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SHORT COMMUNICATION

Evaluation of air quality in the Miechów district, Poland

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ABSTRACT

Air pollution with suspended dust is a major problem not only for large cities and urban-industrial agglomerations but also for areas without industrial plants. Specific areas include the Miechów district are located in the northern part of the Małopolskie voivodeship. The main source of dust air pollutants in the studied area are mainly anthropogenic emissions from the municipal and housing sector and also from public transport. The aim of the study was to assess air pollution with PM10 suspended dust in the season of the calendar year in the Miechów district, with reference to air quality standards applicable in Poland and in the European Union.

***Keywords*:** Miechów district, suspended dust PM10, air pollution, anthropogenic emission, smog

1. INTRODUCTION

The sudden progress of civilization which has been observed over the last decades, and with it the development of industry and progressive urbanization, have had a significant

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impact on the natural environment, causing its excessive contamination. The global environmental threats include, undoubtedly, atmospheric pollution, which due to the cross-border range lead to contamination of large areas and pose a health risk to the exposed population. [1-3] The aim of the study is to assess air pollution with suspended dust PM10 and PM2.5 in a typically agricultural area, deprived of industrial facilities. Results were based on measurements carried out by Airly company in the Miechów city, covering the period of a calendar year.

2. EXPERIMENTAL

2. 1. Research area

Figure 1. Miechów district- administrative division.
(Source : Official Miechów district website http://miechow.pl/page/_Gminy_w_powiecie/id=71 , status on 13th of September 2018).

The Miechów district is located in the northern part of the Małopolskie Voivodeship, by the national road E-7, at a distance of about 40 km from Cracow and 80 km from Kielce.

Administratively, the Miechów district consists of six rural communes and also one urban commune, and it covers an area of 667.73 km^2. Physically and geographically, it is located within the Miechowska Upland, sloping gently towards the south-east and cut in densely with numerous deep valleys. The Miechów district is drained by two main rivers: Nidzica river and Szreniawa river. The highest hill in the district is Biała Góra with an altitude of 414 m above sea level. The Miechów disctrict inhabits approximately 50.000 people with a population density of 73.2 people / km^2. Miechów is the largest city in the Miechów district. Larger units are located mainly close to major communication routes.[1-3]

2. 2. Climate and meteorological conditions

According to the climatic division of Poland, the Miechów district belongs to the climatic region of Śląsk and Małopolska. The average annual air temperature is from 7 °C to 8 C, at the coldest month - January (from -3 °C to -7 °C) and the hottest month of July (+ 19.7 C). Statistically, the winter lasts 92 days and the summer lasts 92 days. The number of sunny days in a year is 62, while the number of cloudy days is 122 days. The snow cover remains in place for about 80 days. Insolation in summer ranges from 550 to 600 hours, in winter is below 150 hours. The annual amount of rainfall is on average 610 mm, which is close to the national average rainfall. In the area of the Miechów district the western and north-western winds dominate. The average relative humidity of the air is about 81%, and the average vegetation period of plants is 210 days. It can therefore be said that the district belongs to warmer areas and is characterized by a moderate climate throughout the year. Such climatic conditions are conducive not only to the development of agricultural activity but also to the formation of pollutants concentration in a given area [4].

2. 3. Sources of pollutant emissions to the atmosphere

The Miechów district is agricultural area. In this district, there are different industrial and agricultural facilities. Activities which are carried out in these facilities cause air pollution by emission of dust and gases. The list of mentioned institutions includes:

- District Dairy Cooperative in Miechów,
- District Dairy Cooperative Production Branch in Charsznica,
- Prima – Car company with limited liability in Miechów,
- District Vehicle Control Station and Petrol Station in Miechów,
- Enterprise of Engineering and Road Works in Miechów,
- Saria Małopolska - company with limited liability in Gołcza,
- Establishment of Municipal Economy in Miechów,
- St. Anna Hospital in Miechów,
- Housing Cooperative ‘Przyszłość’ in Miechów.

Low emitters are the most significant in pollution of atmospheric air in the Miechów district, mainly coal combustion in municipal coal-fired boilers and home furnaces. The influence of obsolete and inefficient heating devices, inadequate condition of chimney installations, low quality of wood and coal as well as combustion in waste furnaces and boilers have a significant influence on air pollution. A characteristic feature of this source of pollution is its seasonal variability (Fig. 3.).

In heating periods, the emission of air pollutants increases. For this reason, it is advisable to carry out an inventory of furnaces in a given area.

