Vol. 10, No. 1, 2025

RESEARCH ON ATMOSPHERIC AIR QUALITY IN THE PRYKARPATTIA REGION

Mykola Moisuk, Mykhailo Hurei, Diana Ovsianetska

Ivano-Frankivsk National Technical University of Oil and Gas,
15, Karpatska Str., Ivano-Frankivsk, 76019, Ukraine
diana.ovsianetska-eko221@nung.edu.ua

https://doi.org/10.23939/ep2025.01.067

Received: 1.11.2024

Abstract. The goal of this study was to assess and analyze the air quality on the territory of the Ivano-Frankivsk National Technical University of Oil and Gas, evaluate pollution levels, and identify the main sources of harmful emissions. The study was conducted on the territory of the university, where measurements of the main atmospheric air parameters were carried out using the multifunctional device FLUS 5-in-1, the gas detector Walcom W-K-600, and the CEM GD-3803 instrument. Parameters such as wind speed, air temperature and humidity, light intensity, and concentrations of formaldehyde, nitrogen oxide, carbon dioxide, carbon monoxide, and oxygen were measured. A systematic approach was applied with an even distribution of measurement points across the university territory, including areas with high traffic, academic buildings, and green zones. As a result of the study, no excess gases concentrations were recorded. The practical value of the study lies in the development of recommendations to improve air quality, including optimizing traffic flows, increasing green zones, and implementing modern air purification technologies. Further research should focus on a detailed analysis of the impact of different pollution sources and the development of innovative technologies to reduce harmful emissions. The results of this study confirm the relevance of the issue and the need for systematic monitoring of atmospheric air quality, as well as the implementation of effective measures to reduce pollution, which is crucial for improving living conditions and public health.

Keywords: air pollution, harmful emissions, environmental situation, anthropogenic pollution, environmental quality monitoring.

1. Introduction

The issue of air quality is extremely relevant in today's world, especially in the context of rapid urban development and industrialization (Giannico et al., 2021). Air pollution affects human health, ecosystems, and the climate, as confirmed by numerous studies (Azimi & Rahman, 2024).

The study of air quality on the territory of the Ivano-Frankivsk National Technical University of Oil and Gas is necessary to ensure a healthy environment and to take measures to reduce the negative impact on the environment.

The goal of this study is to assess and analyze the air quality on the territory of IFNTUOG, evaluate the level of pollution, and identify the main sources of harmful emissions. The task of this work is to conduct systematic measurements of air quality indicators, analyze the obtained data in the context of modern environmental standards, and develop recommendations for reducing the negative impact of pollution.

The scientific novelty of the work lies in a comprehensive approach to studying air quality on the university's territory, which will allow for more accurate identification of specific pollution sources and the development of effective measures for its improvement. This study is significant both for theoretical understanding of the issue and for the practical implementation of the obtained results into real environmental programs (Pershehuba & Lytvychenko, 2009).

2. Materials and Methods

The study was conducted on the territory of the Ivano-Frankivsk National Technical University of Oil and Gas, Ivano-Frankivsk, Ukraine. The sampling strategy involved the even distribution of mea-

For citation: Moisuk, M., Hurei, M., Ovsianetska, D. (2025). Research on a tmospheric air quality in the Prykarpattia region. *Journal Environmental Problems*, *10*(1), 67–71. DOI: https://doi.org/10.23939/ep2025.01.067

surement points across the university's territory to obtain representative data. The criteria for selecting the locations were based on t he various functional zones of the university, including areas with high traffic, academic buildings, green zones, and zones with increased human activity. This approach provided a comprehensive picture of the air quality under different conditions across the university's grounds.

Key atmospheric air parameters, such as wind speed, air temperature, relative humidity, and light intensity, were measured using the multifunctional FLUS 5-in-1 device. To assess air quality, the Walcom W-K-600 gas detector was used to measure formaldehyde and nitrogen oxide concentrations. Additionally, carbon dioxide, carbon monoxide, and oxygen levels were measured at five locations on the university grounds using the CEM GD-3803 device.

The research procedure consisted of several stages. Initially, all devices were calibrated according to the manufacturer's instructions. Then, simultaneous measurements were taken at each selected location using the respective instruments to obtain a comprehensive assessment of the conditions and air quality.

3. Results

In our modern world, air pollution is a very common problem (World Health Organization, 2003). With the development of technologies, more pollutants are entering the atmosphere, harming not only the environment but also humans (Tryhub & Domuschy, 2023).

