

Particulate matter measurements in Macedonia for health impact assessment

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Solid fuel combustion is a common heating source in Macedonia. Small scale combustion in combination with lacking legislation for other emissions lead to high air pollution levels in the Skopje valley. It is suspected that current air quality has significant impact on the population health. To investigate this topic further, risk assessment investigations have been introduced within the EU-funded Twinning project "Further strengthening the capacities for effective implementation of the acquis in the field of air pollution" (MoE 2016). Measured monthly mean concentration of particulate matter (PM) will be used in a pilot study on health impact assessment. The aim of the present work was to assess the correlations between the measured monthly particulate matter mass concentrations (PM_{2.5} and PM₁₀) from different air quality monitoring stations, in order to evaluate their usability in the health impact assessment study.

Method

Monthly PM data were available from the national air quality monitoring network for the period of January 2012 to February 2016. PM_{2.5} was measured at two stations only (both within the city of Skopje) and PM₁₀ at nine stations (4 Skopje city, 1 Skopje region, 4 outside Skopje region). Missing monthly values were imputed using the average PM_{2.5} or PM₁₀ concentration calculated from measurements in the corresponding month of the other years at the same monitoring station. In addition, the average monthly ratios PM_{2.5}:PM₁₀ were calculated for the two stations in Skopje having parallel measurements of these two PM parameters with continuously acting instruments.

Results

A summary description of the monthly PM_{2.5} and PM₁₀ data for the whole monitoring period of Jan 2012 – Feb 2016 is shown in Table 1. The PM_{2.5}:PM₁₀ ratios at the two stations within Skopje city ranged between 0,61 in spring and 0,67 in autumn. Overall, the correlations in PM data between the different monitoring stations were high (Table 2). The correlation in PM_{2.5} between the two stations in Skopje was excellent (R²>90%): The same applied to the PM₁₀ stations within the city of Skopje, where only one monitoring station showed correlation lower than 90% with the others (Gazi Baba; R²>80%). all the Skopje region monitoring stations as well as the monitoring stations outside Skopje region showed generally

intercorrelations higher than 70%. Only PM₁₀ data from the station of Kavadarci, correlated poorly with the other stations. The rural background station of Lazaropole, located on a mountain, showed an inverse correlation with all the other monitoring stations.

Table 1. Summary of the monthly PM data (in µg/m³) measured in Jan 2012-Feb 2016 at Macedonian air quality monitoring stations.

	Mean	Min	Max	Winter (Nov-Feb)	Spring (Mar-Apr)	Summer (May-Aug)	Autumn (Sep-Oct)
Centar, PM _{2.5} ; UT	43,3	13,6	130,6	69,8	25,8	26,9	34,1
Karpos, PM _{2.5} ; UB	47,5	10,2	150,3	82,1	29,8	22,7	37,0
City mean, PM_{2.5}	45,4	16,9	134,7	75,9	27,8	24,8	35,5
Centar, PM ₁₀ ; UT	74,1	29,0	238,3	123,5	49,1	40,2	56,1
Karpos, PM ₁₀ ; UB	65,4	28,8	225,0	108,4	42,1	36,0	50,8
Lisice, PM ₁₀ ; UT	95,5	31,0	301,2	165,3	59,8	47,6	69,7
Gazi Baba, PM ₁₀ ; SU	82,4	39,3	221,9	128,1	63,5	52,5	58,5
City mean, PM₁₀	79,4	32,1	222,8	131,3	53,6	44,1	58,8
Miladinovci, PM ₁₀ ; R	45,6	27,0	121,7	66,1	35,0	34,0	33,5
Region mean, PM₁₀	72,6	31,5	192,1	118,3	49,9	42,0	53,7
Kavadarci, PM ₁₀ ; HT	67,6	31,3	176,0	83,1	106,3	44,2	41,2
Kicevo, PM ₁₀ ; UT	78,8	30,4	212,0	129,6	69,7	41,4	48,7
Kocani, PM ₁₀ ; UT	49,4	31,0	94,0	70,0	46,3	35,0	34,6
Lazaropole, PM ₁₀ ; RB	15,0	7,3	27,2	10,0	14,0	19,6	18,3
Countryside mean, PM₁₀	52,7	29,0	107,7	73,2	59,1	35,1	35,7
Country mean, PM₁₀	63,8	30,8	148,2	98,2	54,0	38,9	45,7

UT – urban traffic site, UB – urban background site, SU - suburban site, RB - rural background site, HT – heavy traffic, R - refinery

Conclusions.