The second type of pollution are substances originating from communication sources. The main substances emitted to the air from road transport include: nitrogen oxides, hydrocarbons, dust, benzo(a)pyrene and carbon monoxide. The upward trend of these substances is noticeable with the increasing number of vehicles on communication routes or the creation of traffic congestion. The most endangered in the Miechów district are the areas, which are located directly at the national road No. E-7, voivodeship road No. 783 and district roads with high traffic intensity. Periodic deterioration of air quality results, to a large extent, from the inflow of pollutants from outside the region, for example from the Cracow agglomeration. It also depends on a poor weather conditions even from the Śląsk agglomeration [4,5].

3. EVALUATION OF THE QUALITY OF ATMOSPHERIC AIR

In order to assess the air quality, the measured concentrations were compared to the values normalized in the Ordinance of the Minister for Environmental Protection, Natural Resources and Forestry of the day April 28, 1998 regarding the permissible concentrations in the air (Journal of Laws No. 55, later 355). In 2017, the Miechów district was included in class C due to over 24-hour norms of PM10 dust concentration in winter. In the case of other compounds such as: nitrogen dioxide, sulfur dioxide, lead, arsenic, cadmium, nickel, carbon monoxide, the district area has been classified as zone A. According to the classification for the criterion of plant protection, the district was classified to class A in 2017 [4].

On February 10, 2017, 'Airly' company installed six air quality sensors in Miechów. The Airly system is fully integrated – from the equipment to the software. Airly sensors enable to collect, process and interpret data in real time (specifically, the concentrations of particulate matter PM2.5 and PM10, temperature, air pressure and humidity). Based on this data, information about air quality is displayed on the online map.

The distribution of pollution sensors at various locations in the city would allow for spatial analysis of PM2.5 and PM10 dusts and would provide residents with knowledge about the state of air in the nearest surroundings. The measurement data is shown by means of a diode whose color corresponds to the current air pollution. In addition, the results are sent to the online platform. Research on the state of air pollution is carried out at the following measurement points located in Miechów:

I. 5 Krótka Street
II. 31 Jana Sobieskiego Street
III. 4 osiedle XXX-lecia PRL Street
IV. 17 Rynek Street
V. 2 Mikołaja Kopernika Street
VI. 1a Szpitalna Street

The air quality depends on the topography and area development level. According to the annual assessment of air quality in the Miechów district for 2017, the average annual concentration of particulate matter PM10 and PM2.5 was increased (Fig. 3). In relation to the results from the measuring stations, the lowest concentration of measured pollutants is on Jana Sobieskiego Street and Szpitalna Street (Fig.4) what results from the position of

measuring stations on steep slopes and higher wind speed that enable dispersion of pollutants. The most polluted air is on the Rynek Street and the osiedle XXX-lecia PRL Street. (Fig.4). The measuring stations are located along communication routes and there is a lot of buildings around them, which significantly hinder the exchange of air and the wind speed , in this areas, is effectively reduced

