

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

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### RESEARCH ARTICLE

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#### Abstract

*This paper studies the level of atmospheric air pollution with nitrogen dioxide (NO<sub>2</sub>) in the area of Oradea city over a period of three years (2020 - 2022). We used data obtained from the Bihor Oradea Environmental Protection Agency, the body that monitors air quality. There are three nitrogen dioxide (NO<sub>2</sub>) monitoring stations located within the city of Oradea. The first monitoring station is located at the headquarters of the Bihor Environmental Protection Agency BH<sub>1</sub> (urban station), followed by the monitoring station in Episcopia Bihor BH<sub>2</sub> (industrial station) and the monitoring station in the Nufărul neighborhood BH<sub>3</sub> (traffic station). This allows us to monitor NO<sub>2</sub> pollution in the city very effectively.*

*Among the main sources of NO<sub>2</sub> pollution in Oradea are means of transport, which contribute to high concentrations on busy streets, as well as industrial and domestic sources.*

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**Keywords:** nitrogen dioxide, monitoring, sampling points.

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#### INTRODUCTION

Observations on the level of atmospheric air pollution are very useful because they provide direct information about pollution at a given moment in an important segment of the urban environment.

Nitrogen oxides are a group of highly reactive gases containing nitrogen and oxygen in varying amounts. These gases are colourless and odourless.

In combination with particles in the air, nitrogen dioxide can form a reddish haze. In the presence of sunlight, nitrogen oxides can also react with hydrocarbons to form photochemical oxidants.

Among the anthropogenic sources of oxides, we can mention combustion processes when fuels are burned at high temperatures, but most often they are the result of road traffic, industrial activities, and electricity production. These gases are also responsible for the formation of smog, acid rain, the greenhouse effect, and reduced visibility in congested urban areas.

It is a highly toxic gas for both humans and animals. People exposed to this pollutant may experience breathing difficulties,

respiratory tract irritation, and lung dysfunction.

#### MATERIAL AND METHOD

In preparing this paper, we used data from the Bihor Oradea Environmental Protection Agency ([www.apmbh.ro](http://www.apmbh.ro)). NO<sub>2</sub> samples are collected at three monitoring stations. BH<sub>1</sub> is located within the APM Bihor headquarters and is an urban station, BH<sub>2</sub> is located in the Diocese of Bihor and is an industrial station, and BH<sub>3</sub> is a traffic station located in the Nufărul neighbourhood.

The period analysed in this paper was three years, from 2020 to 2022.

The data was processed using statistical and mathematical methods, and the results were then plotted graphically to clearly show the variability of atmospheric pollutants over time.

The method for measuring nitrogen dioxide and nitrogen oxides is that provided for in standard SR EN 14211.

According to Law No. 104 of 15 June 2011 Nitrogen oxides – NO<sub>x</sub> – the alert threshold is 400 µg/m<sup>3</sup> (measured over 3 consecutive hours at points representative of air quality for an area of at least 100 km<sup>2</sup> or for an entire zone or agglomeration, whichever is smaller).

Limit values are 200  $\mu\text{g}/\text{m}^3$   $\text{NO}_2$  - hourly is 40  $\mu\text{g}/\text{m}^3$   $\text{NO}_2$  - the annual limit value for the protection of human health (<https://www.calitate aer.ro>).

## RESULTS AND DISCUSSIONS

Annual evolution of nitrogen dioxide concentration

The analysis of the evolution of nitrogen dioxide ( $\text{NO}_2$ ) concentrations for 2020 shows that the highest concentration was determined at the BH<sub>2</sub> sampling point in Episcopia Bihor 28.27  $\mu\text{g}/\text{m}^3$ , followed by the sampling station BH<sub>3</sub> in Nufărul 26.01  $\mu\text{g}/\text{m}^3$ . The lowest

limit value for the protection of human health concentration was recorded at BH<sub>1</sub> (22.11  $\mu\text{g}/\text{m}^3$ ).

In 2021, the highest average annual evolution of  $\text{NO}_2$  concentrations was also recorded at the BH<sub>2</sub> observation point located in Episcopia Bihor 25.20  $\mu\text{g}/\text{m}^3$ , of 22.35  $\mu\text{g}/\text{m}^3$  determined at station BH<sub>1</sub>, followed by station BH<sub>3</sub> in Nufărul (21.59  $\mu\text{g}/\text{m}^3$ ).

In the last year studied (2022),  $\text{NO}_2$  concentrations were lower than in 2020–2021. The highest concentration was measured at station BH<sub>3</sub> in Nufărul 18.94  $\mu\text{g}/\text{m}^3$ , in Episcopia Bihor 16.55  $\mu\text{g}/\text{m}^3$ . The lowest concentration for 2022 was determined at station BH<sub>1</sub> (14.00  $\mu\text{g}/\text{m}^3$ ) (Fig. 1).

