ECAS-7 2025 Conference

The 7th International Electronic Conference on Atmospheric Sciences

04–06 June 2025 | Online

MDPI

Health risks associated with inhalation exposure to toxic metal(loid)s in City of Novi Sad

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INTRODUCTION & AIM

Toxic metal(loid)s bound to particulate matter (PM) in the ambient air can cause serious harm to human health.

The study aimed to investigate the toxic element composition of PM10 (particulate matter, diameter up to 10 µm) and to address toxicological risk to human health.

METHOD

***SAMPLING**:* ambient air

Reference method: **EN 12341**

Apparatus: Sven Leckel sequential sampler with sampling inlet for PM10 (Quartz fiber filters)

Sites: 1- basic rural, 2 - basic urban, 3 - suburban traffic, 4 - urban traffic, 5 - industrial

Period: 24 h sampling, Jan-Dec 2024

Samples: 1357

***ANALYSIS**:*

Reference method: **EN 14902**

Sample preparation: microwave digestion (nitric acid + hydrogen peroxide)

Instrument: **ICP-MS Agilent Technologies 7700x**

Laboratory: Institute of Public Health of Vojvodina, ISO 17025 accredited

RISK ASSESSMENT:

Ec*inh* (ng/m³) = c × ET × EF × ED / ATn

Noncarcinogenic risk: **ATn = ED × 365 × 24**

Carcinogenic risk: **ATn = 70 × 365 × 24**

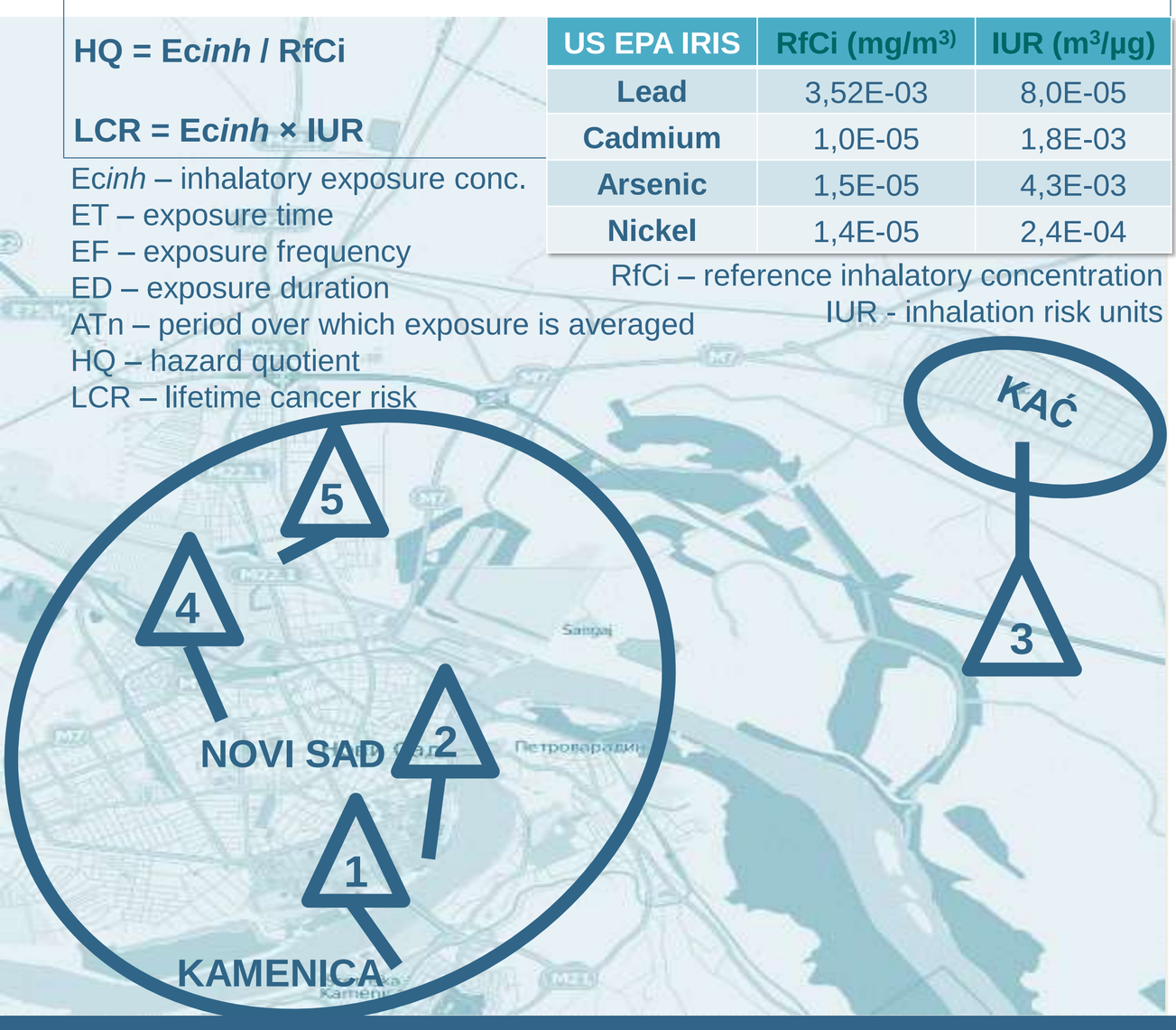
HQ = Ec*inh* / RfCi

LCR = Ec*inh* × IUR

Ec*inh* – inhalatory exposure conc.
ET – exposure time
EF – exposure frequency
ED – exposure duration
ATn – period over which exposure is averaged
HQ – hazard quotient
LCR – lifetime cancer risk

US EPA IRIS	RfCi (mg/m³)	IUR (m³/µg)
Lead	3,52E-03	8,0E-05
Cadmium	1,0E-05	1,8E-03
Arsenic	1,5E-05	4,3E-03
Nickel	1,4E-05	2,4E-04

