THE LEVEL OF AIR POLLUTION WITH SULPHUR DIOXIDE IN THE CITY OF ORADEA IN 2020-2022

Nandor KÖTELES[1#], Ana Cornelia PEREŞ[1], Laviniu Ioan Nuţu BURESCU[1]

**University of Oradea, Faculty of Environmental Protection, Gen. Magheru st., no.26, 410048, Oradea, Romania, e-mail: kotelesnandor@yahoo.com*

RESEARCH ARTICLE

Abstract

The objective of this paper is to analyse the level of atmospheric pollution with sulphur dioxide (SO_2) in the city of Oradea over a period of three years (2020 - 2022). The paper was compiled using data measured by the Environmental Protection Agency, the body that monitors air quality in Romania. The stations for sampling atmospheric pollutants, including sulphur dioxide, are located in strategic locations, namely: BH_1 at the headquarters of APM Bihor, which is an urban station, BH_2 in Episcopia Bihor, which is a neighbourhood in Oradea and is an industrial station, and BH_3 located in the Nufărul neighbourhood, which is a traffic station. In Oradea, the main source of nitrogen dioxide (SO_2) pollution is domestic, because during the cold season many homes still do not use methane gas, and to a lesser extent, emissions from diesel engines.

Keywords: sulphur dioxide, monitoring, sampling points.
#Corresponding author: kotelesnandor@yahoo.com

INTRODUCTION

Sulphur dioxide (SO_2) is a significant pollutant, a colourless gas with a pungent odour that plays an important role in the formation of acid rain. It is used in many industries, including the food industry in the food preservation process.

Natural sources of sulphur dioxide pollution include volcanic eruptions, the decomposition of organic matter and the combustion of vegetation containing sulphur compounds.

Anthropogenic sources are those resulting from the burning of fossil fuels such as coal-fired power plants, oil refineries, and industrial furnaces.

It also plays an important role in the formation of acid rain, which occurs when large amounts of sulphur dioxide are emitted into the atmosphere and react with oxygen in the atmosphere to form sulphur trioxide SO_3. Sulphur trioxide reacts with water in clouds to form sulphuric acid (H_2SO_4). Acid rain can have negative effects on soil health, aquatic ecosystems, and the corrosion of limestone, marble, and concrete structures.

Among the immediate and visible effects of sulphur dioxide on the human body are respiratory problems. If inhaled, it can irritate the nose, throat and respiratory tract. It can trigger asthma attacks in sensitive individuals.

Sulphur dioxide also has a negative effect on plants by damaging their structure and tissues. Plants that are highly sensitive to SO_2 include pine trees, vegetables, ash trees, alfalfa, etc.

MATERIAL AND METHOD

The data used in this paper was provided by the Bihor Oradea Environmental Protection Agency. There are three atmospheric air sampling stations in Oradea, where sulphur dioxide and other pollutants are monitored. The BH_1sampling station is located on the premises of the APM headquarters and is an urban station, BH_2 is located in the Episcopia Bihor neighbourhood and is an industrial station, and $BH_3$is located in Nufărul and is a traffic station (www.apmbh.ro).

The period analysed in this paper was three years, from 2020 to 2022, and the data was processed using statistical and mathematical methods. The results obtained were then plotted graphically to clearly highlight the variability of atmospheric pollutants over time.

The reference method for measuring sulphur dioxide is that provided for in standard SR EN 14212 'Ambient air. Standardised

method for the measurement of sulphur dioxide concentration by ultraviolet fluorescence'.

According to Law No. 104 of 15 June 2011 Sulphur oxides (SO_2) - the alert threshold is 500 ug/m³ (measured over 3 consecutive hours at points representative of air quality for an area of at least 100 km²);

Limit values 350 ug/m³ SO_2 – hourly limit value for the protection of human health and 125 ug/m³ daily limit value for the protection of human health (https://www.calitateaer.ro).

RESULTS AND DISCUSSIONS

Annual evolution of sulphur dioxide concentration

Following the analysis of sulphur dioxide (SO_2) concentrations throughout 2020, we can conclude that the highest concentration was recorded at the BH_3monitoring point in Nufărul, at 10.37 µg/m³. At the BH_2sampling station in Episcopia Bihor, 9.70 µg/m³ was recorded, and the lowest SO2 concentration was recorded at BH_1 (8.58 µg/m³).

During 2021, the average annual concentration was similar to that in 2020, with the highest concentration recorded in Episcopia Bihor, at the BH_2 sampling point. This was followed by the sampling station in Nufărul BH_3 (10.53 µg/m³), and at the APM BH_1 headquarters it was 8.48 µg/m³.

The SO_2 concentrations determined in 2022 are consistent with those in 2020 – 2021, with the highest concentrations measured at the BH_2 sampling point located in Episcopia Bihor 13.20 µg/m³ and 10.06 µg/m³ at the APM headquarters.

