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STATE OF AIR QUALITY IN THE CITY OF BOR IN 2025 – COMPARISON WITH 2024

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Abstract

This paper presents a comparison of ambient air quality in Bor in 2025 and 2024, based on SO_2, PM_{10} and chemical elements determined in PM_{10}. Annual SO_2 concentrations remained within the prescribed limit. PM_{10} concentrations decreased at most monitoring sites, although PM_{10} daily-limit exceedances remained frequent at Brezonik and Oštrelj, predominantly during the winter period. Cd concentrations decreased at all monitoring sites, while As showed a less uniform spatial pattern and remained above the annual target value at several locations. Overall, air quality in Bor improved in 2025 compared with 2024.

Keywords: *air quality, PM_{10}, sulfur dioxide, arsenic, cadmium, Bor*

1. INTRODUCTION

Air quality in the city of Bor has been strongly influenced by mining and copper production for decades. Sulfur dioxide (SO_2) has traditionally been one of the characteristic pollutants associated with copper smelting, while particulate matter (PM_{10}) and its chemical composition represent important indicators for assessing the influence of industrial activities on ambient air quality.

The Bor area represents a complex mining and metallurgical environment in which ambient air quality is influenced by multiple emission sources. In addition to emissions from copper smelting, PM_{10} pollution is associated with fugitive dust from open-pit mining, ore and waste handling, tailings and other activities within the mining and metallurgical complex [1,2]. Previous source-apportionment studies conducted in Bor have confirmed the contribution of several industrial and non-industrial sources to ambient PM_{10}, resulting in pronounced spatial and temporal variability in particulate pollution [1,2].

Continuous air quality monitoring is therefore essential for assessing both temporal and spatial changes in pollution levels. Particular attention is given to PM_{10} and the chemical elements Pb, As, Cd and Ni determined in PM_{10}, due to their importance for the assessment of air quality in mining and metallurgical environments.

The previous assessment showed that air quality in Bor in 2024 deteriorated compared with 2023, particularly in terms of the number of PM_{10} daily-limit exceedances and increased Cd concentrations at some monitoring sites [3]. The aim of this paper is to assess ambient air quality in Bor in 2025 and compare the results with those obtained in 2024, focusing on SO_2, PM_{10} and Pb, As, Cd and Ni determined in PM_{10}, as well as exceedances of the prescribed limit and target values.

2. EXPERIMENTAL

Ambient air quality monitoring in Bor and its suburban settlements was conducted within the local and national air quality monitoring networks. The Mining and Metallurgy Institute Bor performed sampling and analysis according to the applicable monitoring programme and accredited procedures.

PM_{10} concentrations were monitored at Krivelj, Jugopetrol, Oštrelj, Brezonik, Institute, Town Park, Industrial Zone and Metovnica. The chemical elements Pb, As, Cd and Ni were determined in PM_{10} samples at the selected monitoring sites in accordance with the Serbian air quality monitoring requirements.

The assessment presented in this paper is based on the results reported for 2024 and 2025. Annual mean concentrations of SO_2 and PM_{10}, concentrations of Pb, As, Cd and Ni in PM_{10}, and the number of exceedances of the prescribed limit and target values were used to compare air quality between the two years [3,4].

3. RESULTS AND DISCUSSION

Annual SO_2 concentrations in 2025 were generally comparable to or lower than those recorded in 2024. The annual limit value of 50 $\mu g/m^3$ was not exceeded at any monitoring site, confirming that annual SO_2 levels remained within the prescribed limit [4].

Annual mean PM_{10} concentrations in 2025 were lower than in 2024 at six of the eight monitoring sites (Table 1). The most pronounced decreases were observed at Jugopetrol and Town Park, where annual concentrations decreased from 37.0 to 19.4 $\mu g/m^3$ and from 32.5 to 21.6 $\mu g/m^3$, respectively. The annual limit value of 40 $\mu g/m^3$ was not exceeded at any monitoring site in either year. A notable improvement was also observed in the number of days exceeding the daily PM_{10} limit value of 50 $\mu g/m^3$. At Jugopetrol, the number of exceedance days decreased from 77 in 2024 to 22 in 2025. However, Brezonik and Oštrelj still recorded 70 and 65 exceedance days, respectively, thus exceeding the permitted maximum of 35 days per calendar year [3–4].

