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SEASONAL TRENDS OF BENZO(*a*)PYRENE IN SUSPENDED PARTICULATE MATTER IN URBAN AREAS OF BELGRADE, SERBIA*

Polycyclic aromatic hydrocarbons (PAHs) were identified to be one of the major toxic air pollutants in urban environment. PAHs are mostly formed during incomplete combustion or pyrolysis of organic material. According to Serbian National Legislation, benzo(a)pyrene (BaP) concentration in total suspended particles (TSP) in ambient air in the Belgrade metropolitan area has been determined in the last ten years, as a part of a local air pollution monitoring program performed by the Public Health Institute of Belgrade and funded by Belgrade's Municipality. Air samples for analysis of BaP in suspended particles have been collected (as 24 h sample once per month) at selected monitoring sites within the municipal air quality monitoring network. At the beginning, according to National Regulation, all samples were taken as total suspended particles (TSP). Since mid-2008, the procedure of sampling methodology was harmonized with EU requirements and solid fraction PM_{10} has been collected and analyzed using GC/MS. In this study, we have analyzed results of TSP collected between 2005 and 2008. Looking through the results obtained during the period of a whole year, it can be noticed that concentrations of BaP were much higher during winter season at almost all measuring sites.

Key words: air pollution monitoring; particulate matter; benzo(a)pyrene (BaP).

Polycyclic aromatic hydrocarbons (PAHs) are products of incomplete combustion formed during burning or pyrolysis of organic matter such as coal, oil, biomass, gasoline [1] and diesel [2,3]. Also PAHs in ambient air can be emitted from industrial combustions [3,4], aluminum production, cement manufacture, production of coal tare, coke and asphalt, petroleum catalytic cracking and restaurants [5].

Atmospheric PAHs can exist in both gaseous and particle phases, while a greater fraction of airborne organic particulate matter is present in the respirable size range. Some studies found that PAHs with two or three benzene rings exist in the vapor phase, while PAHs with more than five rings were observed primarily in the particulate phase [6]. This suggests that particulate PAHs are regarded as significant hazardous substances to human health when introduced through the skin or through the lungs or ingestion. Air pollution has adverse effects on respiratory and cardiovascular systems such as acute reduction in lung function, aggravation of asthma, increased risk of pneumonia to the elderly, low birth weight and high death in newborns [7,8]. Particulate matter have been suggested to pose a great risk to human health due to their high number concentration in urban environments and potential to penetrate (ultrafine particulate) from the lung alveoli into the blood circulation [9]. The chemical composition of airborne particulate matter (PM) in polluted atmosphere has become a topic of considerable importance over the recent years in relation to public health [10,11]. Particulate matter forms a highly complex mixture of different-sized solid and liquid particles [12-14]. Mass concentration may not be the most appropriate exposure parameter for the assessment of health risks of atmospheric pollution [15]. Many aromatic compounds, commonly identified in airborne particles, are suspected genotoxic agents and carcinogens, and some of them may also cause acute health effects [16,17]. PAHs with four or more structural rings were concen-

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trated on the fine and ultrafine particles, and various PAH investigations can be performed equally well from both the $PM_{2.5}$ and the PM_{10} samples [14]. Thus, inhalation of PAHs in particulate mixture is potentially a serious health risk [18,19].

Benzo(*a*)pyrene has been regarded as one of the markers of the total and carcinogenic PAHs [7,14]. The European Commission has set an annual target value of 1 ng/m^3 for benzo(*a*)pyrene in ambient air from content in PM_{10} fraction, while current legislative in Serbia set an annual limit value of 1 ng/m^3 for Benzo(*a*)pyrene in TSP [20-22]. On the other hand, the natural background level of BaP may be near zero; in rural areas its concentration ranges from 0.01-1 ng/m^3, in urban areas from 1-10 ng/m^3, and in the vicinity of industrial facilities it goes up to 40 ng/m^3 [23].

In order to estimate the carcinogenic risks for humans, the benzo(*a*)pyrene-equivalent (BaPE) carcinogenicity was evaluated by multiplying the concentrations of each PAH with their toxic equivalent factors (TEF) [24] which can be used to calculate the relative carcinogenicity of ambient samples with a known distribution of PAHs.