Carbon dioxide is naturally present in the air, but its concentration increases due to human activities such as burning fossil fuels, industrial processes, and vehicle emissions (Dzyba & Kyriienko, 2024). In the state building codes DBN V.2.5-67:2013 "Heating, Ventilation, Air Conditioning", the permissible concentrations of CO_2 in the air are specified, taking into account the amount of carbon dioxide in the air outside the buildings. 350-400 ppm is the level for outdoor air, representing conditions for being outdoors in fresh air (Shpak et al., 2022.

Carbon monoxide enters the atmosphere in the greatest quantity from vehicle exhaust gases, as well as from emissions from oil, petroleum refining industries, ferrous metallurgy, and thermal power plants. It is classified as an inert gas, does not participate in chemical reactions with other impurities, and is hardly removed by precipitation (Buckland & Pojani, 2023). Its content is mainly regulated by the conditions of transport and dispersion (Van Dingenen et al., 2009). The permissible concentration of carbon monoxide (CO) in fresh air is less than 10 ppm. A concentration above 520 ppm for two hours causes headaches, dizziness, nausea, while a concentration at the level of 1000 ppm leads to loss of consciousness. At a CO concentration of 1500 ppm, a fatal outcome is possible (Bashtannik et al., 2014).

Formaldehyde in the air is formed due to both human activity and natural processes. The main sources of anthropogenic origin are emissions from industrial enterprises, motor vehicles, the burning of fossil fuels, and construction materials. Inhalation of formaldehyde vapors leads to allergies, coughing, irritation of the eyes, nose, throat, and skin, sleep disorders, headaches, and chronic fatigue (Chuhai et al., 2019). The maximum allowable concentration (MAC) of formaldehyde is 0.5 mg/m³ (Nesterenko et al., 2021).

Oxygen is a vital gas necessary for the respiration of most living organisms. Its concentration in the atmosphere is consistently maintained at around 20.9 %. For humans, an oxygen level in the air below 17 % can be dangerous (Kozlowski et al., 2023).

The main sources of nitrogen oxides (NO, NO_2) entering the atmosphere are emissions of high-temperature combustion products and incomplete fuel combustion (Azimi et al., 2024). Natural sources include microbiological processes occurring in the surface layer, photochemical oxidation of ammonia and nitrous oxide in the air, as well as thunderstorms (Kutia et al., 2023). The relative influence of anthropogenic and natural sources on t he level of ground-level nitrogen oxide pollution (lower troposphere) varies significantly and depends on many factors (degree of urbanization, amount and quality of fuel, surface characteristics, and season) (Oleshko & Petrovska, 2020). The maximum allowable concentration of nitrogen dioxide is 400 μg/m³ (Dyvak, 2023).

Air quality was assessed on the territory of Ivano-Frankivsk National Technical University of Oil and Gas, with measurements taken at five sites (Fig. 1). The research results are presented in Table.

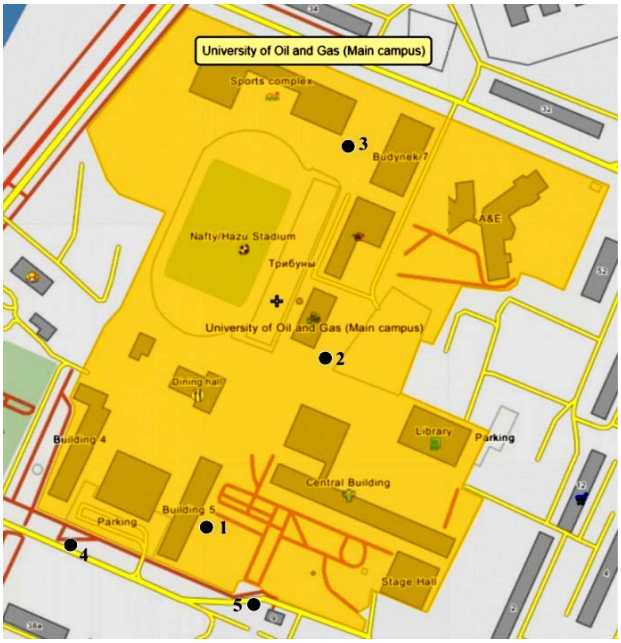

Fig. 1. Study sites on the territory of IFNTUOG

Source: created by the author.

