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SPATIAL EVALUATION OF NO_2, SO_2, PM10 AND BTEX CONCENTRATIONS IN URBAN AMBIENT AIR

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Abstract

During the 2014-2015 period of environmental air quality research, concentrations of NO_2, SO_2 and BTEX (benzene, toluene, ethylbenzene and xylenes) and PM10 were measured. In order to evaluate the spatial distribution of pollutants, 5 sampling sites in Anykščiai city (Lithuania) were chosen. Measured values of NO_2, SO_2, PM10 and benzene were compared with limit values set for these pollutants in ambient air according to 2008/50/EC and 2000/69/EC directives. Toluene, ethylbenzene, and xylenes (*ortho*, *meta*, and *para*) were not included into the list of pollutants, which amount in ambient air is regulated according to European Union criteria. These pollutants are regulated since July 1, 2007 according to national criteria of Lithuania. The NO_2 concentrations in Anykščiai varied from 3.1–4.5 μg/m^3. The SO_2 concentration was found in the range of <0.3–3.7 μg/m^3. PM10 concentration was found in the range of 10.0–29.0 μg/m^3. Benzene concentrations in Anykščiai varied from 0.4 – 2.8 μg/m^3, toluene concentrations in Anykščiai varied from 0.9–2.8 μg/m^3, ethylbenzene concentrations in Anykščiai varied from <0.4–1.8 μg/m^3, xylenes concentrations in Anykščiai varied from 0.6–5.7 μg/m^3. The annual average of NO_2, SO_2, PM10 and BTEX and concentrations were below the permissible limits in all five places.

Key words: ambient air, BTEX, NO_2, SO_2, PM10

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1. Introduction

Air pollution now is a hot topic (Zavadskas et al., 2018). Current trends in urban development, including growth of road transport, increasing energy demand and rising household energy consumption, place severe pressure on the urban environment (Azapagic et al., 2013; Guttikunda et al., 2012). These sectors are responsible for harmful compounds emission into the atmosphere. Air pollution is harmful to plants and animals and causes health hazards for humans (Baltrėnas et al., 2008). About 400 000 premature adult deaths attributable to air pollution occur each year in Europe (Amato et al., 2014). Urban automobile transport has become the dominant source of air pollution in larger urban cities (Rosu et. al., 2018). Ground-level vehicular traffic in urban area is typically natural gas-fueled, gasoline-fueled or diesel-fueled (Singh et al., 2018). Ambient air pollution is a complex mixture composed of both solid particles and gaseous pollutants (Kan et al., 2012). In Lithuanian cities, the primary air pollutants (i.e. NO_2, SO_2, PM10 and BTEX) are mainly emitted from industrial activities, domestic energy consumption and transportation. Given the negative impact on humans, animals and plants, the ambient presence of primary air pollutants must be monitored. Outdoor pollutants, such as vehicle and gas emissions, can also enter indoor environments through ventilation systems (Wang et al., 2018). The possibility of forecasting pollutant concentration near the ground with high spatial detail offers the opportunity of constantly monitoring and managing the territory (Matarazzo et. al., 2018). Ambient air monitoring can provide important information about the surrounding atmospheric pollution (Lizuka et al.,

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2014). Air quality control is also performed for assessing the impact of air pollution on human health, the environment and climate in order to take the necessary measures to protect material goods and living organism. The passive sampler method is widely used in order to quantify ambient gaseous air pollutant concentrations (Adema et al., 2012; Byanju et al., 2012; Caballero et al., 2012; Estellano et al., 2012; Fridh et al., 2014; Hien et al., 2014; Król et al., 2012; López–Aparicio and Hak, 2013; Pekey and Yılmaz, 2011; Přibylová et al., 2012; Šerevičienė et al., 2014; Zielinska et al., 2014). Passive diffusion samplers provide a cost–effective way to monitor air–pollutant species at both local and regional scales. Compared with conventional methods, they can be deployed unattended for extended periods and do not require power supply (Adema et al., 2012). In EU countries maximum permissible levels (MACs) have been defined for some substances found in the air in the context of human health and plant protection. Council Directives – 2000/69/EC (Król et al., 2012; Pekey and Yılmaz, 2011), 96/62/EC (Adema et al., 2012; Słomińska et al., 2014) and 2008/50/EC (Šerevičienė et al., 2014) are used for ambient air–quality assessment and management. Measured values of NO_2, SO_2, PM10 and benzene in ambient air were compared with limit values according to 2008/50/EC directive. Toluene, ethylbenzene, and xylenes (*ortho, meta,* and *para*), are not included into the list of pollutants, which amount in ambient air is regulated according to European Union criteria. These pollutants are regulated since 1 July 2007 according to national criteria of Lithuania. Anykščiai has been granted status of resort territory, therefore concentrations of ambient air pollutants must meet requirements of standards. NO_2, SO_2, PM10 and BTEX were assessed at five different places within Anykščiai city for a one–year period (June 2014 – March 2015) for all seasons. The measuring points were chosen for evaluation of ambient air quality.