In the present study the concentration of BaP in ambient air of the Belgrade metropolitan area, recorded at selected number of different types of sampling sites in period 2005-2008 has been evaluated for the first time. TSP samples of ambient air were collected from January 1, 2005, to May 1, 2008, while PM10 samples were collected from May 1 to December, 2008. BaP concentrations were assessed during different seasonal conditions. Annual and seasonal BaP levels in TSP samples in Belgrade were compared with BaP concentration in the cities of other European countries.

EXPERIMENTAL

Aerosol sampling

The sampling sites that belong to the municipal air quality monitoring network have been located in the city center as well as in the wider Belgrade metropolitan area. The total size of the Belgrade metropolitan area is about 360 km^2 with 1,710.000 inhabitants. The municipal monitoring network consists of 17 manual, 6 fixed automatic and 2 mobile automatic stations (Figure 1). PM monitoring within the municipal monitoring network is currently performing at 6 urban traffic (UT), 1 urban basic (UB), 1 rural industrial (RI), 1 sub-rural industrial (SRI) and 2 urban in-

Figure 1. Measurement sites within the monitoring network in Belgrade.

dustrial (UI). The monitoring sites in Belgrade are characterized by different traffic levels and housing density. Some of the sampling sites are located in an urban background, which means that the sites are not directly exposed to traffic or other sources of emission, as it is noted in Table 1 and Figure 1. Sampling sites 18_SUI, 20_RI and 22_SRT that are not shown in Figure 1, are located in the wider Belgrade metropolitan area: 18_SUI is in vicinity of thermal power plant "Obrenovac", 20_RI in vicinity of thermal power plant "Kolubara" and 22_SRT is located 30 km south in the city of Mladenovac which also belongs to the Belgrade metropolitan area.

TSP were collected between 2005 and 2008 for BaP analysis at 6 sampling sites. Since 2008 the monitoring network for PAH was improved. Five sampling sites were added, which contributed to better spatial representativity. Instead of collecting TSP, PM_{10} has been sampled with the recommended reference sampler.

Air samples for analysis of BaP in TSP were collected within 24 h using a High Volume Sampler Proekos situated at a height of 1.5-2 m from the ground level. The pump was set at 17 m^3 h^{-1}. Air was passing through GF/A glass fibre filter Whatman 110 mm diameter. Before sampling, filters were heated in an oven on 105 °C for 1 h and then put in isothermal box for cooling and weighing. A Precisa XR 125 SB microbalance with 0.01 mg sensitivity was used to measure weight.

Since 2008, the procedure of sampling methodology has been harmonized with EU requirements and solid fraction PM_{10} has been collected and analyzed. Sampling of PM_{10} was done by a low volume sampler, Leckel model LV3 on to glass fiber filter Whatman 47 mm diameter according to standard EN 12341 [25]. The flow rate was set at 2.3 m^3 h^{-1}. Heights above ground level for all measurement sites were about 2.5 m.

Determination of BaP

TSP-BaP samples were prepared according to Compendium Method TO-13A [26]: determination of PAHs in ambient air using GC/MS. All samples were extracted using a Soxhlet extractor with a solvent solution of 250 ml (a mixture of 125 ml *n*-hexane and 125 ml acetone) for 18 h. The obtained extracts were then concentrated to 1 ml using a rotary evaporator and cleaned up on the column with 10 g activated silica gel and sodium sulfate on the top of the column. The column was rinsed with 60 ml dichloromethane and 40 ml pentane. The collected extract was rejected and, when the level of the pentane layer was above the sodium sulfate, 1 ml of sample extract was

Table 1. Selected sampling sites for BaP collecting within the local monitoring network

Number	Name	Type of site	Abbreviation	Co-ordinate
1	Despot Stefan Boulevard 54/	Urban traffic	1_UT	44°49′67.8′′ 20°47′03.6′′
2	M.Vidakovića	Urban traffic	5_UT	44°47′41.0′′ 20°28′59.4′′
3	Queen Jelena	Urban industrial	6_UI	44°44′41.3′′ 20°26′22.5′′
4	JNA Place	Urban traffic	7_UT	44°51′04.8′′ 20°23′25.1′′
5	Mansion of Grga Andrijanović	Urban industrial	8_UI	44°51′18.1′′ 20°28′54.0′′
6	Čukarica, Prince Višeslav	Urban basic	9_UB	44°44′49.3′′ 20°25′20.8′
7	Institute of Biology	Urban traffic	14_UT	44°49′02.7′′ 20°30′34.9′′
8	New Belgrade, Parking service	Urban traffic	17_UT	44°48′22.2′′ 20°23′50.8′′
9	Obrenovac	Suburban industrial	18_ SUI	44°36′15.2′′ 20°06′19.5′′
10	Vreoci	Rural industrial	20_ RI	44° 26′ 19" 20° 16′ 32"
11	Mladenovac	Subrural traffic	22_SRT	44°26'11" 20°40'16"
12	Rail street, Karadjoredjeva	Urban traffic	23_UT	44°48′34.3′′ 20°27′15.1′′

