

ENVIRONMENTAL MONITORING SYSTEM OF THE CITY OF SŁUPSK – QUALITY AND CLEANLINESS OF AIR

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ABSTRACT

Recent studies and reports on cleanliness and quality of air indicate that Poland belongs to a group of European Union countries where air pollution is at one of the highest levels.¹ Low air quality in many areas of Poland should be considered not only in the context of environmental destruction, but also in the context of the developmental negligence of the country in the context of the care of ecology. This article summarizes the results of research into the scale of threats regarding air quality occurring locally in the city of Słupsk. The paper also discusses the scale of air pollution-related risks and their consequences for the life and health of the individual.

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¹ A. Dworakowska, *Jakość powietrza w Polsce na tle Unii Europejskiej*, “SmogLAB”, 12 October 2016, <https://smoglab.pl/jakosc-powietrza-w-polsce-na-tle-unii-europejskiej/> (accessed 4.05.2020).

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INTRODUCTION

Along with Europe's economic development increases the risk of environmental pollution. Despite the efforts of central and local government administrations, pollution exceeds the norms. Regardless of the intensified policy aimed at reducing environmental pollution, Poland lags behind Western Europe. Thanks to the use of EU funds over the last decade, Poland has managed to make considerable progress "in the field of water management, and in recent years waste management has also been regulated".² However, throughout Poland's membership in the EU and before, the issue of air protection was not raised. Air quality was not a focal point to the members of European Union.³ National air protection policy is based on ad hoc action, so it can be concluded that it is largely reactive. Although the level of air pollution generated by industry and energy has been severely reduced, unfortunately, this has happened not so much because of the local policy, but because of successively introduces EU directives. A large gap can be seen in the private sector, where there is a lack of "any regulation in household installations, i.e. all kinds of solid fuel fires furnaces and boilers, or fireplaces".⁴ Another problem is neglect in the field of motor transport. The lack of ministerial supervision over the requirements for exhaust from motor transport is no less dangerous for the health and life of residents than dust from municipal furnaces.⁵

According to industry services and non-governmental agencies, the above negligence has led to the fact that "Polish air is among the most polluted in the entire European Union, and both Community and Polish law on

² *Ibidem.*

³ T. Młyński, *Bezpieczeństwo energetyczne i ochrona klimatu w drugiej dekadzie XXI wieku*, Kraków 2017, p. 30.

⁴ A. Dworakowska, *Jakość powietrza...*, *op. cit.*

⁵ M. Treder, *Smog zagrożeniem bezpieczeństwa zdrowotnego w Polsce*, "Rocznik Bezpieczeństwa Międzynarodowego", 2017, no. 11, p. 191.

air quality standards has been broken for over 10 years”.⁶ Polluted air is a growing problem and a real threat to the inhabitants of the entire world.

When analyzing documents in the field of crisis management of the city of Słupsk, one can see that the threat grid does not include the threat of polluted air.

BASIC AIR QUALITY DETERMINANTS AND THEIR RISKS TO HUMANS

Data from the report⁷ of the European Environmental Agency indicate that “the biggest problem with air pollution in Poland is related to polycyclic aromatic hydrocarbons and particulate matter known as PM10 (particles with a diameter of less than 10 micrometers)”.⁸ Another threat regarding Polish air is even finer “dust fraction designated as PM2.5, consisting of particles with a diameter less than 2.5 micrometers”.⁹ Unfortunately, it is clear from EU statistics that Poland is a leader among EU countries in this respect.

According to *Air quality in Europe – 2017* report, in other countries the standards set by EU law are not exceeded as often as in Poland. Standards are exceeded several times or even more.¹⁰ In this paper, the authors take into account indicators relevant in determining air quality, namely:

- PM10
- PM2.5
- aromatic hydrocarbons (PAHs)

In the paper, the authors provide a summary of data on air pollution in Poland “with particulate matter (PM10 and PM2.5 fractions), polycyclic aromatic hydrocarbons, nitrogen dioxide, and ozone”.¹¹ To understand the

⁶ P. Łyczko, *Jakość powietrza w Polsce na tle Unii Europejskiej*, “Małopolska w zdrowej atmosferze”, 13 September 2017, <https://powietrze.malopolska.pl/baza/jakosc-powietrza-w-polsce-na-tle-unii-europejskiej/> (accessed 4.11.2018).