Air quality evaluation is important for assessing the nature of population exposure to air pollution. Assessment of population exposure is necessary for health impact assessment, which in turn is crucial for developing plans for air quality management and protecting the public health. Anykščiai has been granted status of resort territory, therefore concentrations of ambient air pollutants must meet requirements of standards or even must be lower than in other urban territory. It is very important to evaluate concentrations level of main air pollutants in ambient air, because it is lack of data for Anykščiai city. This information is very important for tourists and local inhabitants. There is no much data about application of passive samplers for evaluation of ambient air quality, therefore data presented in article should be important for researchers.

The principle objectives were: to measure the concentration of NO_2, SO_2, PM10 and BTEX in the five measurement sites covering Anykščiai city and to compare the results with ambient air standards.

2. Materials and methods

2.1. Study area

The study was carried out in the Northern Europe, Lithuania (Anykščiai city), where there is only one permanent air quality monitoring place (Panevėžys monitoring station located 35 km from Anykščiai city). According to *Lithuanian Department* of *Statistics* (2013), Anykščiai population is 10 196 (2013). Anykščiai is located in Utena district, Lithuania (55° 31' 32.0" N, 25° 6' 9.5" E). The city lies on the Šventoji River. The area of Anykščiai city is 11.50 km^2.

According to *Lithuanian Department* of *Statistics* (2012), the number of registered vehicles in Anykščiai district was 576 per one thousand of people. There are 3 country roads in Anykščiai city: Molėtai–Anykščiai (No 119), Radiškis–Anykščiai–Rokiškis (No 120), Anykščiai–Troškūnai–Panevėžys (No 121).

According to Lithuanian Road Administration under the Ministry of Transport and Communications of the Republic of Lithuania (2014) average annual 24 h traffic intensity was: in country road No. 119 Molėtai–Anykščiai 655 cars/day, in country road No. 120 Radiškis–Anykščiai–Rokiškis 1929 cars/day, in country road No 121 Anykščiai–Troškūnai–Panevėžys 2023 cars/day. Statistics show that the volume of traffic in the future will inevitably grow. Natural gas is used in Anykščiai city urban heat boiler.

Studies of Anykščiai city air quality were carried out in 5 urban locations (points). Map of selected places in Anykščiai city is shown in Fig. 1.

The annual mean temperature of Anykščiai is about 6.0–7.0°C. The city's mean average temperature spring is 6.8°C, average temperature in summer is 17.7°C, average temperature in autumn is 7.6°C and average temperature in winter is –3.2°C. The average annual rainfall is about 650 mm and the period with snow cover is about 90 days. Average wind velocity – 3.5 m/s.

The 5 – measurement places in the city of Anykščiai were selected as representative of recreational, residential and transport impact areas. First place of measurements was in recreation territory (N55°30'39" E25°5'2.3"), second – in residential territory (N55°31'15" E25°5'50"), third (N55°31'36" E25°6'15"), fourth (N55°31'38" E 25°6'2"), and fifth (N55°31'35" E 25°6'59.6") – near intense transport streets.

Measurement of NO_2, SO_2, PM10 and BTEX concentrations

The air quality measurements were carried out for 1 year from the months of June 2014 to March 2015. The air quality assessment period is presented in Table 1. The concentration of gaseous pollutants (SO_2, NO_2, BTEX) were analyzed by diffusive sampling method and concentration of PM10 – applying analyzer MP101M.