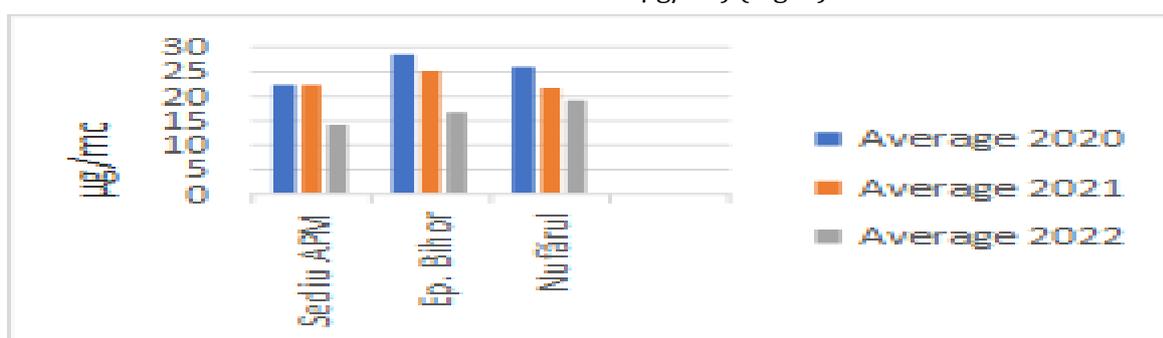


Figure.1 Evolution of average annual  $\text{NO}_2$  concentrations ( $\mu\text{g}/\text{m}^3$ ) at monitoring points in Oradea, between 2020 and 2022

Monthly evolution of nitrogen dioxide concentrations

From the analysis of monthly  $\text{NO}_2$  concentrations for 2020, we can see that the highest concentration was recorded in August

at 42.84  $\mu\text{g}/\text{m}^3$ , at the BH<sub>2</sub> station in Episcopia Bihor, followed by 41.08  $\mu\text{g}/\text{m}^3$  in January at the BH<sub>3</sub> Nufărul and in January 37.64  $\mu\text{g}/\text{m}^3$  at station BH<sub>1</sub> (Fig. 2).

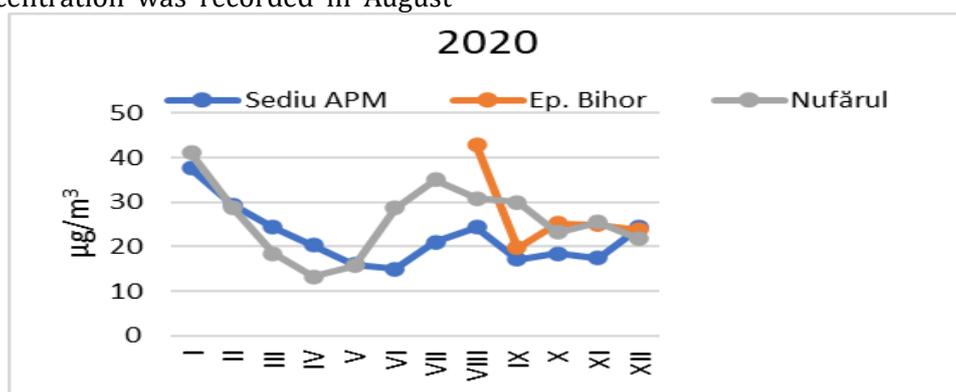


Figure.2 Evolution of monthly average  $\text{NO}_2$  concentrations ( $\mu\text{g}/\text{m}^3$ ) at monitoring points in Oradea in 2020

In 2021, the highest values were recorded in March 22.18  $\mu\text{g}/\text{m}^3$  at the BH<sub>3</sub> Nufărul and 22.10  $\mu\text{g}/\text{m}^3$  also in March at the BH<sub>2</sub> station in

Episcopia Bihor, followed by February 21.66  $\mu\text{g}/\text{m}^3$  at the BH<sub>2</sub> station (Fig. 3).