⁷ European Environment Agency, *Air quality in Europe – 2017 report*, EEA Report No 13/2017, Luxembourg 11 October 2017, DOI 10.2800/850018. The European Environment Agency’s report shows an assessment of emissions of pollutants into the atmosphere in Europe, their concentration and the related effects on health and the environment.

⁸ E. Fraszczyńska, *Niska emisja – wysoka szkodliwość*, “Zespół Parków Krajobrazowych Województwa Łódzkiego”, <https://parkilodzkie.pl/spk/aktualnosci/627-niska-emisja-wysoka-szkodliwosc#!>, (accessed 4.05.2020).

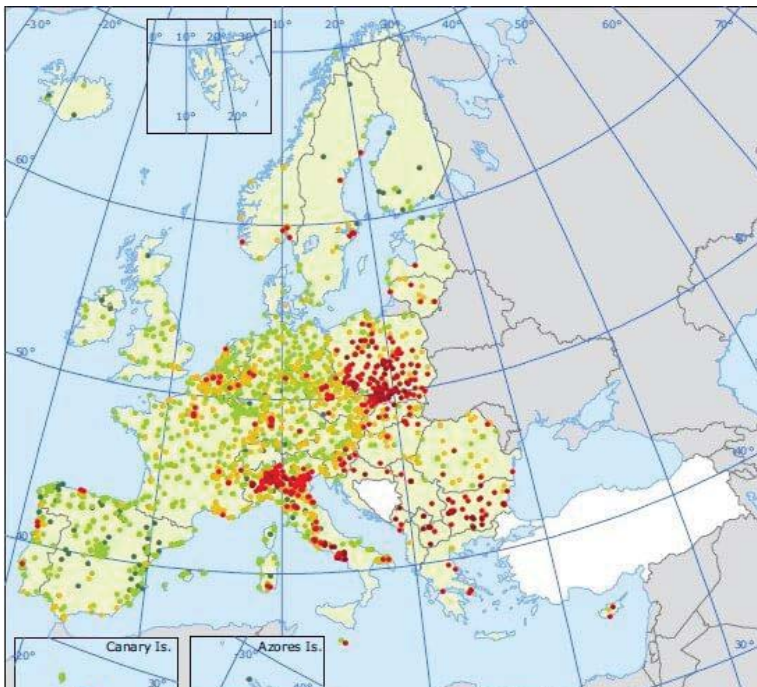
⁹ *Ibidem*.

¹⁰ P. Łyczko, *Jakość powietrza...*, *op. cit.*

¹¹ A. Dworakowska, *Jakość powietrza...*, *op. cit.*

essence of the local air quality problem, national data were correlated with data from the local environment. This approach allows for drawing correct conclusions and for comparing the degree of air pollution with these substances with the degree in other Member States of the European Union. The conclusions allow to indicate how the above threats affect the level of security, taking into account the Crisis Management Plan of Słupsk Poviak.

FIG. 1. CONCENTRATIONS OF PARTICULATE MATTER IN EUROPEAN COUNTRIES IN 2017



Source: European Environment Agency, *Air quality in Europe – 2018 report*, EEA Report No 12/2018, Luxembourg 29 October 2018, DOI 10.2800/777411.

What is particulate matter? According to the definition of industry websites, “dust consists of a mixture of organic and inorganic substances”.¹² It may contain toxic substances, such as “polycyclic aromatic hydrocarbons (e.g. carcinogenic benzo[a]pyrene), transition and heavy metals and their compounds, as well as dioxins and furans”.¹³

¹² P. Łyczko, *Jakość powietrza...*, *op. cit.*

¹³ *Ibidem.*

TABLE 1. EFFECTS OF AIR POLLUTION ON THE HUMAN BODY

EFFECTS OF AIR POLLUTION ON THE HUMAN BODY - EFFECTS ON:		
Foeti	Children	Adults
<ul style="list-style-type: none"> - higher risk of prematurity - weaker functioning of the immune system later in life - lower birth weight, height, lung capacity and head circumference - weaker intellectual development later in life - higher risk of fetal death 	<ul style="list-style-type: none"> - higher level of anxiety and depressive behaviour - problems with memory and concentration - anatomical changes in the brain - decrease in intelligence quotient - asthma 	<ul style="list-style-type: none"> - asthma - stroke - vein thrombosis - hypertension - heart failure - arrhythmias - increased risk of suicide - chronic obstructive pulmonary disease - increased risk of Alzheimer's disease in old age - ischemic heart disease - myocardial infarction - infertility - depression - lung cancer

Source: *Wpływ zanieczyszczeń powietrza na ludzkie zdrowie*, "Dolnośląski Alarm Smogowy", n.d., <http://dolnoslaskialarmsmogowy.pl/zdrowie.php?dzial=2&kat=14&art=1> (accessed 11.10.2018).