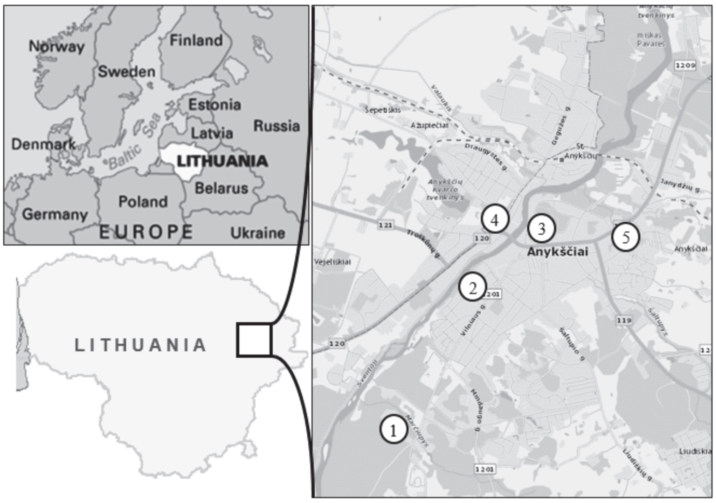

Fig. 1. Location of the study area

Table 1. Air quality in Anykščiai city assessment period

Season	*Pollutant*	*Period of measurements*
Summer	NO_2, SO_2, BTEX	June 10, 2014 – June 23, 2014
	PM10	June 10–16, 2014
Autumn	NO_2, SO_2, BTEX	September 11, 2014 – September 24, 2014
	PM10	September 22–26, 2014
Winter	NO_2, SO_2, BTEX	January 21, 2015 – February 6, 2015
	PM10	January 21, 2015 – January 23, 2015
Spring	NO_2, SO_2, BTEX	March 16, 2015 – March 30, 2015
	PM10	March 16, 2015 – March 18, 2015

In order to reduce uncertainty and the risk of data loss, three samplers for each compound (NO_2, SO_2 and BTEX) were exposed in parallel at each of the sampling locations for a period of approximately 2 weeks at different seasons of the year: during the cold period – the winter season; during the transition period – the spring and autumn seasons; during the warm period – the summer season. A total number of 60 samples for each pollutant (NO_2, SO_2 and BTEX) were collected. After exposure, the diffusion samplers were analyzed in accredited laboratory, Passam ltd (Switzerland) and the quantity of NO_2, SO_2, BTEX was determined (Lithuanian Air Monitoring System, 2010). According to air quality directive (2008/50/EC), the results of indicative measurements shall be taken into account for the assessment of air quality with respect to the limit values. For the indicative measurements, minimum time coverage is 14 % that provides 8 weeks evenly distributed over the year. The applied measurements' time was in accordance to these requirements. Therefore, the obtained results can be compared with defined limits for measured pollutants. During the transportation and forwarding for analysis, the passive samplers were sealed. The samplers in casings were fixed at 3–4 m above the ground. The area of the samplers' exposure was open, free from buildings, trees and other objects, at least 1 m from any structures that could disrupt the airflow. Particulate matter PM10 was measured by the method of beta radiation absorption (Method ISO 10473) on an Environment S.A. (France) Model MP101M PM10 Beta Gauge Monitor device for a period of 8 h at an average flow rate of 1.0 m^3/hour. In each measuring point an average value of PM10 was calculated.

2.2. Statistical analysis

Descriptive statistical analysis was used (mean, standard deviation interval and Pearson coefficients). A two–sample t test assuming unequal variances was used to compare mean concentrations of pollutants in different measuring points or in different seasons of the year. The significance of association (p) was accepted as statistically significant at an alpha level of <0.05. Data were analyzed with Excel 2013.

3. Results and discussion

3.1. NO_2 concentration in Anykščiai city

Seasonal variations in the ambient levels of measured pollutants can be influenced by a number of factors, including source variations, fuel consumption, chemical reactivity, meteorology the location, time of sampling etc.

NO_2 concentrations in Anykščiai varied from 3.1 to 14.5 μg/m^3 with an average of 9.45 μg/m^3. The minimum value of NO_2 concentration was found 3.1

μg/m^3 (average of autumn – 8.0±2.82 μg/m^3) in September 2014. The maximum value of NO_2 was recorded 14.5 μg/m^3 (average of winter – 11.5±3.26 μg/m^3) in January – February 2015.

Overall, 100% monitored values of NO_2 were smaller than permissible limit according to 2008/50/EC Directive (40 μg/m^3). There is no statistically significant difference was registered between NO_2 concentrations in all seasons of 2014/2015 year. Results of NO_2, SO_2, PM10 measurements are shown in Fig. 2. Annual limit values for ambient air pollutants: nitrogen dioxide – 40 μg/m^3; sulphur dioxide – 20 μg/m^3; PM10 – 40 μg/m^3. Exposures of women with increased concentration of NO_2 and PM10 in ambient air during pregnancy was associated with a relative increase in the odds of having a child diagnosed with autism (Becerra et al., 2013). The increase in NO_2 concentrations was recorded in the winter and spring seasons, due to reduced solar radiation and lower temperatures and also due impact of heating and transport. Road transport is one of the major NO_x emitting sectors.