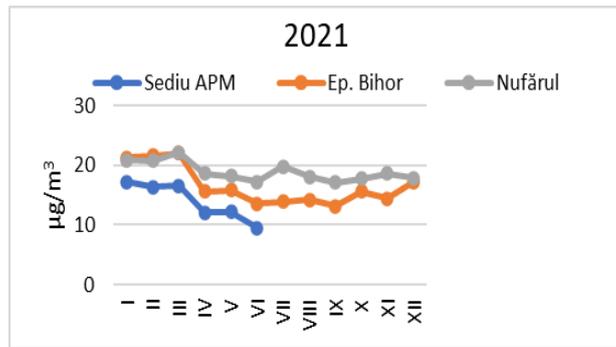


Figure 3. Evolution of monthly average NO<sub>2</sub> concentrations (µg/m<sup>3</sup>) at monitoring points in Oradea in 2021

For 2022, the maximum concentration of the pollutant was recorded in March at 22.18 µg/m<sup>3</sup>, at the BH<sub>3</sub> Nufărul station. Similar values

were also determined in March 22.10 µg/m<sup>3</sup> at station BH<sub>2</sub> and in February 21.66 µg/m<sup>3</sup> also at station BH<sub>2</sub> (Fig. 4).

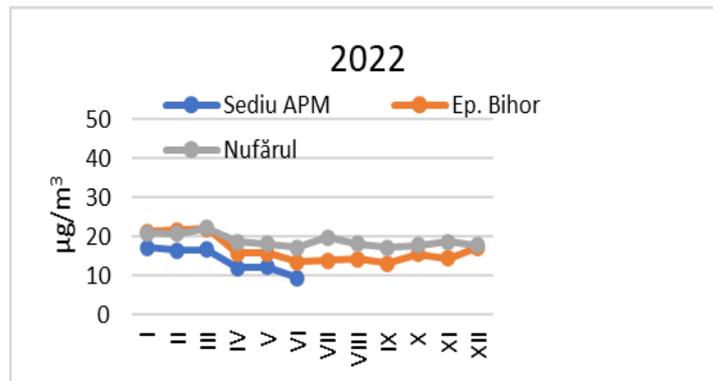


Figure.4 Evolution of monthly average NO<sub>2</sub> concentrations (µg/m<sup>3</sup>) at monitoring points in Oradea in 2022

Monthly evolution of nitrogen dioxide in correlation with air temperature

Nitrogen dioxide, when encountering certain climatic conditions such as thermal inversion, atmospheric calm and lack of precipitation, can lead to the stagnation of these gases in the emission areas.

The lower the temperature, the higher the concentration of NO<sub>2</sub>, and the higher the temperature, the lower the concentration of the gas. This highlights the purifying role of air

temperature through convective movements during the warm period of the year.

Figure 5 shows that the highest concentrations were recorded in January (30.19 µg/m<sup>3</sup>), February (27.63 µg/m<sup>3</sup>), March (23.15 µg/m<sup>3</sup>), October (22.48 µg/m<sup>3</sup>), November (21.95 µg/m<sup>3</sup>) and December (23.71 µg/m<sup>3</sup>). The lowest concentrations were recorded in June (11.97 µg/m<sup>3</sup>), May (14.30 µg/m<sup>3</sup>) and July (16.34 µg/m<sup>3</sup>).

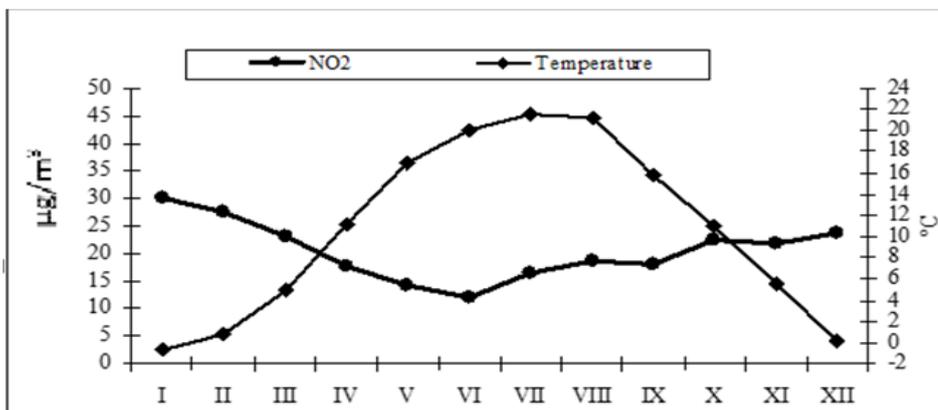


Figure.5 Variation in monthly average (NO<sub>2</sub>) concentrations (µg/m<sup>3</sup>) and air temperature (°C) in Oradea

## CONCLUSIONS

During the years studied, 2020–2022, the maximum permissible concentrations were exceeded only accidentally for short periods of time.

The areas most exposed to NO<sub>2</sub> pollution are those located near busy roads and major intersections.

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

The highest nitrogen dioxide concentrations have been recorded during the coldest periods of the year, when the air temperature is low. For this reason, we can assume that air temperature plays a purifying role through convective movements during the warmest periods of the year.

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

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