Measurement results

Measurement indicator	No. study area				
	1	2	3	4	5
v, m/s	0.2	0.1	5.1	5.1	1.3
t, °C	15.1	16.7	18.4	18.4	21.1
RH, %	41.7	40	46.4	39	35
E, kLux	3.8	3.73	3.78	3.78	3.81
CO, ppm	0	0	0	0	0
CO_2, ppm	362	355	378	395	400
CH_2O, mg/m^3	0	0.3	0.4	0.5	0.5
O_2, %	20.5	20.5	20.4	20.3	20.3
NO_2, mg/m^3	0	0	0	0.4	0.4

Source: created by the author

The study results indicate that there were no recorded exceedances of gas concentration levels in the examined areas. This suggests that the overall air pollution levels within the study area meet established environmental standards and do not pose a threat to public health.

However, the study found elevated levels of pollutants in areas located near roads and construction sites. Although these concentrations remain within permissible limits and do not exceed established norms, they do reflect a local increase in pollution. This increase is likely related to vehicle emissions and ongoing construction activities.

A comparison with data from other studies (Belova et al., 2023) indicates similar trends in air pollution levels in other urban agglomerations. In particular, the study by Savenets (Savenets, 2023) also highlights the high concentration of pollutants in the air of large cities.

These results emphasize the importance of regular monitoring and the implementation of measures toreduce harmful emissions into the atmosphere, particularly in urban environments (Dmytriieva et al., 2016).

4. Discussion

Recent studies by scientists show a significant impact of anthropogenic factors on air quality in urban agglomerations.

Belova et al., (Belova et al., 2023) analyzed the impact of environmental factors on the health of the population in the Ivano-Frankivsk region, pointing to the serious effects of air pollution on human health. Kalenska (Kalenska, 2012) studied the economic consequences of environmental pollution on public health, emphasizing that pollution not only harms health but also negatively affects household incomes.

Rybalova et al. (Rybalova et al., 2015) presented integral and comprehensive assessments of the state of the natural environment, allowing for an overall picture of pollution and its impact on various components of the ecosystem.

Savenets (Savenets, 2023), in his study, focused on the current state of air pollution in Ukraine, highlighting the significant influence of vehicular emissions on overall pollution. Dotsenko and Demidenko (Dotsenko & Demidenko, 2014) compared various methods of determining air pollution levels, which helps in selecting the most effective techniques for monitoring and analysis.

Hryhorieva et al (Hryhorieva et al., 2023) considered environmental monitoring of air quality using indicative measurements, which is important for timely detection and assessment of pollution levels.

Ananieva (Ananieva, 2017) researched the hygienic assessment of air pollution from vehicle emissions, which is relevant in the context of the increasing number of cars in cities and the rise in harmful emissions. Turos et al. (Turos et al., 2014) proposed improved approaches to the quantitative assessment of air pollution from motor vehicles, which is important for developing effective pollution reduction measures. Serdiuk et al. (Serdiuk et al., 2021) emphasized the importance of assessing air pollution levels and its safety for the population, which is necessary for taking appropriate health protection measures.

These studies highlight the importance of monitoring and analyzing air quality to develop effective strategies for reducing the negative impact on the environment and public health.

5. Conclusions

The study of air quality on the territory of the Ivano-Frankivsk National Technical University of Oil and Gas found that, in some areas, concentrations of carbon dioxide, formaldehyde, and nitrogen dioxide were elevated but remained within permissible limits. The primary sources of these pollutants are vehicle traffic and construction activities, confirming the significant impact of human activities on air quality.

Elevated concentrations of carbon dioxide, formaldehyde, and nitrogen dioxide were detected in areas with heavy traffic and near construction sites. However, all these levels remain within permissible limits, indicating the presence of local pollution sources without exceeding maximum allowable values.

Future research directions include a more detailed analysis of the impact of various pollution sources on air quality, the development of advanced technologies for emission reduction, and the establishment of comprehensive environmental monitoring programs to enhance living conditions and public health.

References

Ananieva, O. V. (2017). *Vdoskonalennia hihiienichnoi otsinky zabrudnennia atmosfernoho povitria vykydamy avtomobilnoho transportu* (Autoref. dys. na zdobuttia nauk. stupenia kand. biol. nauk: spets. 14.02.01 “hihiiena ta profesiina patolohiia”). Kyiv.