A lower concentration of sulphur dioxide was determined at the sampling point in Nufărul BH_3 7.66 µg/m³ (Fig.1).

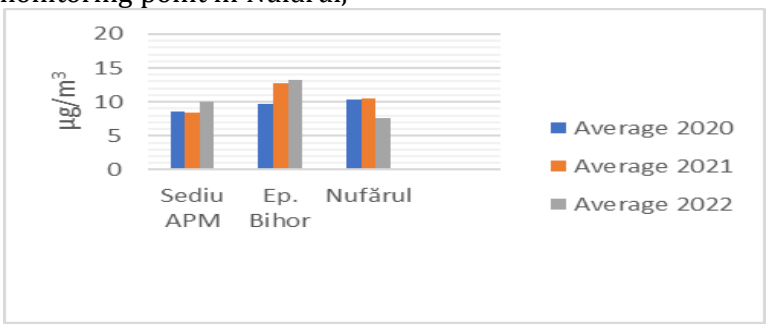

Figure **1 Evolution of annual average SO_2concentrations (µg/m³) at monitoring points in Oradea, between 2020 and 2022**

Monthly evolution of sulphur dioxide concentrations

From the monthly evolution of SO_2 concentrations throughout 202, it appears that the highest value was recorded in September at 26.87 µg/m³, (at the BH_3station in Nufărul) and in October 18.07 µg/m³ also measured at the BH_3 station in Nufărul. A higher concentration was also measured in January, 13.55 µg/m³ at station BH_1 at the APM headquarters (Fig. 2).

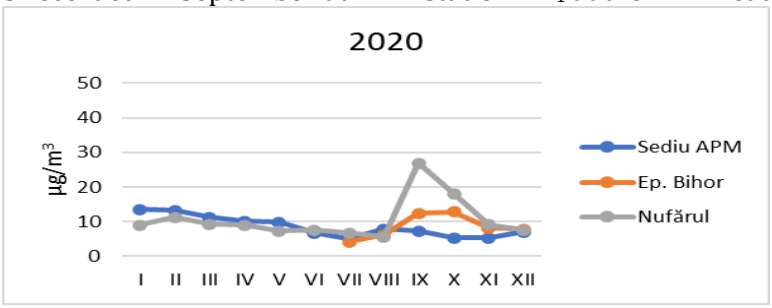

Figure **2 Evolution of monthly average SO_2 concentrations (µg/m³) at monitoring points in Oradea in 2020**

The sulphur dioxide concentration values for 2021 were measured in November 26.15 µg/m³ at the sampling station in Episcopia Bihor BH_2, March 19.78 µg/m³ at the sampling point BH_3 and July 16.16 µg/m³ at the sampling point BH_3 (Fig. 3).

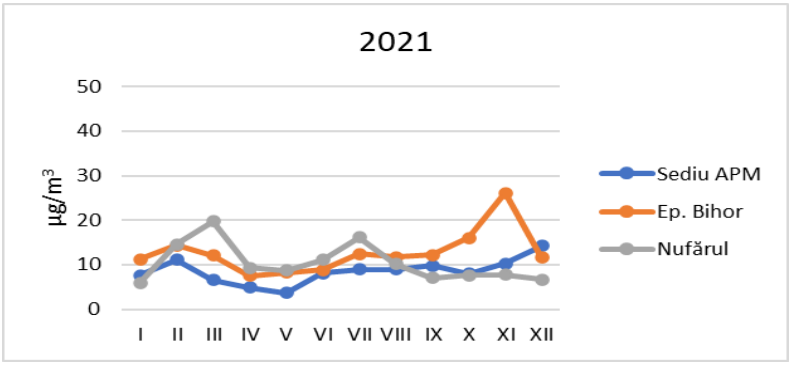

Figure. **3 Evolution of monthly average SO_2 concentrations (µg/m³) at monitoring points in Oradea in 2021**

During 2022, due to technical malfunctions, SO_2 concentration monitoring was carried out until June. The highest values were reached in February and January, 14.72 µg/m³ and 12.47 µg/m³ respectively, at the BH_2 Episcopia Bihor station (Fig. 4).

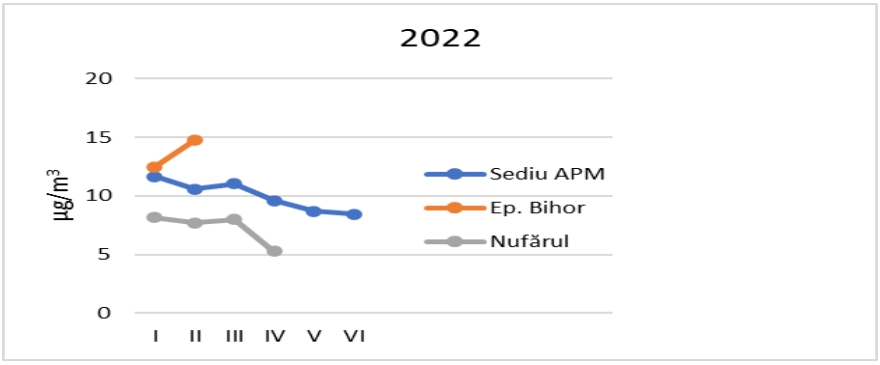

Figure. **4 Evolution of monthly average SO_2 concentrations (µg/m³) at monitoring points in Oradea in 2022**

Monthly evolution of sulphur dioxide in correlation with air temperature.