As it can be seen, air quality is not only a threat to the current state of health, but also has many long-term consequences.

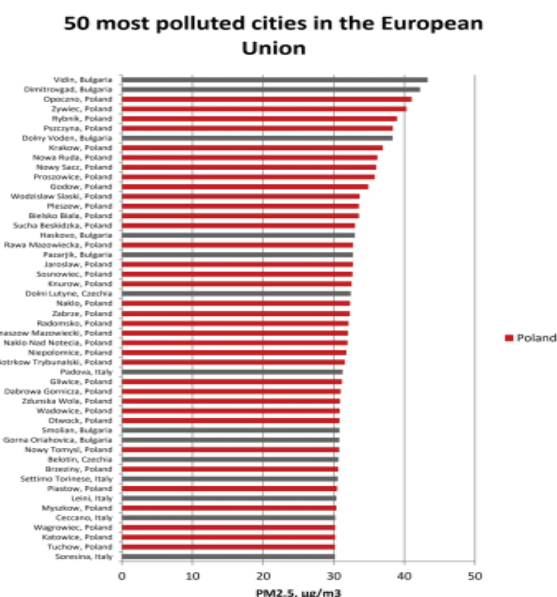
Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on air quality and cleaner air for Europe, hereinafter referred to as the CAFE Directive, introduced two standards for PM10 and PM2.5 particulate matter.¹⁴ The directive applies to the average annual concentration: according to it, the maximum permissible annual concentrations of PM10 dust fraction in the air are up to 40 µg/m³. In addition, a norm is established for daily average concentration – 50 µg/m³; the permissible number of days in a given year in which such concentration may occur is 35.

¹⁴ *Directive 2008/50/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe*, <https://eur-lex.europa.eu/legal-content/PL/TXT/?uri=CELEX%3A32008L0050> (accessed 4.05.2020).

The situation is different for PM_{2.5} dust fractions. The CAFE Directive sets only the standards for the average annual concentration – 25 µg/m³.¹⁵ It should be emphasized that neither EU nor Polish law establishes a daily standard for PM_{2.5} dust fractions. The only document regulating this fraction is World Health Organization's guidelines.¹⁶ WHO reports that the average annual concentration of PM₁₀ should not exceed 20 µg/m³.

In Figure 2, one can see how many days a year the daily standards of PM_{2.5} are exceeded at selected stations. As it can be seen, the cities from Poland and Bulgaria lead the way.¹⁷

FIG. 2. RANKING OF 50 LOCATIONS WITH THE HIGHEST PM_{2.5} PARTICULATE MATTER POLLUTION IN 2019 (NORM: 25 µg/M³)



Source: L. Myllyvirta, E. Howard, *Five things we learned from the world's biggest air pollution database*, "Unearthed", 2.05.2018, <https://unearthed.greenpeace.org/2018/05/02/air-pollution-cities-worst-global-data-world-health-organisation/> (accessed 25.08.2020).

¹⁵ *Ibidem*.

¹⁶ World Health Organization, *WHO Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide. Global update 2005. Summary of risk assessment*, Geneva 2006.

¹⁷ *Europe's Polluted Cities*, "The New York Times", 15 October 2013, <https://archive.nytimes.com/www.nytimes.com/interactive/2013/10/15/business/international/europe-air-quality.html> (accessed 4.11.2018).

As one can see, Polish cities are at the forefront. What is worrying, as many as seven Polish cities are in the top ten. In Krakow, PM10 concentration norms were exceeded on 151 days, the remaining cities did not give way significantly, because the exceedances reached 120 days. This means that the cities alternately exceeded EU directives by an average of 85 days.