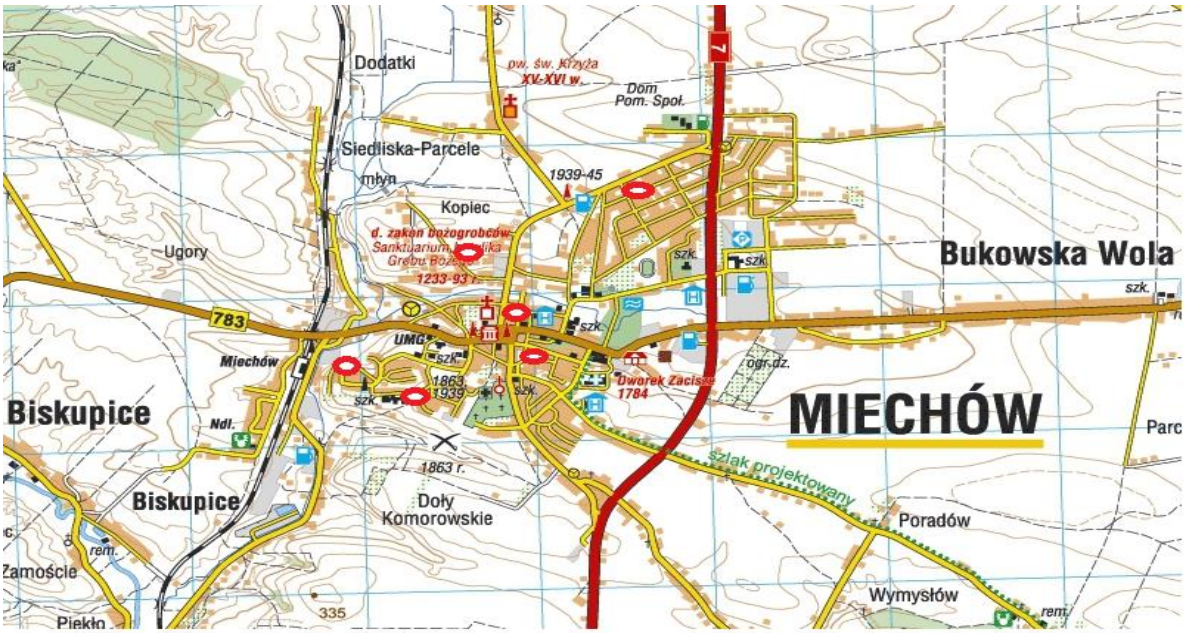

Figure 2. Location of measurement points in Miechów.
(Source: http://www.compass.home.pl/klient/!Sklep/Zoomify/WyzMiech_14.html , status on 13th of September 2018)

Acceptable level of 40 µg /m^3 is a limit value according to Regulation of the Minister of the Environment of August 24, 2012 on the levels of certain substances in the air (Journal of Laws of 2012, item 1031).

Two maximum and minimum in the daily course of the concentration of pollutants were observed at all measuring stations. Morning maximum (9:00 - 11:00 a.m.) is associated with heating houses and apartments at that time and with increased air circulation. Evening maximum (08.00 - 12:00 p.m.) is associated with the fact of heating apartments and houses. In the afternoon, minimum associated with the development of convection is observed. In the annual cycle, two seasons can be distinguished: heating season (a large amount of pollution - especially in winter) and season without heating (Fig. 3).

The most important meteorological factors which conducive to the accumulation of pollutants in the studied area are: low temperatures in winter and high in the summer, stable atmosphere, high atmospheric pressure and low wind speed.