RfCi – reference inhalatory concentration
IUR - inhalation risk units



RESULTS & DISCUSSION

Table 1. Toxic metal(loid)s concentrations (ng/m³) in ambient air

Site	N	Pb			Cd			As			Ni		
		min	max	mean	min	max	mean	min	max	mean	min	max	mean
1	223	0,90	14,7	4,55	0	1,26	0,19	0,04	3,37	0,81	0,0	10,1	3,0
2	286	0,20	50,6	3,91	0,01	1,05	0,15	0,02	5,96	0,80	0,1	12,7	3,0
3	244	0,10	84,8	5,96	0,01	1,24	0,24	0,02	2,98	0,83	0,1	13,4	3,3
4	330	0,30	41,4	5,33	0,01	2,65	0,21	0,02	3,87	0,81	0,2	25,3	4,2
5	274	0,40	52,0	5,74	0,01	1,21	0,22	0,02	2,90	0,80	0,1	20,0	3,40

Table 2. Toxicological risk assessment of toxic metal(loid)s in ambient air

		Exposure	HQ		Exposure		LCR	
		Children / Adults	Non-carcinogenic risk		Children	Adults	Carcinogenic risk	
		µg/m³	Children	Adults	µg/m³	µg/m³	Children	Adults
TM	Site							
Pb	1	4,5E-03	0,0013	0,0013	6,4E-04	2,5E-03	5,1E-08	2,0E-07
	2	3,9E-03	0,0011	0,0011	5,6E-04	2,2E-03	4,5E-08	1,8E-07
	3	5,9E-03	0,0017	0,0017	8,4E-04	3,4E-03	6,7E-08	2,7E-07
	4	5,3E-03	0,0015	0,0015	7,6E-04	3,0E-03	6,1E-08	2,4E-07
	5	5,7E-03	0,0016	0,0016	8,2E-04	3,3E-03	6,6E-08	2,6E-07
	All	5,1E-03	0,0014	0,0014	7,2E-04	2,9E-03	5,8E-08	2,3E-07
Cd	1	1,9E-04	0,019	0,019	2,7E-05	1,1E-04	4,8E-08	1,9E-07
	2	1,5E-04	0,015	0,015	2,2E-05	8,7E-05	3,9E-08	1,6E-07
	3	2,4E-04	0,024	0,024	3,5E-05	1,4E-04	6,2E-08	2,5E-07
	4	2,1E-04	0,021	0,021	3,0E-05	1,2E-04	5,4E-08	2,1E-07
	5	2,2E-04	0,022	0,022	3,1E-05	1,2E-04	5,6E-08	2,2E-07
	All	2,0E-04	0,020	0,020	2,9E-05	1,2E-04	5,2E-08	2,1E-07
As	1	8,1E-04	0,054	0,054	1,2E-04	4,6E-04	4,9E-07	2,0E-06
	2	8,0E-04	0,053	0,053	1,1E-04	4,6E-04	4,9E-07	2,0E-06
	3	8,3E-04	0,055	0,055	1,2E-04	4,7E-04	5,1E-07	2,0E-06
	4	8,1E-04	0,054	0,054	1,2E-04	4,6E-04	5,0E-07	2,0E-06
	5	8,0E-04	0,053	0,053	1,1E-04	4,6E-04	4,9E-07	2,0E-06
	All	8,1E-04	0,054	0,054	1,2E-04	4,6E-04	5,0E-07	2,0E-06
Ni	1	3,0E-03	0,22	0,22	4,3E-04	1,7E-03	1,0E-07	4,2E-07
	2	3,0E-03	0,22	0,22	4,4E-04	1,7E-03	1,0E-07	4,2E-07
	3	3,3E-03	0,23	0,23	4,7E-04	1,9E-03	1,1E-07	4,5E-07
	4	4,2E-03	0,30	0,30	6,0E-04	2,4E-03	1,4E-07	5,8E-07
	5	3,4E-03	0,25	0,25	4,9E-04	2,0E-03	1,2E-07	4,7E-07
	All	3,4E-03	0,24	0,24	4,9E-04	1,9E-03	1,2E-07	4,7E-07
Σ	1	HI	0,29	0,29			LCR	
	2		0,29	0,29			6,8E-07	2,7E-06
	3		0,32	0,32			7,5E-07	3,0E-06
	4		0,38	0,38			7,6E-07	3,0E-06
	5		0,32	0,32			7,3E-07	2,9E-06
	All		0,32	0,32			7,2E-07	2,9E-06

Toxic metal(loid)s

The elements occurrence rate: 85.3% Pb > 65.2% As > 36.6% Cd > 27.7% Ni.
The lowest mean concentrations - the basic-urban site, the highest - suburban-traffic (Pb, Cd, As) and urban-traffic site (Ni). Overall mean concentrations: Pb > Ni > As > Cd.

Non-carcinogenic risk

Hazard index (HI; the sum of HQs of each element) values ranged from 0.29 on basic-rural/-urban to 0.38 on suburban-traffic site, with an overall mean of 0.32, revealing no health risk. Ni was the highest risk contributor (68.3%).

Carcinogenic risk

For children, the risk was the lowest at the basic-urban and the highest at the urban-traffic site, with a mean showing negligible risk. In case of adults, carcinogenic risk varied only slightly, with a mean indicating low risk. As was the highest risk contributor (68.7%), followed by Ni > Pb > Cd.

CONCLUSION

Considering toxic metal(loid)s ubiquitous nature, low levels of risk related to inhalation exposure are insufficient to ensure human health protection.

REFERENCES

Directive 2008/50/EC on ambient air quality and cleaner air for Europe. OJ, 2008, L152.