applied to a column. The column was rinsed with 25 ml of pentane, fractioned with pentane containing aliphatic hydrocarbons, and it was rejected. Column rinsing was continued with 25 ml of methylene chloride: pentane (4:6) mixture. The extract was then concentrated using a rotary evaporator with 100 µl toluene as keeper, solvent was exchanged to toluene until 0.5 ml and analyzed on GC/MS.

PM_{10}-BaP samples were extracted with solvent solution of 50 ml (a mixture of 12.5 ml hexane and 12.5 ml acetone (1:1) in Multiwave 3000 with rotor 8SOLV and cleaned up the same way as PAH-TSP. The obtained extracts with 100 µl toluene as keeper were concentrated using the rotary evaporator to 0.5 ml and analyzed on GC/MS. Benzo(*a*)pirene was determined using an Agilent 6890N Gass chromatograph with an Agilent 5973 Mass selective detector and capillary column DB-5 MS I, 30m 0.25 mm×25 µm. The oven temperature was programmed to be from 70 °C at a rate of 8 °C/min to 310 °C and held for 5 min with helium as the carrier gas. Semi-internal standard was used (deutered PAHs) for internal calibration. Prior to analysis, a calibration curve for the benzo(*a*)piren was obtained by spiking seven known quantities of substance with an R^2 of the calibration curve above 0.95. With each set of samples, both field and laboratory blank samples were prepared and analyzed together with the samples. Benzo(*a*)piren concentrations were corrected with reference to a blank.

UltraScientific PAH Mixture PM-831 PAHs mixture with Benzo(*a*)pyrene concentration of 500.8±2.5 µg/ml was used as the external standard for the calibration curve. Ultra scientific semi-volatiles internal standard mixture ISM-560 with deuterated compounds: acenaphthene-d10; chrysene-d10; 1,4-dichlorobenzene; Naphthalene-d8; perylene-d12; penanthrene-d10 was used as the internal standard.

The detection limit (DL) for each species was determined according to US-EPA test methods SW--846 (http://www.epa.gov/sw-846/pdfs/chap1.pdf). A known quantity of each standard substance was measured seven times, and the DL for each species was three times the standard deviation from the seven tests. When converted to atmospheric concentration, the detection limit for each of PAH species, including BaP, was 0.02 ng/m^3.

RESULTS AND DISCUSSION

In this study, we evaluated results from the last four years between 2005 and 2008. The annual average concentration of TSP in Belgrade urban area is shown in Figure 2. All values were above 70 µg/m^3 which is the annual target value for TSP according to current Serbian legislation [21]. The maximum monthly value was 729.7 µg/m^3 in November 2005 at measurement site 5_UT urban traffic and the minimum monthly value was 135 µg/m^3 in April 2006 at measurement site 1_UT urban traffic. All average annual values of TSP were between 150-230 µg/m^3.

The annual average BaP mass concentrations of TSP, samples collected between January 1st, 2005 and May 1st, 2008, are presented in Figure 3. Table 2 shows the average BaP mass concentration, median and percentile 0.75 measured at five sampling sites in the Belgrade urban area from January 1st, 2005, to May1st, 2008.