In Słupsk, measurements show that despite relatively good air quality in the period from 2012 to 2017, daily concentrations reached $172.1 \mu\text{g}/\text{m}^3$, with an average concentration of $25.45 \mu\text{g}/\text{m}^3$.¹⁸ In the case of PM 2.5 fractions, the daily concentrations reached $96 \mu\text{g}/\text{m}^3$, with an average concentration of $14.6 \mu\text{g}/\text{m}^3$.¹⁹

In addition to PM10 and PM2.5, the highest concentration also applies to benzo[a]pyrene (BaP). “BaP is a carcinogenic and mutagenic compound that exhibits high chronic toxicity, which is related to its ability to accumulate in the body”.²⁰ European standards allow a limit for average annual BaP concentration of $1 \text{ ng}/\text{m}^3$.²¹

The biggest contrast between Poland and other Member States occurs in the case of benzo[a]pyrene. The figure below shows the average national concentrations for individual EU countries. There is a huge difference between Poland and other countries of the community.

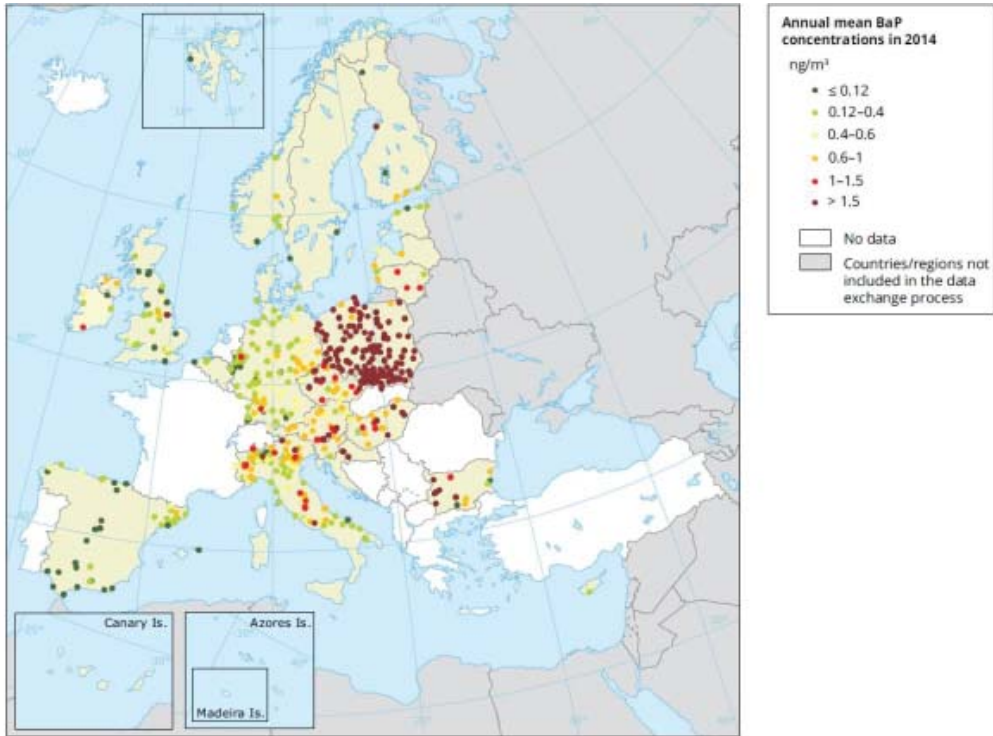
¹⁸ *Bank danych pomiarowych*, “Główny Inspektorat Ochrony Środowiska”, n.d., <http://powietrze.gios.gov.pl/pjp/archives> (accessed 4.11.2018).

¹⁹ *Ibidem*.

²⁰ P. Łyczko, *Jakość powietrza...*, *op. cit.*

²¹ *Directive 2004/107/EC of the European Parliament and of the Council of 15 December 2004 on arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons in ambient air*, <https://eur-lex.europa.eu/eli/dir/2004/107/oj> (accessed 27.08.2020).

FIG. 3. ANNUAL BENZO(A)PYRENE EXCEEDANCES IN 2016 AVERAGED FOR ALL URBAN BACKGROUND MEASURING STATIONS IN INDIVIDUAL EU COUNTRIES



Source: European Environment Agency, *Air quality in Europe – 2016 report*, EEA Report No 28/2016, Luxembourg 23 November 2016, DOI 10.2800/80982.