Thermal inversion, atmospheric calm and lack of precipitation are meteorological phenomena that can lead to the stagnation of sulphur dioxide in the area of emission sources.

The evolution of SO_2concentration (Fig. 5) shows that at lower temperatures, the concentration of nitrogen dioxide is higher. When temperatures are higher, the concentration of the gas is lower.

From the monthly evolution of sulphur dioxide, we can see that higher concentrations were recorded in September 12.57 µg/m³, February 12.21 µg/m³, and October 11.30 µg/m³.

The lowest values were recorded in May (7.72 µg/m^3), April (7.95 µg/m^3) and August (8.39 µg/m^3).

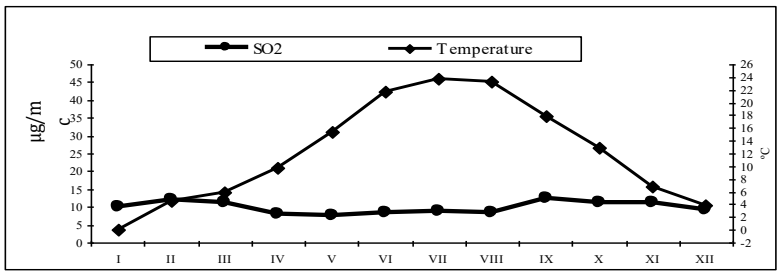

Figure **5 Variation in monthly average (SO_2) concentration (µg/m³) and air temperature (○C) in Oradea**

CONCLUSIONS

During the years studied (2020–2022), the maximum permissible concentrations were not exceeded.

Higher levels of SO_2 concentration were determined at the BH_2 Episcopia Bihor station, which is located in an industrial area.

Higher SO_2 values were recorded at the BH_3 station in Nufărul because it is located near a busy road.

Pollution can also occur in areas with industrial waste dumps, livestock farms, unregulated and uncontrolled rubbish dumps, and chemical industry.

It can be observed that the highest SO_2 concentration values were recorded during the cold period of the year when the air temperature was lower, highlighting the purifying role of air temperature through convective movements during the warm periods of the year.

Another important factor is that the prevailing wind direction is from the south, which favors the dispersion of pollutants.

REFERENCES

Ciulache S., 2004, Influence of weather and climate conditions on air pollution, Com. Geogr. V, Univ Publishing. Bucharest.

Köteles Nandor, Moza Ana Cornelia, 2010, Aspects on Air Pollution with Sulphur Dioxide in Oradea City, Research Journal of Agricultural Science Timişoara, Vol. 42 (3), 2010, ISSN: 2066-1843, pp. 648-653.

Köteles, N., Domuţa, C, & Pereş A, C., 2016, The Level of Air Pollution with Nitrogen Dioxide in the City of Satu-Mare in 2014 – 2015, Natural Resources and Sustainable Development, University of Oradea, Publishing House Oradea, Vol. 8/ 2016, ISBN 978–3–902938–02-2; ISSN 2066-6276, pp.79-84, indexed BDI (CABI, SSRN, REPEC, DRJI, ARI).

Köteles, N., Pereș, A. C. & Todea A. O., 2021, The Level of Air Pollution with Nitrogen Dioxide in the City of Zalău in 2020, Annals of the University of Oradea, Fascicle: Environmental Protection, Vol. XXXVII, Year 26, Oradea University Press 2021, ISSN 1224-6255, pp. 261-264, Category B+ and indexed BDI (CABI, SSRN, REPEC, DRJI, ARI).

Köteles, N., Pereș, A. C. & Venter A. O., 2023, The Level of Air Pollution with Nitrogen Dioxide in the City of Satu-Mare in 2018-2022, Annals of the University of Oradea, Fascicle: Environmental Protection, 2023/B, Vol. XL, Year 28, Oradea University Press, ISSN 1224-6255, pp. 153 - 156.

Pereș, A. C. & Köteles, N., 2010, Aspects on Air Pollution with Nitrogen Dioxide in the City Area Oradea, Annals of the University of Oradea, Fascicle: Environmental Protection, 2010, Vol. XV, Year 15, Oradea University Press. ISSN 1224-6255, pp. 735-739.

www.apmbh.ro

https://www.calitateaer.ro