The main sources of BaP around the measuring sites were mostly influenced by emission from different sources such as residential heating, industrial facilities and traffic. Generally, BaP concentrations are higher during the winter (heating period, from October

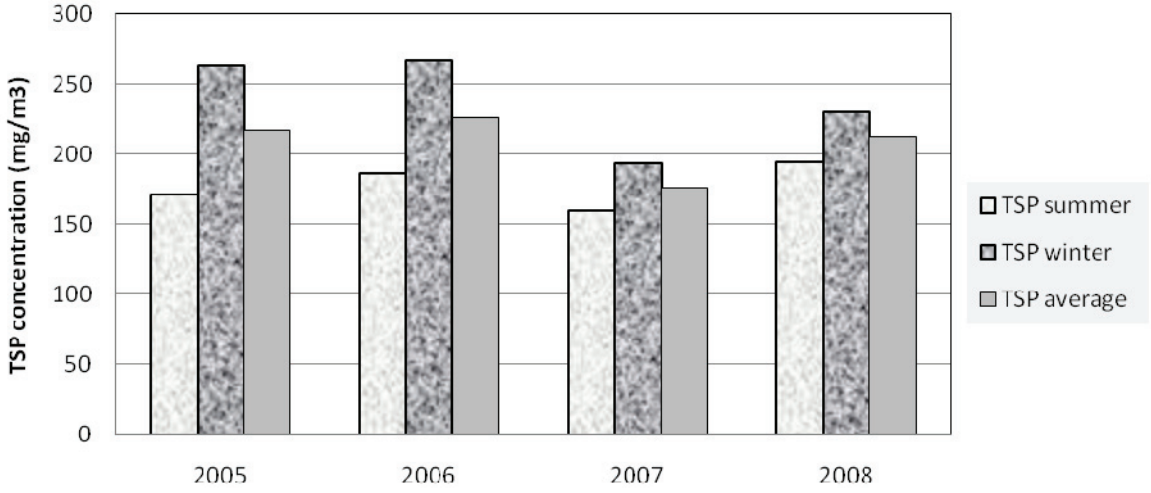

Figure 2. Annual mean concentration of TSP in the Belgrade urban area.

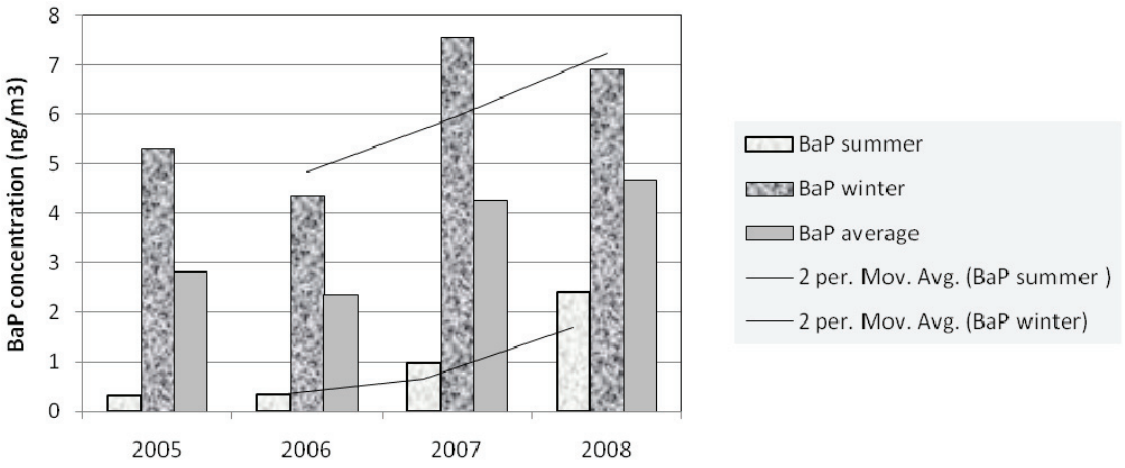

Figure 3. Annual mean concentration of BaP in the Belgrade urban area.

Table 2. Average BaP mass concentration analyzed from TSP, median and 75 percentile at 5 sampling sites in the Belgrade urban area for period January 1st, 2005-June 1st, 2008

Season	Staistical value	5_UT	6_UI	7_UT	8_UI	14_UT	22_SRT
Winter	*N*	20	21	18	19	18	17
	Average	6.53	5.06	8.87	8.62	2.73	4.09
	Meadian	5.00	3.29	9.58	8.66	2.00	2.40
	75th Percentile	7.30	7.06	14.31	12.59	3.88	3.92
Summer	*N*	16	15	15	16	16	13
	Average	1.18	0.41	0.97	0.90	0.78	0.73
	Median	0.58	0.25	0.29	0.63	0.35	0.52
	75th Percentile	1.15	0.70	1.33	1.24	1.36	0.70

to March) than during the summer (non-heating period, from April to September) period. Concentrations of BaP depend on sources strength and weather conditions. In Belgrade, coal and wood combustion for domestic heating were probably major contributors to the higher BaP loading in winter. The lower BaP concentrations in the summer period in Belgrade were likely influenced by higher degrees of atmospheric photo degradation and evaporation. One of the reasons that PAHs are lower during the summer is because semi-volatile PAHs are present in the gas phase in the summer due to higher temperature, while in the winter ambient temperatures are much lower. BaP was found to be a relatively unstable compound and it is questionable if it is a good indicator of total PAHs or carcinogenic PAHs [12].