AIR PURITY LEVEL IN SŁUPSK

According to the document *The Environmental Protection Programme for the City of Słupsk for 2016–2020 with a perspective for 2021–2024*²², the city of Słupsk is located in the Pomeranian atmospheric air quality monitoring zone.²³ The report is based on periodic air quality tests, carried out by Gdańsk Voivodeship Environmental Protection Inspectorate as part of the State Environmental Monitoring.

²² *Programy ochrony środowiska*, "Urząd Miejski w Słupsku – Biuletyn Informacji Publicznej", n.d., <http://bip.um.slupsk.pl/dokumenty/829.html> (accessed 4.05.2020).

²³ *Ibidem*, p. 12.

In accordance with the *Act of 27 April 2001 – Environmental Protection Law* (Journal of Laws of 2013, item 1232, as amended), the Pomeranian Voivodeship Inspector of Environmental Protection assessed the level of substances in the air in the zones of the Pomeranian Voivodeship.²⁴

According to the guidelines of the above law, each zone was categorized into one of the seven classes:

TABLE 2. CLASSIFICATION OF THE ZONES OF THE POMERANIAN VOIVODESHIP REGARDING THE AMOUNTS OF SUBSTANCES IN ATMOSPHERIC AIR

No.	Class	Norm
1.	A	does not exceed the permissible level
2.	A2	does not exceed the target level
3.	B	between the limit level and the limit level plus a margin of tolerance
4.	C1	exceeds the limit level plus a margin of tolerance
5.	C2	exceeds the target level
6.	D1	does not exceed the level of the long-term goal
7.	D2	exceeds the level of the long-term goal

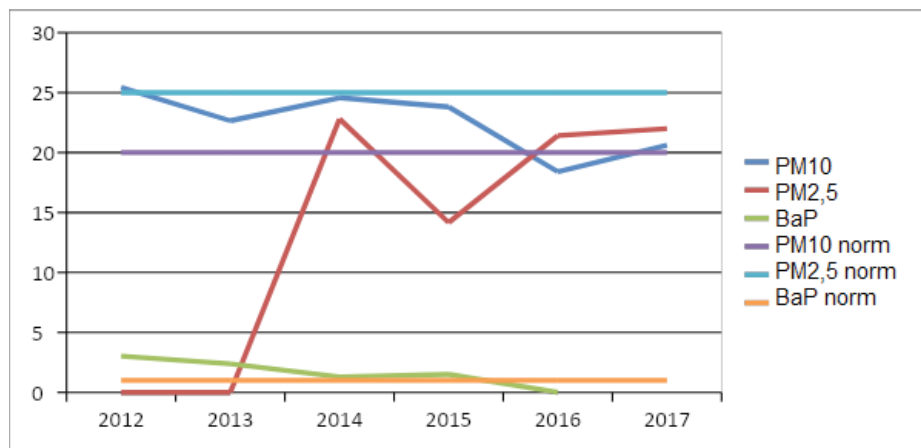
Source: own study on the basis of: *Programy ochrony środowiska*, “Urząd Miejski w Słupsku – Biuletyn Informacji Publicznej”, n.d., <http://bip.um.slupsk.pl/dokumenty/829.html> (accessed 4.05.2020).

In 2018, measurements were carried out in only one station in Słupsk. The research was conducted in automatic and manual mode. The measurements of air quality concerned the concentrations of “sulphur dioxide, nitrogen dioxide, oxides of nitrogen, ozone, PM10 and PM2.5 particulate matter, and carbon monoxide”.²⁵ Figure 4 presents the average annual concentration of the above mentioned components in the air.

²⁴ *Ibidem*, p. 89.

²⁵ *Ibidem*, p. 90.

FIG. 4. AVERAGE ANNUAL CONCENTRATION OF SUBSTANCES IN SŁUPSK IN 2018



Source: own study on the basis of: *AIRPOMERANIA: Raporty z danych manualnych*, "Air Pomerania", <https://airpomerania.pl/raporty/index/> (accessed 22.02.2020).

When analyzing the data, it can be seen that despite the decrease in the average annual concentration, the standards are increasingly exceeded daily and reach the level of PM10 $180 \mu\text{g}/\text{m}^3$, PM2.5 $80 \mu\text{g}/\text{m}^3$, and BaP up to $9 \text{ ng}/\text{m}^3$.