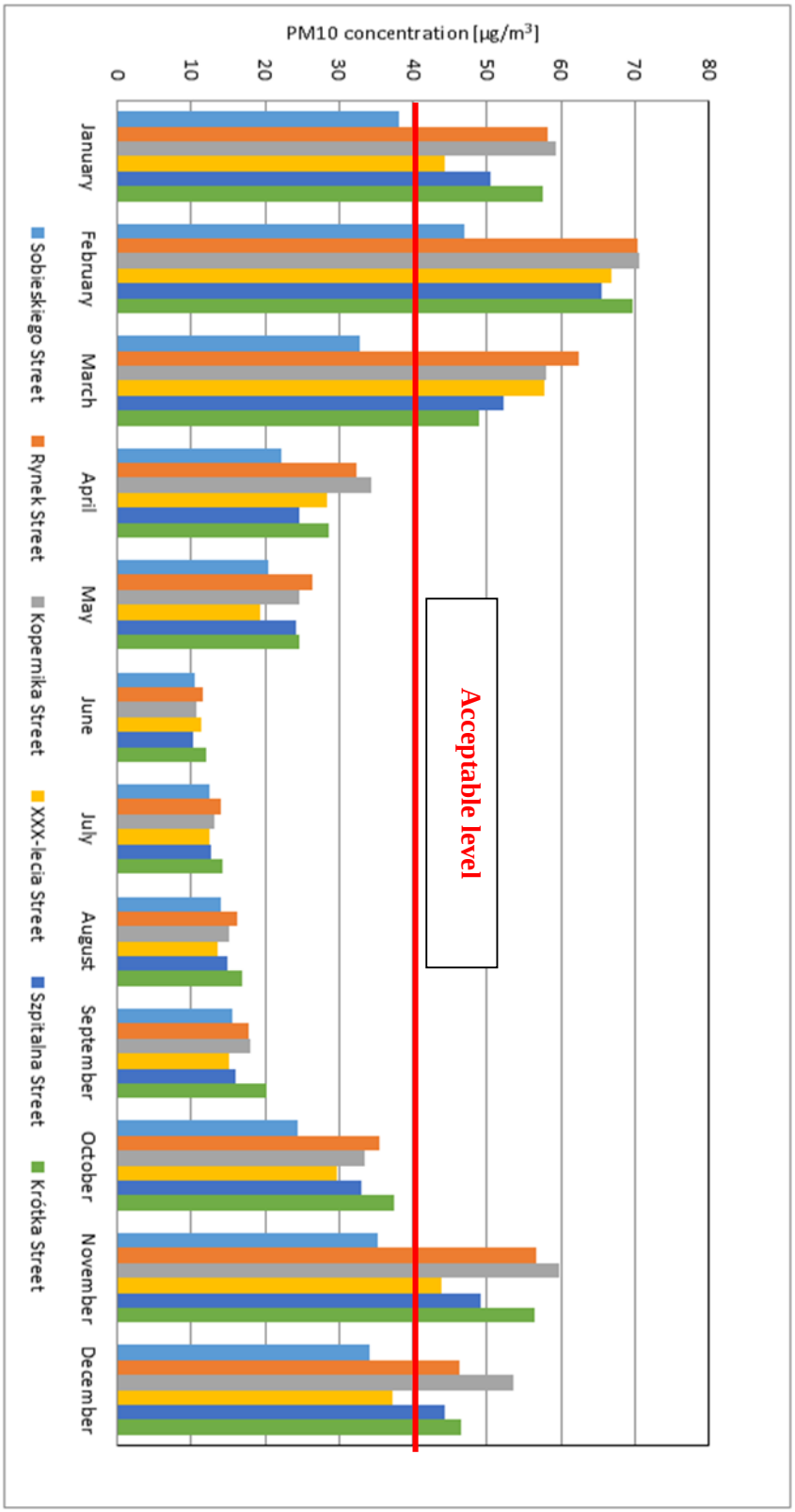

Figure 3. Average annual PM10 particulate matter concentration in Miechów at the turn of 2017-2018.

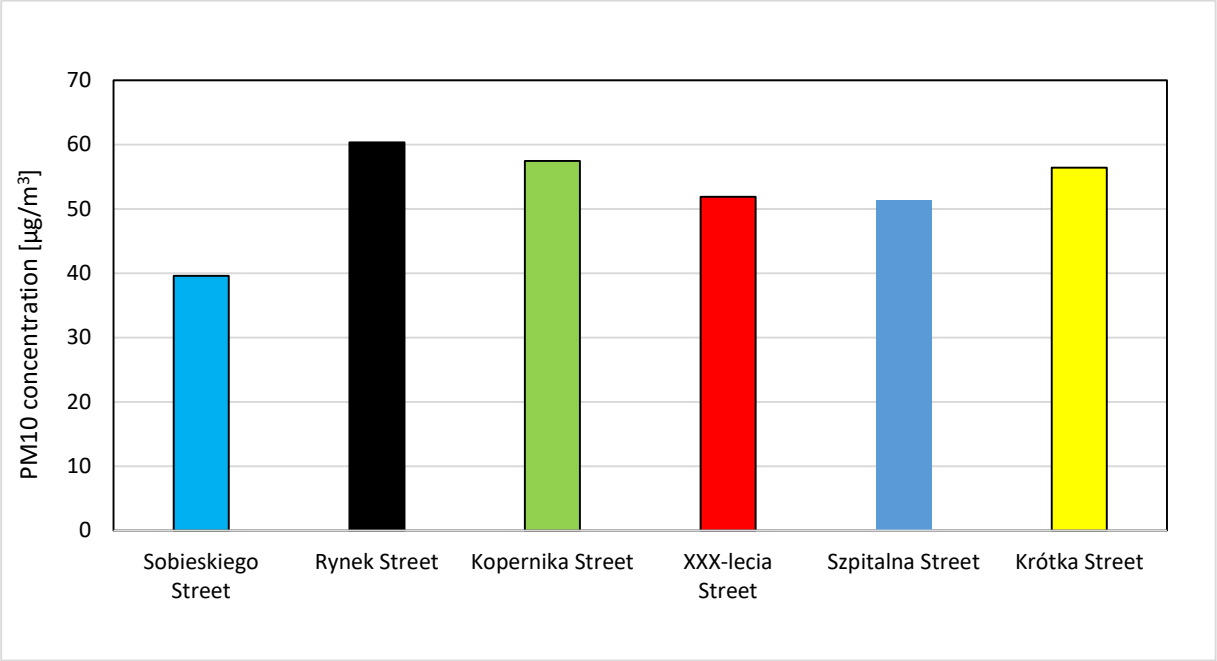

Figure 4. Average annual PM10 particulate matter concentration in Miechów in 2017.

3. CONCLUSIONS

Analysis of the air pollution with PM10 and PM2.5 suspended dust revealed that there are unfavorable emission and immission conditions in the district, resulting in excessive concentrations of particulate matter which remain for a long period of time. The Miechów district belongs to typically agricultural districts. It is devoid of industrial facilities that cause air pollution by emission of dust and gases. Low emission from local heat sources, both from the boiler room of companies and municipal facilities as well as boiler rooms located in individual residential buildings, significantly affect the air quality.

This is evidenced by the fact that much higher concentrations of particulate matter occur in the heating season than in the summer season (Fig. 3, Fig. 4).

Significant effects in the field of air quality protection can be obtained by adopting the following directions of activities:

- development of an air protection program,
- limitation of transport and traffic,
- reducing low emissions through the modernization of local coal-fired boilers and furnaces burning coal,
- thermomodernization of buildings which constitute communal property,
- modernization and encapsulation of production processes to reduce emissions,
- promotion of boiler rooms using alternative energy sources [5,6].

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