There is also a possibility that lower levels of BaP in summer are due to summer rainfall which may have rinsed PAHs including BaP from the ambient air [27]. The precipitation level in the summer is significantly higher than in winter season in Belgrade. Table 3 shows precipitation levels at selected sampling sites in Belgrade during summer and winter season.

The highest seasonal mean value of BaP in TSP (16.65 ng/m^3) was detected in 2008. The highest monthly value was 35.7 ng/m^3 in November 2005 on measurement site 5_UT and minimum monthly values were about DLV (0.02 ng/m^3) on three measurement sites 5_UT, 6_UI and 8_UI during the summer months. Between 2005 and 2008 the annual mean concentrations were above target value. Figure 4 displays seasonal variations of BaP and TSP on measuring sites in Belgrade. Table 4 shows a number of measurements where BaP in TSP were higher than 1 ng/m^3.

TSP were sampled until May 2008, while after that we continued with sampling of PM_{10} on the same and new sampling sites. BaP data obtained from filters collected before and after May 2008 are shown in separate figures. Determination of BaP in PM_{10} collected since May, 2008, is shown in Figure 5.

It is underlined that generally between 80 and almost 100% of PAH including BaP can be associated with particles with an aerodynamic diameter of less than 2.5 μm, $PM_{2.5}$ [7]. However, in some recently published papers there are data about concentrations of BaP in TSP two times higher than in PM_{10} at residential sites, and in same towns the same level of

Table 3. Annual precipitation level, standard deviation, median and 75 percentile at selected sampling sites in the Belgrade urban area

Precipitation level, mg/m^2/day		2005	2006	2007	2008	Average	Standard deviation	Median	75th Percentile
1_UT	Winter	-	244	227	128	200	62	227	235
	Summer	-	291	856	288	479	327	291	574
5_UT	Winter	125	146	233	89	148	61	136	168
	Summer	323	318	381	383	351	36	352	382
6_UI	Winter	84	209	268	165	181	77	187	224
	Summer	339	234	432	333	334	81	336	362
7_UT	Winter	77	171	134	108	123	40	121	144
	Summer	237	241	352	263	273	54	252	286
8_UI	Winter	119	241	352	263	244	96	252	286
	Summer	347	291	358	560	389	118	352	408
9_UB	Winter	175	119	255	208	189	57	191	219
	Summer	281	248	404	285	304	68	283	315
17_UT	Winter	149	152	164	120	146	19	151	155
	Summer	270	190	378	252	272	78	261	297
18_ SUI	Winter	178	223	102	151	163	51	164	189
	Summer	319	286	337	261	301	34	302	324
20_ RI	Winter	118	354	289	149	227	112	219	305
	Summer	270	378	327	490	366	94	352	406
22_SRT	Winter	-	244	93	169	169	76	169	207
	Summer	-	332	391	345	356	31	345	368