The annual air quality check, carried out for 2017 according to criteria established for the protection of health and plant protection, showed that the occurrence of benzo[a]pyrene, and PM10 and PM2.5 dust exceeds the standard. According to the data published by the Voivodeship Inspector of Environmental Protection in the years 2013–2017, air purity level in Słupsk regarding PM10 and PM2.5 was within class B and C1, which is relatively good outside the selected periods. In the scope of partial measurements from 2012 to 2017, daily concentrations reached $16.5 \text{ ng}/\text{m}^3$, reaching an average concentration of $3.9 \text{ ng}/\text{m}^3$.²⁶ This is an exceedance of the standard in the case of a maximum concentration by 1650%, while the average level is constantly exceeded by 390%.²⁷

It should also be noted that the assessment of air quality in Słupsk was carried out taking into account the impact of poor air quality on human

²⁶ *Bank danych pomiarowych*, "Główny Inspektorat Ochrony Środowiska", n.d., <http://powietrze.gios.gov.pl/pjp/archives> (accessed 4.11.2018).

²⁷ *Ibidem*.

and plant health. Unfortunately, Słupsk performed an annual analysis only in 2014–2016. The analysis conducted by the authors relates to the period 2013–2018. Therefore, the analysis for other pollutants such as sulphur dioxide, nitrogen dioxide and nitrogen oxide, ozone, benzene, carbon monoxide, metals (lead, arsenic, nickel and cadmium), showed no significant increases.²⁸ It can be concluded that the criteria for cleanliness and air quality have been met for these harmful substances.

SOURCES OF ATMOSPHERIC AIR POLLUTION IN SŁUPSK CITY

Słupsk has been dealing with the problem of air pollution for years. In the current reality, this means “any gaseous, solid or liquid substances that are in the atmospheric air and are not its natural components”.²⁹ This threat occurs when the emission of harmful substances in the air disrupts the composition of its natural ingredients.

Unfortunately, air pollution is particularly difficult to analyse. It is mainly due to the fact that the physical features of air pollutants somehow help them to move easily, due to which they can affect large areas and have an impact on environmental entities.

Słupsk, like any medium-sized city with aspirations to be a metropolis, struggles with characteristic atmospheric air pollution. According to the classification provided in *The Environmental Protection Programme for the City of Słupsk for 2016–2020 with a perspective for 2021–2024*³⁰ the main sources of air pollution are:

- the energy sector – i.e. the use of fossil fuels and the illegal combustion of plastics and other harmful substances,
- industry – the secretion of harmful substances in industrial production,
- transport – secretion of substances as a side effect of fuel burning.³¹

Despite the development of renewable energy technologies and an active promotional campaign, household chimneys are still the largest generators of harmful substances. Large clusters of people emitting large amounts of harmful substances pose a serious threat both to themselves and to their neighborhood.

²⁸ *Ibidem.*

²⁹ *Programy ochrony środowiska, op. cit.*

³⁰ *Ibidem.*

³¹ *Ibidem*, p. 93.

The time of year is also an important factor for the air quality. Comparing the periodic charts of the air composition, one can conclude that along with the change of the season, pollution changes. In heating seasons, a clear increase can be seen, which is due to the burning of fossil fuels, such as coal, in household furnaces, but also due to the use of outdated furnaces that are not equipped with modern ecological solutions. However, the problem is more complex, as its source is mainly the incineration of waste, especially of plastics, in domestic heating systems. Minimizing these sources of pollution is of interest to local authorities. This is illustrated by the example of Słupsk. Exhaust gas reduction is carried out by connecting homes to the municipal district heating and gas network, organising subsidy programmes for the modernisation of district heating systems, and promoting as well as encouraging the installation of other heating sources.³²

It should be noted that due to the developed district heating system and the gas network in Słupsk, most of the pollutants are generated during the generation of district heat and are on a realistically lower level than they would be if the current properties using this solution were heated by individual sources.

CONCLUSION

The above article merely provides a reason for further research on the relation between the state of cleanliness of the environment and personal safety. Air quality is closely linked to economic and environmental development. Air quality can be seen as an indicator of the degree of air pollution. Pollutants are all substances whose share in the atmospheric air exceeds norms for clean air.

