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The Role of the University in Environmental Education. The Problem of Particulate Pollution in Poland

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Abstract

University didactics determines the individual's place in the educational process as well as provides for a multidirectional continuing education which environmental protection is an important point. This discipline perfectly combines methods of working and scientific research. This paper describes particulates which are produced naturally and by anthropogenic sources. The influence of fossil fuel combustion on atmosphere conditions in a large urban agglomeration is shown. I discuss the causes of the high concentration of particulate matter pollution in Poland, which is tied to city planning and the development of the energy industry as well as the municipal and residential sector. The effects of introducing a ban on burning solid fuels in Krakow are reported.

Keywords: university, air pollution, particulate matter, energy

Introduction

The didactics of a modern university improve the process of planned and systematic organisation of knowledge, skills and social competences. Teaching provides the opportunity to acquire and apply knowledge in practice. It is also important in developing attitudes, worldview and mental processes. In the didactics of the university, attention is paid to the principles of the selection of methods and techniques. They provide a better understanding of research themes. The features of a modern school according to Dewey are taught by doing, practice and the searching didactic course (Schrade, 2010, p. 44).

Environmental protection is an important element of multidirectional education. Economic development consumes large amounts of energy and natural resources. The abuse of non-renewable energy resources leads to their exhaustion and widespread environmental pollution. An increased concentration of pollutants derived from the combustion of solid fuels can be observed, especially in metropolitan areas. Such pollution inflicts negative health and environmental effects on a regional and global scale (Karaczun, Obidowska, Indeka, 2016, p. 143).

The most common and hazardous pollutants include particulate matter. Suspended particulate matter is emitted by natural processes, such as volcanic eruptions, forest fires and earthquakes, and by anthropogenic processes, such as energy production, transportation, manufacturing and the agricultural industry (Janka, 2014, p. 6). The emitted pollutants react chemically in the air. This is especially dangerous when heavy metals and reagents are absorbed in the surface layer of these particles (Pałasz, 2016, p. 58).

The Total Suspended Particulates (TSP) consist of all airborne particles. The most common TSP classification is based on particle diameter (Janka, 2014, p. 3):

- PM_{10} – for particles up to 10 μm in diameter;
- $PM_{2.5–10}$ – for fine particulate matter between 2.5 μm and 10 μm in diameter;
- $PM_{2.5}$ – for superfine particulate matter with a diameter of less than 2.5 μm;
- PM_{1} – for submicron particulate matter with a diameter of less than 1 μm;
- $PM_{0,1}$ – for ultrafine particulate matter with a diameter of less than 0.1 μm.

Most air pollutants consist of particulate matter with a diameter greater than 2.5 μm. Their chemical composition depends on the location of the emitter. They may contain elements and chemical compounds, aerosols, bacteria, viruses, and moss. Their distribution in the environment depends on meteorological, topographic, and technical factors (Hys, Dumańska, Tworek, 2018, p. 14).

The Negative Effects of Air Pollution

Air pollution is addressed on a regional and/or global scale. For regional areas, anthropogenic sources emit particulates which have a detrimental impact on the health and life of local residents. The impact depends on the size of the particles and their chemical composition (Karaczun et al., 2016, p. 151, 168; Suszanowicz, Kolasa-Więcek, 2019, p. 2–6). Fine particles, smaller than 5 μm, penetrate the interstitial tissue of the lungs and enter the bloodstream. In addition, water in the environment is poisoned with heavy metals, which contributes to the extinction of animal species. Smog, both sulfuric and photochemical, could develop under special conditions and is highly toxic. We are faced with global pollution when it is felt all over the planet (Juda-Rezler, Toczko, 2016, p. 20). An example is a volcanic activity, which is particularly dangerous. Erup-