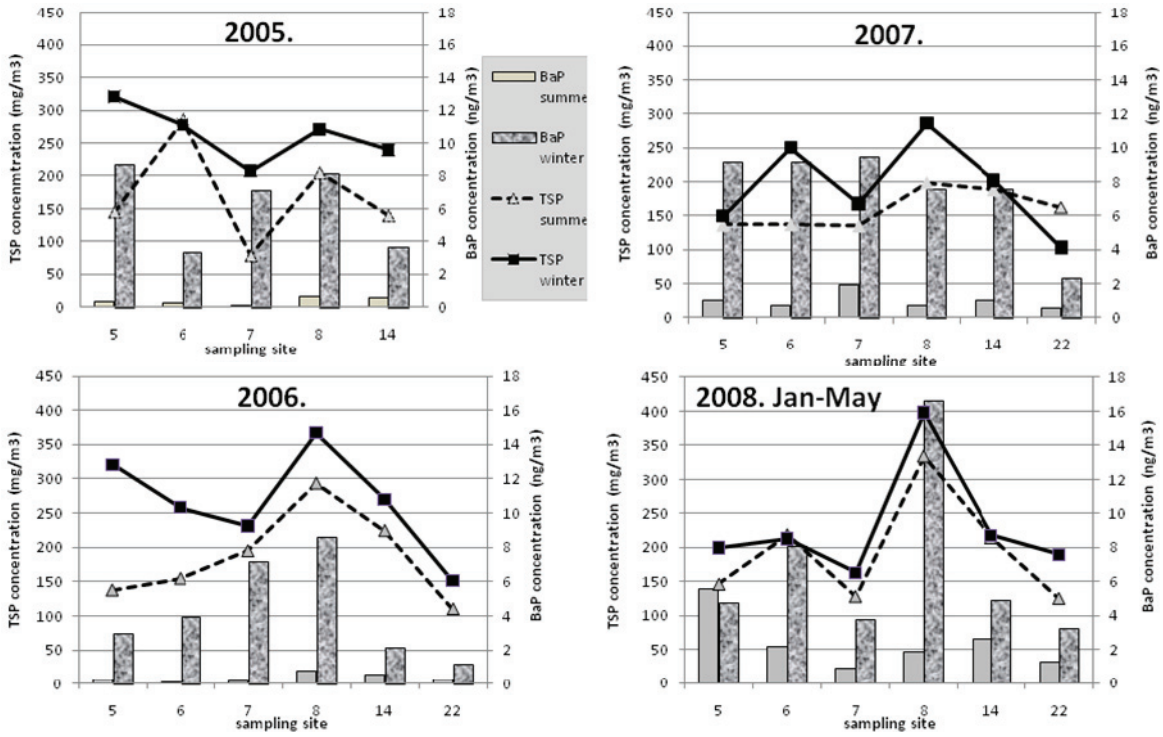

Figure 4. Seasonal variations of TSP and BaP in TSP at different sampling sites in the Belgrade urban area in period 2005-2008.

BaP in TSP and PM_{10} at industrial sites [28]. The meteorological conditions in the Belgrade metropolitan area are characterized with stronger wind in the winter and higher level of precipitation in the summer. Stronger winds enable soil dust and road dust to re-suspend in the winter period and remain in the ambient air contributing to higher level of BaP.

The obtained results for PM_{10} concentration were higher during the heating season than the non-heating season, except at two urban traffic sites. At site

Table 4. Concentrations of BaP in TSP above limit value according to Serbian legislative

Year	Number of measurement	Values above 1 ng/m^3	Content, %
2005	42	21	50.0
2006	69	27	39.1
2007	67	41	61.2
2008 (January-May)	32	27	84.4

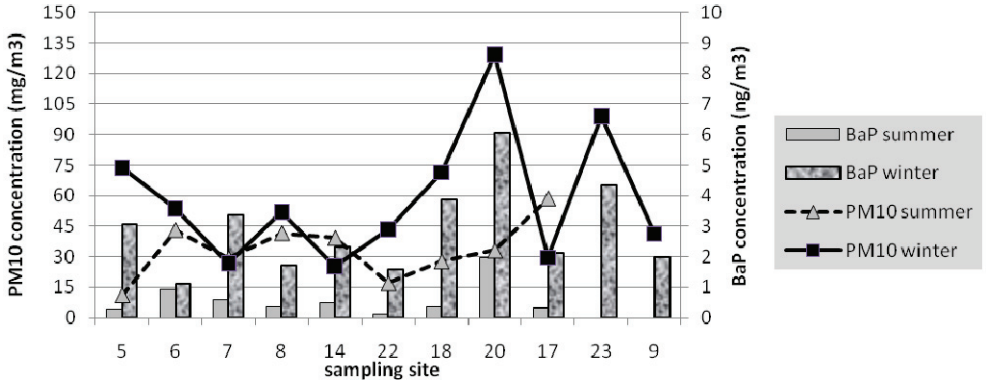

Figure 5. Seasonal variations of PM_{10} and BaP in PM_{10} in the Belgrade urban area.