The state of air purity is a serious challenge not only in Poland. Growing threat of climate changes caused indirectly by air pollution makes it necessary that Europe, as well as the world as a whole, must fight against this phenomenon. As it is shown in this article, Poland, alongside Bulgaria, is the largest emitter of harmful substances as compared to the rest of the European Union. The Organisation for Economic Cooperation and Development (OECD) in a recently published speech indicates “that by 2050 urban air pollution will be the leading environmental cause of death worldwide. Polluted air will pose a greater risk than the lack of adequate drinking water quality and lack of adequate sanitation”.³³

³² *Ibidem.*

³³ *Wpływ zanieczyszczeń powietrza..., op. cit.*

Lack of action by the local government to protect air is perceivable. In municipal and powiat communication channels (websites, social networks, bulletin boards, electronic boards in public space) there is no information about quality of atmospheric air. It also applies to general education about the impact of the polluted air on health or about how to protect health in case of high concentrations of pollutants in the air.

With this in mind, it is impossible to care for air quality without sensitizing the public to its effects. The problem lies in the approach to the threat by residents. Therefore, every step should be taken to better educate society so that it takes actions to reduce air pollution, including the use of heating fuels, restrictions on car traffic, etc.

It is worth emphasizing the appeals of activists fighting for clean air, aimed at making the voivodeship and powiat crisis management centers fulfil their statutory tasks more conscientiously, that is to notify about the risk of exceedance or actual exceedance of the permissible concentrations of pollutants in the air.³⁴ Unfortunately in most cases the institutions do not prioritise air pollution. Furthermore, according to an analysis of the activities of the Powiat Crisis Management Centre, alarms notifying of high air pollution usually do not reach places they should, i.e. places used by particularly sensitive members of society, that is kindergartens, schools or hospitals. This should become an information priority in the crisis management system. Only regular provision of information by the Voivodeship and Powiat Emergency Management Centers will mobilize the public to pay attention to the problem of air pollution. The conclusions of the above analysis make it possible to develop a thesis that the process of sending information should be fully automated and should not depend on the availability of an official. The information on exceedance of air purity standards should be included in the National Notification System. The creation of a separate system or the inclusion of this threat in the automated system could notify about dangerous situations through Government Centre for Security (GCS). Owing to this, messages sent from powiat crisis management centres could go to all hospitals, clinics, kindergartens, schools and the media, and can give a clear message to the public that this threat exists and has an impact on the safety of society. Such actions would be neither complicated nor costly, and they are necessary to protect health.

³⁴ *Ibidem.*

Another conclusion is that it is necessary to modernize air quality monitoring system by equipping it with automated PM10 and PM2.5 dust measuring stations. Today, most stations measure dust by gravimetric method.³⁵ The disadvantage of this solution is that the measurement result is available after a long period of time, usually after a few weeks.³⁶

Unfortunately, the example above shows that the current tendency is a loss of interest of the authorities in this issue. From 2001 to 2014, there were two measuring stations in Słupsk. Currently the system has been limited to one station for measuring substances such as PM10, PM2.5, CO₂, and O₃. As a result, the data obtained from measuring stations only show a certain trend and do not perform their basic function, that is informing the public about the current air pollution.³⁷ Equipping local research stations with automatic dust meters would not generate high costs. It would only require purchasing devices and integrating them with the current air monitoring system.

The environmental monitoring system is extremely dispersed. This is due to the fact that an array of institutions is monitoring various areas of the environment, which causes significant problems in the integration of the overall monitoring system and, consequently, trouble with obtaining complete information about the threat. The administration at the central and local level should strive to ensure that the system is consistent, and that it is not just a conglomerate of existing subsystems that cannot have a real impact on the processes of analysing, monitoring and lowering the level of security threats.

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³⁵ *Jak się mierzy pył zawieszony w powietrzu*, "Główny Inspektorat Ochrony Środowiska", 22 January 2016, <http://www.gios.gov.pl/pl/aktualnosci/315-jak-sie-mierzy-pyl-zawieszony-w-powietrzu> (accessed 10.11.2018).

³⁶ *Ibidem*.

³⁷ *Wpływ zanieczyszczeń powietrza...*, *op. cit.*

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