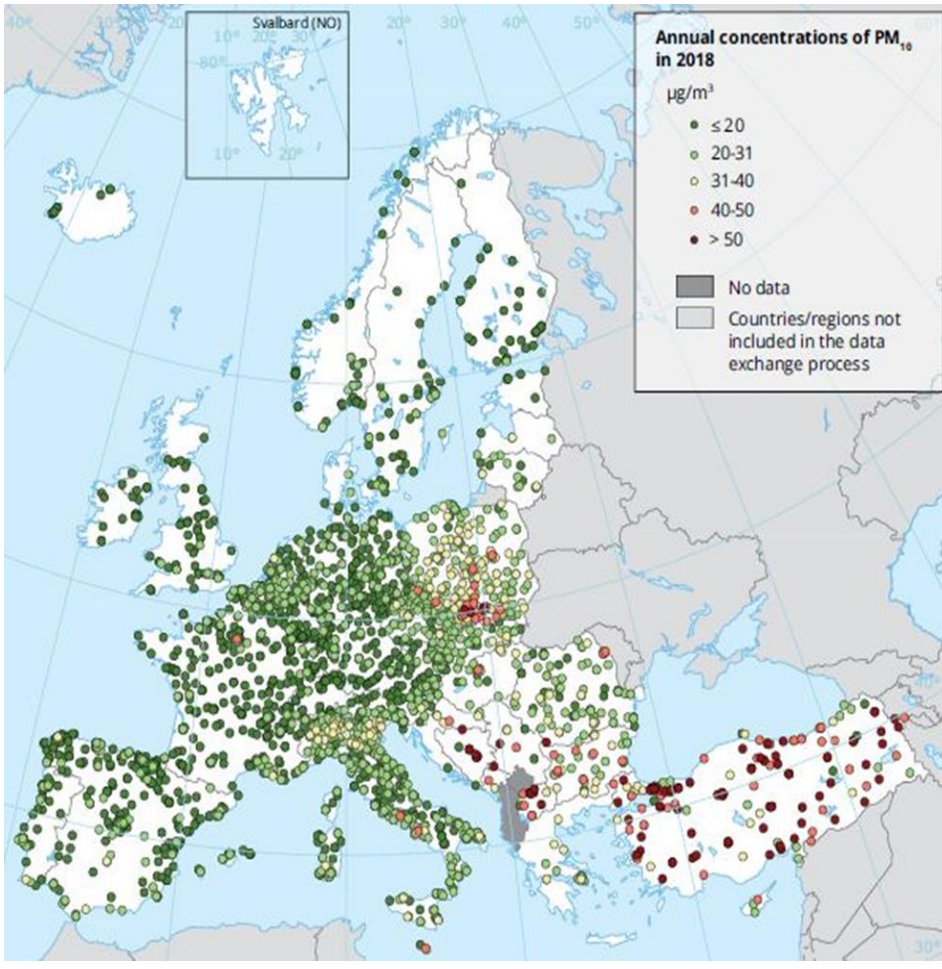
tions emit huge amounts of dust and gases into the atmosphere, resulting in pollutants that capture sunlight. The result of the process is a reduction in the surface temperature of the Earth commonly known as volcanic winter. An example is a volcanic eruption that emits vast amounts of pollutants which then absorb solar radiation. This process results in the reduction of the Earth's surface temperature. Such a phenomenon could include the eruption of the Tambora volcano (in 1815) which triggered a global disaster. The eruption's impact could also be observed in Poland (Picture 1). Negative temperatures during the summer led to the devastation of crops and famine (Plag, 2015).

Picture 1. The ash cloud of the Mount Tambora Eruption in 1815

Source: Plag (2015)

Polish Air Quality

Poland is one of the most polluted countries in Europe, as confirmed by Picture 2 which shows the measurements of the annual value of PM_{10} in 2018 taken by the European Environment Agency. In numerous locations in Poland, measurements ranged from 31–40 $\mu g/m^3$, and in the south of Poland, the measured values surpassed 50 $\mu g/m^3$ (EEA, 2020, p. 40).