Azimi, F., Hafezi, F., Ghaderpoori, M., Kamarehie, B., Karami, M. A., Sorooshian, A., & Baghani, A. N. (2024). Temporal characteristics and health effects related to NO_2, O_3, and SO_2 in an urban area of Iran. *Environmental pollution*, *349*, 123975. DOI: https://doi.org/10.1016/j.envpol.2024.123975

Azimi, M. N., & Rahman, M. M. (2024). Unveiling the health consequences of air pollution in the world’s most polluted nations. *Scientific Reports*, *14*(1), 9856. DOI: https://doi.org/10.1038/s41598-024-60786-0

Bashtannik, M. P., Zhemera, N. S., Kiptenko, Ye. M., & Kozlenko, T. V. (2014). Stan zabrudnennia atmosfernoho povitria nad terytoriieiu Ukrainy. *Naukovi pratsi Ukrainskoho naukovo-doslidnoho hidrometeorolohichnoho instytutu*, *266*, 70–93. Retrieved from http://www.irbis-nbuv.gov.ua/cgi-bin/irbis_nbuv/cgiirbis_64.exe?I21DBN=LINK&P21DBN=UJRN&Z21ID=&S21REF=10&S21CNR=20&S21STN=1&S21FMT=ASP_meta&C21COM=S&2_S21P03=FILA=&2_S21STR=Npundgi_2014_266_11

Bielova, N., Mykytyn, T., & Dolynko, N. (2023). Otsinka vplyvu faktoriv dovkillia na formuvannia zdorovia naselennia Ivano-Frankivskoi oblasti. *Zhurnal Prykarpatskoho natsionalnoho universytetu imeni Vasylia Stefanyka. Biolohiia*, *10*, 87–95.

Buckland, M., & Pojani, D. (2023). Green space accessibility in Europe: A comparative study of five major cities. *European Planning Studies*, *31*(1), 146–167. DOI: https://doi.org/10.1080/09654313.2022.2088230

Chuhai, A. V., Kolisnyk, A. V., Cherniakova, O. I., & Snesar, A. V. (2019). Otsinka vplyvu vmistu formaldehidu v atmosfernomu povitri na tryvalist zhyttia liudyny (na prykladi m. Odesa, Ukraina). *Znanstvena misel journal*, *37*(1), 12–22.

Dmytriieva, O. O., Varlamov, Ye. M., Kvasov, V. A., Palahuta, O. A., Nesterenko, L. M., & Nesterenko,U. Yu. (2016). Stan merezhi sposterezhennia za atmosfernym povitriam v Ukraini ta yii vidpovidnist vymoham dyrektyvy 2008/50/YeS. *Problemy okhorony navkolyshnoho pryrodnoho seredovyshcha ta ekolohichnoi bezpeky*, *38*, 99–110.

Dotsenko, L. V., & Demydenko, A. S. (2014). Porivnialnyi analiz metodiv vyznachennia rivnia zabrudnennia atmosfernoho povitria. *Ekolohichna bezpeka*, *2*, 71–74.

Dyvak, M., Spivak, I., Melnyk, A., Manzhula, V., Dyvak, T., Rot, A., & Hernes, M. (2023). Modeling Based on the Analysis of Interval Data of Atmospheric Air Pollution Processes with Nitrogen Dioxide due to the Spread of Vehicle Exhaust Gases. *Sustainability*, *15*(3), 2163. DOI: https://doi.org/10.3390/su15032163

Dzyba, A., & Kyriienko, V. (2024). Recovery of Velykyi Luh through ecological restoration of the Kakhovka Reservoir. *Scientific Journal Ukrainian Journal of Forest & Wood Science*, *15*(1), 25–40. DOI: https://doi.org/10.31548/forest/1.2024.25

Giannico, V., Spano, G., Elia, M., D'Este, M., Sanesi, G., & Lafortezza, R. (2021). Green spaces, quality of life, and citizen perception in European cities. *Environmental research*, *196*, 110922. DOI: https://doi.org/10.1016/j.envres.2021.110922

Hryhorieva, L. I., Aleksieieva, A. O., Makarova, O. V., Burovytska, Yu. M., & Hryhoriev, K. V. (2023). *Ekolohichnyi monitorynh stanu atmosfernoho povitria za indykatyvnymy vymiriuvanniamy*.

Kalenska, O. (2012). Ekonomichni naslidky vplyvu zabrudnennia dovkillia na zdorovia naselennia ta dokhody domohospodarstv. *Ekonomichnyi analiz*, *11*(3), 233–236.

