in each. Until now 19 hazardous waste landfills have been closed and only two new ones are planned. The number of that type of dumping places is still insufficient as for quantity of listed asbestos products in Poland, especially when we assume that future asbestos inventory will be more exact and precise, what in consequence will increase quantity of asbestos for neutralization. The other aspect is significant delay in fulfilling the goals of ‘The Program for Asbestos Abatement in Poland for 2009–2032’ (which assumed 34 landfills for 2003–2012, while data show that the plan was completed as late as in 2017).

Comparing our results with present world situation in the field, we evidently observe that the majority of Asian and the Pacific countries work without any defined program for asbestos and asbestos-containing products disposal [30]. After Li et al. [30] every country must estimate the situation and its own needs, work out special strategy for removing asbestos from use, define directives concerning asbestos storage, transport, disposal and proper monitoring of the area.

Asbestos harmful impact on human life is observed in European countries, as well. Paglietti et al. [3] point out that despite the fact that Italy banned asbestos use in 1992, asbestos pollution is still present in the country. To limit health negative consequences and improve the situation,



Italy introduced many anti-asbestos regulations. There are several legal loopholes, however, being obstacles in implementing improving actions, standard procedures concerning risk management do not exist (especially in the stage of waste transport and disposing harmful material). The problem is generated by limited number of hazardous waste landfills and very high charges for asbestos storage. It means illegal landfills for the material localization [3].

Difficulties in introducing proper regulations concerning asbestos disposal are also reported in the UK. Following Kazan-Allen [58] remarks, quoting British Members of Parliament, by 2020 a quarter of a million of British citizens will have died from asbestos diseases, over 6 million tons of asbestos were brought to Great Britain, most of which still remain within the national infrastructure, 75% of school buildings contain asbestos and every year 5000 persons die from cancers caused by asbestos and respiratory diseases. Facing these threats and despite resolution of European Parliament calling for having removed asbestos from public buildings by 2028 “no such measures have been considered by the British government which continues to defer to the industry-friendly policy of “safe management of a deadly hazard,” under which occupational and environmental exposures remain commonplace” [58].

Poland, what is worth mentioning, was the first country in EU to remove asbestos products from public space (European Parliament resolution of 14 March 2013 on asbestos-related occupational health threats and prospects for abolishing all existing asbestos (2012/2065(INI) in paragraph 4 appealed to EU countries to follow Polish example and evaluate the results and analyze costs and profits of the plan by 2028 for safe asbestos removal from all public buildings with regular customers’ access, provide information and directives for private building owners, encouraging them for effective controls detecting asbestos presence in their properties.

Many world countries have their general obligatory regulations concerning asbestos, but they lack detailed directives referring to asbestos disposal from the environment. According to Li et al. [30], supervision over obligatory law is still insufficient, and introducing particular regulations becomes difficult due to deficiency in proper funds and qualified staff.

## Conclusions

In the light of above discussion, four problems concerning asbestos products procedures arise. First—mechanisms of co-financing asbestos removal are implemented slowly and in insufficient sums. Similar problems are reported in other post-socialistic countries, where fight with asbestos is performed more in institutional-legal dimension, than in practical one. Second—Poland has not had complete inventory list

containing all asbestos products and locations. Third—not all communes and poviats have prepared their own programs of removing asbestos from their territories. Fourth—the society is characterized by a relatively low awareness concerning harmful effects of asbestos waste for human health and life, dangers resulting from improper procedures, particularly in the context of releasing harmful substances caused by atmospheric conditions. All these factors make the fight with asbestos still present and important.

It must be emphasized once again, that to achieve the goals of various programs accepted to remove asbestos from the country one must intensify the efforts in making complete lists of asbestos occurrence, implement new financial mechanisms supporting communes and private persons encouraging them to remove asbestos materials, educate and raise awareness of both—self-government authorities, local societies and entrepreneurs. Without this complex look at the problem of asbestos existence we will not achieve for long successful results and harmful asbestos activity will be still felt by generations of 22nd century.

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