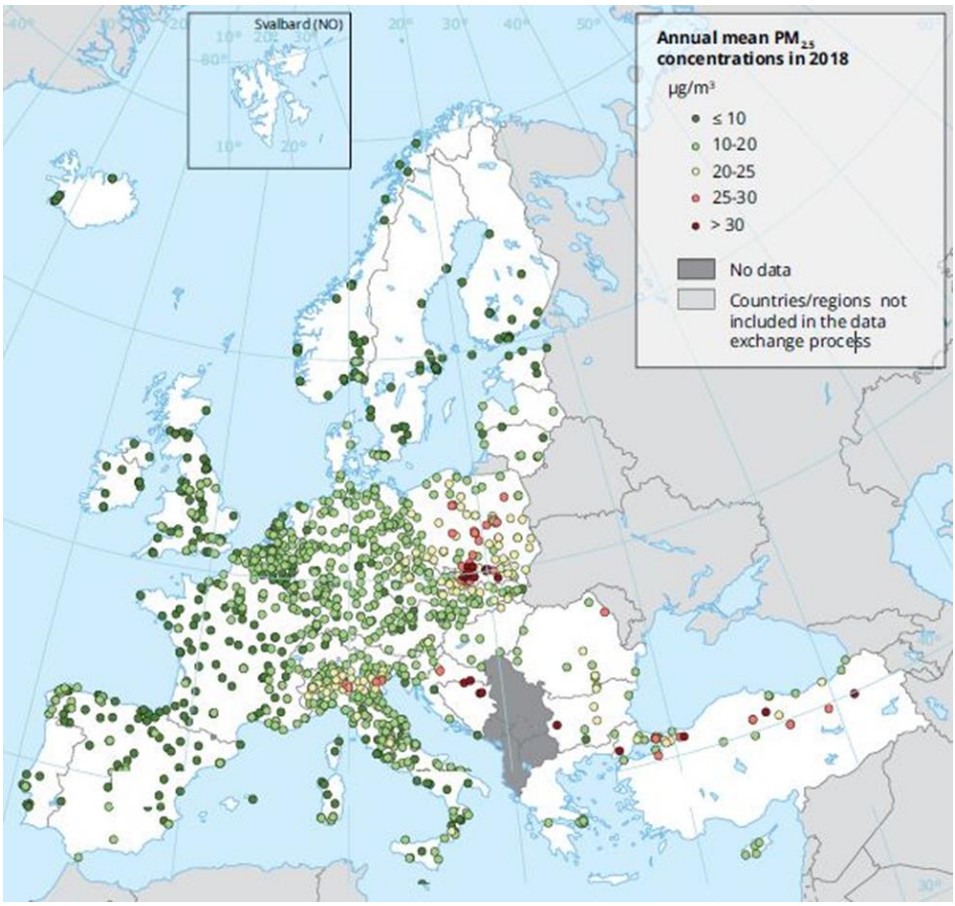


Picture 2. Annual concentrations of PM_{10} in 2018

Source: EEA (2020) p. 40

A similar situation appeared in the case of the annual $PM_{2.5}$ level in 2018 (Picture 3). The highest amount of pollution was observed in the southern part of Poland, amounting to over 25 µg/m^3 (EEA, 2020, p. 42; Kolasa-Więcek, Suszanowicz, 2019, p. 1337).

The average yearly values of PM_{10} and $PM_{2.5}$ particulates have exceeded the safe concentration levels defined by the World Health Organization: for PM_{10} it is up to 20 µg/m^3 and for $PM_{2.5}$ it is up to 10 µg/m^3. What is worth emphasizing is that it is difficult to define a threshold below which there are no negative consequences, because even very small amounts of particulates are detrimental to living beings (WHO, 2018).



Picture 3. Annual concentrations of $PM_{2.5}$ in 2018

Source: EEA (2020) p. 42

Energy in Poland

Bituminous coal is considered to be a strategic fossil fuel in Poland. The popularity of bituminous coal stems from its low price and easy availability. In 2018, the consumption of bituminous coal in Poland amounted to 74.2 million tons. This includes the professional energy sector, which consumed 59.9%, the industrial and construction sectors at 23.9%, and households at 13.5% (GUS, 2019, p. 11). For dispersed development, the construction of a district heating network or gas installation is not cost-effective because of high installation costs and energy losses. In such places, low-power heating boilers usually prevail, e.g. manually fired boilers, masonry heaters, and fireplaces, which often do not meet emission standards. As a result unchecked emissions of pollutants follow (Kleczkowski, 2020, p. 134, 135).

In the energy, utilities and household sectors, the formation of particulates is primarily associated with the combustion of solid fuels. During the combustion process, solid inorganic matter is carried up with the air flow. Emissions increase along with the increased supply of oxygen. One of the most important factors in this process involves the fuel combustion system, which reduces the amount of particulate matter that is emitted. Depending on the type of installation, the emission – which is the coefficient of particulate matter elevation – is proportional to the mineral content of the material used as a fuel (Wielgosiński, Zarzycki, 2018, p. 119).

An Ordinance Prohibiting the Combustion of Solid Fuels

Notably, Krakow has introduced a comprehensive ban on burning solid fuels, such as wood and coal, which are combusted in furnaces, boilers and fireplaces, which is regulated by the Anti-smog Act, an amendment to the Environmental Protection Act and the Air Protection Program. This obliges residents to change their heating system, to be based on natural gas, heating oil, electricity, or to be integrated with the city heating network. According to the restrictions, the inhabitants of Krakow were granted subsidies for the replacement of inefficient solid-fuel heaters, for more environmentally friendly heating systems. The program also relies on renewable energy sources, i.e. heat pumps or solar collectors (UMWM, 2019).

The solid fuel combustion ban and associated fines provide a good mechanism for reducing pollutant emissions in Krakow. Unfortunately, the problem of particulate matter pollution will continue to be raised by furnaces and boilers fired with solid fuels and located outside city limits. Considering that Krakow is located in a basin, significant particulate emissions from towns and villages located near the city are still observable. More than 40 thousand solid-fuel heaters and boilers were identified by means of an inventory. Consequently, the program of grants for the replacement of heating systems should cover the entire Cracovian metropolitan area (Ogórek, 2019).

Conclusions

The problem of particulate matter pollution in Poland is noticeable and stands out from other countries in Europe. Despite a ban on burning solid fuels in Krakow, there will still be a problem with the inflow of pollutants emitted from neighboring localities, where this ban will not be introduced. It is essential to raise ecological awareness and pro-ecological efforts such as the Low Emission Reduction Program to achieve the goal of reducing levels of particulate matter in the atmosphere. Above all, other communities struggling with the problem of air pollution should similarly follow the path taken by Krakow.

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