7_UT concentrations were about the same level in both seasons and at site 17_UT concentrations were much higher during summer then during winter season. At sites 5_UT, 8_UI, 6_UI, 18_SRI, 20_RI and 23_UT PM_{10} concentrations were above 50 μg/m^3, meaning above target value according to current EU legislation. The maximum PM_{10} value was 150.2 μg/m^3 in December at site 14_UT, and the minimum was 3.8 μg/m^3 in September at site 5_UT. Also, the concentration of BaP in winter followed PM_{10} concentrations. All values were above target value for BaP. The maximum value was 9.09 ng/m^3 in December at an industrial measurement site with rural surrounding (20_RI) in the vicinity of Thermal Power Plant Kolubara and the minimum value was 0.05 ng/m^3 in August at site 22_SRT.

Table 5 shows information about BaP studies in European cities performed in the last 10 years. Presented for each study are: the location and country where monitoring was performed; type of sampling site; characteristic of collected samples, TSP or PM_{10}, case I only particulate fraction or both particulate and gas fractions were collected; number and duration of sampling; period of sampling; as well as the determined concentration of BaP in ng/m^3. At sampling sites in Belgrade only one sample was collected each month, which is too limited to obtain representative results according to the requirements for data capture and time coverage in EU legislation [20]. Nevertheless, the results of BaP analysis for particular types of sampling sites, as well as the annual average concentration in the Belgrade metropolitan area were comparable with levels of BaP determined in the other European cities.

CONCLUSION

The mean annual TSP concentrations in the period January 2005-May 2008 were above 70 ng/m^3 for each year in the Belgrade urban area. The results of this study show that BaP followed the pattern of seasonal variations of suspended particulate matter, being higer in the winter and lower in the summer. During winter season, which is in fact heating season, concentrations were higher at almost all measuring sites due to strong influence of local heating, influence of higher degree of atmospheric photo degradation, evaporation processes, as well as other meteorological conditions. There is a slight trend of rising levels of BaP from year to year in samples of TSP collected between Janaury, 2005, and May, 2008, that may be associated with the increasing frequency of traffic in the Belgrade metropolitan area.

Generally, this study confirms that the concentations of BaP in particulate matter were comparable with levels detected in other Europen cities. For determination of the uncertainty of the time coverage of air quality measurements of BaP at the municipal monitoring network according to requirements from 4th Daughter directive, it is important to improve time coverage of data. That means that at least 4-5 measurements are necessary per month for fixed measurements and 2 per month for indicative measurements.

Table 5. BaP studies in European cities in the last 10 years

Location, Country	Type of site	PM10/TSP/organic compounds in the gas phase	Year of sampling	Number and duration of sampling	Season	Level ng/m^3
Belgrade, Serbia, this study	Urban traffic	TSP	January 2005--May 2008	1-day per month, 24 h	Winter Summer	6.63 1.18
	Urban traffic	TSP	January 2005--May 2008	1-day per month, 24 h	Winter Summer	8.87 0.97
	Urban traffic	TSP	January 2005--May 2008	1-day per month, 24 h	Winter Summer	7.73 0.78
	Urban industrial	TSP	January 2005--May 2008	1-day per month, 24 h	Winter Summer	5.06 0.41
	Urban industrial	TSP	January 2005--May 2008	1-day per month,24 h	Winter Summer	8.62 0.90
	Suburban traffic	TSP	January 2005--May 2008	1-day per month, 24 h	Winter Summer	4.09 0.73
Zonguldak, Turkey [12]	Industrial (iron-steel industry)	PM_{10}	January--December 2007	Twice a week ,24 h	Winter Summer	16.04 0.95
Duisburg, Germany [13]	Urban Background	PM_{10}	2002	7 weeks, 3- and 4-day periods per week	Autmn	1.05
Prague, Czech Republic [13]	Urban Background	PM_{10}	2003	7 weeks 3- and 4-day periods per week	Winter	3.03
Amsterdam, Netherlands [13]	Urban Background	PM_{10}	2003	7 weeks 3- and 4-day periods per week	Winter	0.33
Helsinki, Finland[13]	Urban Background	PM_{10}	2003	7 weeks 3- and 4-day periods per week	Spring	0.14
Barcelona, Spain[13]	Urban Background	PM_{10}	2003	7 weeks 3- and 4-day periods per week	Spring	0.08
Athens, Greece[13]	Urban Background	PM_{10}	2003	7 weeks 3- and 4-day periods per week	Summer	0.05
Budapest, Hungary [29]	Traffic police	-	January	28 Personal sampling, 8 hours	Winter	8.2
	Road builder	-	January	10 Personal sampling, 8 hours	Winter	0.6
Zagreb, Croatia [30]	Fixed site	TSP	-	24 h	Winter Summer	5.12 0.05
Zagreb, Croatia [31]	Residential	PM_{10}	2001	355, 24 h	-	1.37
			2002	362, 24 h	-	1.24
			2003	362, 24 h	-	1.79
			2004	364, 24 h	-	1.17
Zagreb, Croatia [31]	Residential	PM_{10}	2003	91, 24 h	Spring	0.58
			2003	92, 24 h	Summer	0.12
			2003	89, 24 h	Autman	2.76
			2004	90, 24 h	Winter	2.94
Sarajevo, Bosnia and Hercegovina [32]	Industrial	TSP and PUF	May 2004	5, 24 h	Spring	0.46
	Urban residential		May 2004	5, 24 h	Spring	0.57
	Industrial		May 2004	5, 24 h	Spring	0.38
	Industrial		May 2004	5, 24 h	Spring	0.64
	Background		May 2004	5, 24 h	Spring	0.14