The limited size of the newly started national air quality monitoring programme in Macedonia poses challenges for air pollution exposure assessment. High PM_{2.5} and PM₁₀ intercorrelations, however, suggest that the PM₁₀ data can be used to improve spatial coverage of PM exposures. Most likely due to same sources, PM pollution levels have similar monthly profiles to those in Skopje city also at the three urban monitoring sites outside Skopje.

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References

MoE, 2016 <http://airquality.moep.gov.mk/?lang=en#>

Table 2. Correlation matrix of the arithmetic means of the measured PM (Jan 2012 – Feb 2016). UT – urban traffic site, UB – urban background site, SU - suburban site, RB - rural background site; HT – heavy traffic, R -refinery

	Centar, PM _{2.5} ; UT	Karpos, PM _{2.5} ; UB	City mean, PM_{2.5}	Centar, PM ₁₀ ; UT	Karpos, PM ₁₀ ; UB	Lisice, PM ₁₀ ; UT	Gazi Baba, PM ₁₀ ; SU	City mean, PM₁₀	Miladinovci, PM ₁₀ ; R	Region mean, PM₁₀	Kavadarci, PM ₁₀ ; HT	Kicevo, PM ₁₀ ; UT	Kocani, PM ₁₀ ; UT	Lazaropole, PM ₁₀ ; RB	Not Skopje region, PM₁₀	Country mean, PM₁₀
Centar, PM _{2.5} ; UT	1															
Karpos, PM _{2.5} ; UB	0,930	1														
City mean, PM_{2.5}	0,979	0,985	1													
Centar, PM ₁₀ ; UT	0,950	0,946	0,965	1												
Karpos, PM ₁₀ ; UB	0,940	0,926	0,949	0,977	1											
Lisice, PM ₁₀ ; UT	0,917	0,925	0,938	0,971	0,939	1										
Gazi Baba, PM ₁₀ ; SU	0,822	0,875	0,866	0,896	0,834	0,925	1									
City mean, PM₁₀	0,934	0,945	0,957	0,989	0,964	0,990	0,940	1								
Miladinovci, PM ₁₀ ; R	0,731	0,759	0,760	0,791	0,778	0,810	0,832	0,839	1							
Region mean, PM₁₀	0,928	0,940	0,951	0,984	0,960	0,987	0,948	0,999	0,866	1						
Kavadarci, PM ₁₀ ; HT	0,197	0,276	0,244	0,311	0,279	0,329	0,421	0,343	0,362	0,349	1					
Kicevo, PM ₁₀ ; UT	0,755	0,819	0,803	0,877	0,840	0,889	0,901	0,902	0,825	0,907	0,492	1				
Kocani, PM ₁₀ ; UT	0,731	0,824	0,795	0,844	0,806	0,860	0,890	0,874	0,817	0,881	0,511	0,962	1			
Lazaropole, PM ₁₀ ; RB	-0,530	-0,650	-0,605	-0,618	-0,582	-0,629	-0,667	-0,642	-0,588	-0,645	-0,394	-0,730	-0,766	1		
Not Skopje region, PM₁₀	0,632	0,713	0,688	0,766	0,726	0,783	0,832	0,799	0,764	0,806	0,775	0,929	0,922	-0,676	1	
Country mean, PM₁₀	0,880	0,913	0,914	0,962	0,932	0,968	0,954	0,982	0,869	0,968	0,488	0,952	0,930	-0,681	0,896	1