3.2. SO_2 concentration in Anykščiai city

SO_2 is a respiratory irritant and bronchoconstrictor that has been associated with cardiovascular abnormalities including decrease in heart rate variability (Chen et al., 2012). Therefore, ambient SO_2 concentration must be controlled. SO_2 concentrations in Anykščiai varied from <0.3 to 3.7 μg/m^3 with average value of 1.03 μg/m^3. The minimum value of SO_2 concentration was recorded <0.3 μg/m^3 (average spring value – <0.4±0.21 μg/m^3) in March 2015, whereas maximum – 3.7 μg/m^3 (average autumn value – 2.0±1.1 μg/m^3) was detected in September, 2014. Overall, 100% recorded values of SO_2 was found within the permissible limit according to 2008/50/EC directive 20 μg/m^3.

The average SO_2 concentration in Anykščiai was low round the year. The biggest concentrations of SO_2 were recorded during summer and autumn due to impact of transport. Measurement seasonal SO_2 concentration results show that the SO_2 annual average level was significantly different in all seasons of 2014/2015 year except summer, 2014 and autumn, 2014.

3.3. PM10 concentration in Anykščiai city

PM10 concentrations in Anykščiai varied from 10.0 to 29.0 μg/m^3 with an average value of 19.53 μg/m^3. The minimum value of PM10 concentration was recorded 10.0 μg/m^3 (summer average value – 15.0±3.37 μg/m^3) in June 2014. The maximum value of PM10 – 29.0 μg/m^3 (spring average value – 26.9±3.43 μg/m^3) was detected in March 2015. Overall, 100% recorded values of PM10 was found within the permissible limit according to 2008/50/EC directive 40 μg/m^3. There is no statistically significant difference was registered between PM10 concentrations in all seasons of 2014/2015 year. Respirable particulates having aerodynamic diameter PM10 and PM2.5 and fine particles are an important part of the atmosphere. The particle size is very important both in terms of deeper penetration into the lungs and are carriers of toxic air pollutants including heavy metals and organic compounds (Pandey et al., 2012).

So it is very important to evaluate level of these pollutants in ambient air. The average PM10 concentration in Anykščiai was low round the year, but there was a sudden increase found in winter 2014/2015 and in spring 2015 due to cumulative effect of house heating and transport. Traffic is a major contributor to particulate air pollution in urban areas, producing particles of all sizes from coarse (2.5 - 10 μm diameter) to ultrafine (Janhäll et al., 2012).