Table 5. Continued

Location, Country	Type of site	PM10/TSP/organic compounds in the gas phase	Year of sampling	Number and duration of sampling	Season	Level ng/m^3
Tuzla, Bosnia and Herzegovina [32]	Residential	TSP and PUF	May 2004	5, 24 h	Spring	1.58
	Industrial		May 2004	5, 24 h	Spring	1.74
	Industrial		May 2004	5, 24 h	Spring	1.06
	Residential and Industrial		May 2004	5, 24 h	Spring	1.17
	Urban background		May 2004	5, 24 h	Spring	0.83
Florence, Italy [33]	Traffic site	TSP and XAD-2	December 1999--March 2000	7 consecutive days during the second week of each month	Winter	2.1
	Urban Background	TSP and XAD-2	December 1999-November 2000	7 consecutive days during the second week of each month	Whole year	0.06
Rome, Italy [34]	Urban residential	PM10 and PUF	February 2000--January 2001	One sample every other week, 24 h	Whole year	1.13
	Regional Background	PM10 and PUF	February 2000--January 2001	One sample every other week, 24 h	Whole year	0.02

Future work will be to determine the content of BaP and other PAHs in smaller solid fractions from ambient air such as PM_{10} and to confirm spatial and temporal reperesentativity of current sampling sites that were established within municipal monitoring network since 2008. It is also of great importance to investigate levels and content of different PAHs in fine and ultrafine fractions, with particular attention to PAHs species that are more toxic and responsible for adverse health effects, to monitor PAHs species at background sites and, at last but not least, to perform source apportionment modeling.

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NAUČNI RAD

SEZONSKI TRENDOVI BENZO(*a*)PIRENA U SUSPENDOVANIM ČESTICAMA U URBANIM PODRUČJIMA BEOGRADA (SRBIJA)

Poliaromatični ugljovodonici (PAH) su identifikovani kao jedni od najtoksičnijih zagadjivača u urbanim sredinama. PAH-ovi se najvećim delom formiraju usled nepotpunog sagorevanja ili pirolzom organskih materija.U Srbiji u skladu sa nacionlnom legislativom, benzoapiren (BaP) u ukupnim suspendovanim česticama (TSP) u ambijentnom vazduhu Beograda se određuje u posledenjih deset godina u okviru lokalnog programa monitoringa koji finansira Gradska skupština a realizuje Gradski zavod za javno zdrvalje Beograda. Uzorci vazuha za analizu BaP iz suspendovanih čestica se uzorkuju (jednom mesečno 24 h) na izabranim mestima u okviru gradske monitoring mreže za kontrolu aerozagađenja. Od početka merenja BaP-a u ambijentnom vazduhu u skladu sa nacionalnom legislativom, prikupljane su i analizirane ukupne suspendovane čestice (TSP). Od sredine 2008. procedura uzorkovanja je usaglašenja sa zahtevima EU, od kada se prikuplja i analizira čvsta frakcija PM_{10} korščenjem GC/MS. U ovoj studiji smo analizirali rezultate TSP prikupljenih u periodu 2005 -2008. godine. Posmatrajući rezultate prikupljene tokom cele godine utvđeno je da je i u Beogradu na uglavnom svim mernim mestima koncentracija BaP daleko viša tokom zimske sezone.

Ključne reči: Monitoring aerozagadjenja; čestice; benzo(a)piren.