Table 1. *Mean annual concentrations of PM_{10} ($\mu g/m^3$) in Bor in 2024 and 2025*

Year	TP	IN	JP	KR	BR	OS	IZ	ME
2024	32.5	30.7	37.0	26.8	39.6	36.7	32.8	22.6
2025	21.6	32.5	19.4	26.2	35.4	34.7	25.5	23.2
LV	40	40	40	40	40	40	40	40

TP – Town Park; IN – Institute; JP – Jugopetrol; KR – Krivelj; BR – Brezonik; OS – Oštrelj; IZ – Industrial Zone; ME – Metovnica; LV – annual limit value.

PM_{10} daily-limit exceedances in 2025 were predominantly recorded during the winter period (1 January – 14 April and 15 October – 31 December). This seasonal pattern was particularly pronounced at Jugopetrol, where all 22 exceedances occurred during the winter period, as well as at Brezonik and Oštrelj, where 63 and 44 exceedances, respectively, were recorded during this period. Thus, although annual PM_{10} concentrations remained below the limit value, exceedances of the daily limit value remained an air quality concern at individual monitoring sites.

Annual As concentrations in PM_{10} showed different trends among the monitoring sites (Table 2). Compared with 2024, concentrations decreased at Town Park, Institute, Jugopetrol and Oštrelj, while increases were recorded at Krivelj, Brezonik and Industrial Zone. At Metovnica, the concentration remained practically unchanged. The most pronounced decrease was observed at Jugopetrol, from 42.0 ng/m^3 in 2024 to 28.2 ng/m^3 in 2025. Nevertheless, Jugopetrol remained the monitoring site with the highest annual As concentration. In 2025, the annual target value of 6 ng/m^3 was exceeded at Town Park, Jugopetrol, Brezonik and Industrial Zone. A notable increase was observed at Industrial Zone, from 15.1 to 17.3 ng/m^3, while at Brezonik the annual concentration increased from 5.6 to 6.32 ng/m^3, resulting in an exceedance of the target value in 2025 [3,4].

Table 2. *Mean annual concentrations of arsenic in PM_{10} (ng/m^3) in Bor in 2024 and 2025*

Year	TP	IN	JP	KR	BR	OS	IZ	ME
2024	16.8	6.8	42.0	1.4	5.6	3.3	15.1	2.3
2025	11.1	5.63	28.2	1.59	6.32	2.78	17.3	2.29
ATV	6	6	6	6	6	6	6	6

ATV – annual target value.

A clear improvement was observed for Cd concentrations in PM_{10} (Table 3). Annual Cd concentrations decreased at all eight monitoring sites in 2025 compared with 2024. The largest decreases were recorded at Jugopetrol, from 19.8 to 6.32 ng/m^3, Town Park, from 9.5 to 3.07 ng/m^3, and Industrial Zone, from 8.0 to 3.52 ng/m^3. In 2024, the annual target value of 5 ng/m^3 was exceeded at Town Park, Jugopetrol and Industrial Zone, whereas in 2025 an exceedance was recorded only at Jugopetrol [3,4].

Table 3. *Mean annual concentrations of cadmium in PM_{10} (ng/m^3) in Bor in 2024 and 2025*

Year	TP	IN	JP	KR	BR	OS	IZ	ME
2024	9.5	3.9	19.8	0.7	2.7	1.4	8.0	0.7
2025	3.07	1.45	6.32	0.32	1.60	0.57	3.52	0.34
ATV	5	5	5	5	5	5	5	5

ATV – annual target value.

At Jugopetrol, the daily Pb limit value was exceeded on four days in 2025, compared with 14 days in 2024, while the annual target value for Ni was not exceeded at any monitoring site in 2025 [3,4].

4. CONCLUSION

The comparison of air quality in Bor in 2025 and 2024 indicates an overall improvement for several investigated pollutants. Annual PM_{10} concentrations decreased at most monitoring sites, although the number of daily-limit exceedances remained above the permitted maximum at Brezonik and Oštrelj. The majority of PM_{10} exceedances in 2025 occurred during the winter period.

A substantial decrease in Cd concentrations was recorded at all monitoring sites, with the annual target value exceeded only at Jugopetrol in 2025. Arsenic showed a less uniform spatial pattern. Although As concentrations decreased at several monitoring sites, including Jugopetrol and Town Park, the annual target value was still exceeded at Town Park, Jugopetrol, Brezonik and Industrial Zone. Overall, the results indicate improved air quality in 2025 compared with 2024, while PM_{10} daily exceedances and elevated As concentrations remain the principal air quality concerns in the Bor area.

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