Kozlowski, T., Noran, O., & Trevathan, J. (2023). Designing an evaluation framework for iot environmental monitoring systems. *Procedia Computer Science*, *219*, 220–227. DOI: https://doi.org/10.1016/j.procs.2023.01.284

Kutia, M., Li, J., Sarkissian, A., & Pagella, T. (2023). Land cover classification and urbanization monitoring using Landsat data: A case study in Changsha city, Hunan province, China. *Scientific Journal Ukrainian Journal of Forest & Wood Science*, *14*(1), 72–91. DOI: https://doi.org/10.31548/forest/1.2023.72

Nesterenko, O. V., Bahmut, L. L., Samokhvalova, A. I., & Onyshchenko, N. H. (2021). Vyznachennia zabrud nennia pylom, formaldehidom, letiuchymy rechovy namy atmosfernoho povitria u m. Kharkiv. *Naukovyi visnyk budivnytstva*, *104*(2), 292–298.

Oleshko, O., & Petrovska, Y. (2020). Khudozhno-kompozytsiini pryiomy ozelenennia yak zasoby vyraznosti v prostori mista. *Suchasni problemy Arkhitektury ta Mistobuduvannia*, 56, 256–265. DOI: https://doi.org/10.32347/2077-3455.2020.56.256-265

Pershehuba, Ya. V., & Lytvychenko, O. M. (2009). Do pytannia otsinky stanu zabrudnennia atmosfernoho povitria i yoho bezpeky dlia naselennia. *Dovkillia ta zdorovia*, 3(50), 19–22. DOI: https://doi.org/10.1088/2058-7058/22/05/29

Rybalova, O. V., Vasenko, O. H., & Artemev, S. R. (2015). *Intehralni ta kompleksni otsinky stanu navkolyshnoho pryrodnoho seredovyshcha*.

Savenets, M. V. (2023). Intehrovanyi pohliad na suchasnyi stan zabrudnennia atmosfernoho povitria v Ukraini: Za materialamy naukovoho povidomlennia na zasidanni Prezydii NAN Ukrainy 12 lypnia 2023 roku. *Visnyk Natsionalnoi akademii nauk Ukrainy*, 9, 80–86.

Serdiuk, A. M., Chernychenko, I. O., Lytvychenko, O. M., Babii, V. F., Kondratenko, O. Y., & Hlavachek, D. O. (2021). Carcinogenic Substances in the Atmospheric Air of Dnipro City and Risk to the Population. *Medicni Perspektivi*, *26(*1), 226–231. DOI: https://doi.org/10.26641/2307-0404.2021.1.228020

Shpak, N., Ohinok, S., Kulyniak, I., Sroka, W., Fedun, Y., Ginevičius, R., & Cygler, J. (2022). CO_2 emissions and macroeconomic indicators: Analysis of the most polluted regions in the world. *Energies*, *15*(8), 2928. DOI: https://doi.org/10.3390/en15082928

Tryhub, V. I., & Domuschy, S. V. (2023). Ekotoksykolohichna otsinka vplyvu avtozapravnykh stantsii na zabrudnennia miskykh hruntiv vazhkymy metalamy. *Visnyk Odeskoho natsionalnoho universytetu. Heohrafichni ta heolohichni nauky*, *28*(1(42)), 68–83.

Turos, O. I., Ananieva, O. B., & Petrosian, A. A. (2014). Vdoskonalennia pidkhodiv do kilkisnoi otsinky zabrudnennia atmosfernoho povitria vykydamy avtomobilnykh transportnykh zasobiv. *Hihiiena naselenykh mists: zb. nauk. pr.*, 22–31.

Van Dingenen, R., Dentener, F. J., Raes, F., Krol, M. C., Emberson, L., & Cofala, J. (2009). The global impact of ozone on agricultural crop yields under current and future air quality legislation. *Atmospheric Environment*, *43*(3), 604–618. DOI: https://doi.org/10.1016/j.atmosenv.2008.10.033

World Health Organization. (2003). *Health aspects of air pollution with particulate matter, ozone and nitrogen dioxide: Report on a WHO working group, Bonn, Germany 13-15 January 2003* (No. EUR/03/5042688). Copenhagen: WHO Regional Office for Europe.

Van Dingenen, R., Dentener, F. J., Raes, F., Krol, M. C., Emberson, L., & Cofala, J. (2009). The global impact of ozone on agricultural crop yields under current and future air quality legislation. *Atmospheric Environment*, 43(3), 604–618. DOI: https://doi.org/10.1016/j.atmosenv.2008.10.033

World Health Organization (2003). Health aspects of air pollution with particulate matter, ozone and nitrogen dioxide: Report on a WHO working group, Bonn, Germany 13–15 January 2003 (No. EUR/03/5042688). Copenhagen: WHO Regional Office for Europe.