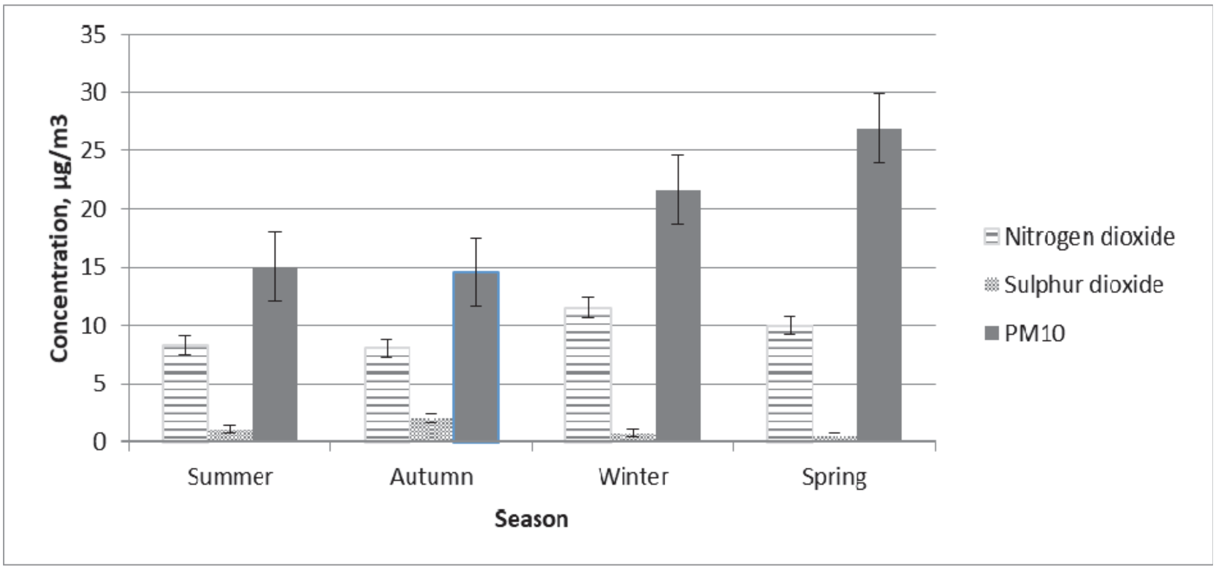

Fig. 2. Average concentrations (±std. dev.) of NO_2, SO_2 and PM10 in Anykščiai

3.4. BTEX concentration in Anykščiai city

The concentration of BTEX was recorded from June 2014 to March 2015. Benzene concentrations in Anykščiai varied from 0.4 to 4.4 μg/m^3, average value – 1.58 μg/m^3. The minimum value of benzene concentration was recorded 0.4 μg/m^3 (summer average value – 0.7±0.20 μg/m^3) in June 2014. The maximum value of benzene – 4.4 μg/m^3 (winter average value – 3.0±0.88 μg/m^3) was detected in January/February 2015. The average benzene concentrations in Anykščiai was low round the year. Overall, 100% recorded values of benzene were found within the permissible limit for benzene according to 2008/50/EC Directive.

There is no statistically significant difference was registered between benzene concentrations in all seasons of 2014/2015 year except winter, 2014/2015 and spring 2015. According to the WHO, lifetime exposure of urban populations to benzene concentrations of 1.7 μg/m^3 results in an average of ten cases of leukemia per million inhabitants (Król et al., 2012). This limit value was exceeded during winter and spring seasons in Anykščiai, thus reducing benzene emissions into the atmosphere is very important. The toluene to benzene (T/B) ratio has been commonly used as an indicator of traffic emissions. The observed trend at Anykščiai places is shown in Fig. 3. Limit values for ambient air pollutants: benzene – 5 μg/m^3 (annual); toluene – 600 μg/m^3 (24 h); ethylbenzene – 20 μg/m^3 (24 h); xylenes – 200 μg/m^3 (24 h).

Vehicular emissions are the major source of air pollution in urban environments (Niaz et al., 2015). Benzene and toluene are constituents of gasoline and are emitted into the atmosphere by motor vehicle exhausts. The toluene content of gasoline and motor vehicle exhaust is 3–4 times higher than benzene content. A value of around 2–3 is characteristic of vehicular emission in many urban areas worldwide. Typical value of T/B ratio is 1–5 in rural areas (Pekey and Yılmaz, 2011). The range of T/B ratio measured for the study area of Anykščiai was between 0.7 and 5.3 so it is typical value for rural and particularly for urban area. The main sources of emissions of BTEX compounds into outdoor air are: motor vehicle transport, refinery, coke, and smelting industries, paint and varnish industries etc. (Słomińska et al., 2014). Consequently, motor vehicles and house heating during winter season and beginning of spring were the most important source of benzene concentrations measured in the present study.

Toluene concentrations in Anykščiai varied from 0.9 to 4.7 μg/m^3, average value – 2.1 μg/m^3. The minimum value of toluene concentration was recorded 0.9 μg/m^3 (autumn average value – 1.4±0.43 μg/m^3) in September 2014. The maximum value of toluene – 4.7 μg/m^3 (winter average value – 2.9±1.20 μg/m^3) was detected in January/February 2015. There is statistically significant difference was registered between toluene concentrations in summer, 2014 and autumn, 2014, also between toluene concentrations in summer, 2014 and spring, 2015, and winter, 2014/2015 and spring, 2015. The biggest concentrations of toluene were recorded during winter due to impact of house heating and transport.

Ethylbenzene concentrations in Anykščiai varied from <0.4 to 1.8 μg/m^3, average value – 0.78 μg/m^3. The minimum value of ethylbenzene concentration was recorded <0.4 μg/m^3 (winter average value – 0.5±0.13 μg/m^3) in January/February 2015. The maximum value of ethylbenzene – 1.8 μg/m^3 (summer average value – 1.4±0.41 μg/m^3) was detected in June 2014. There are statistically significant differences were registered between ethylbenzene concentrations in summer, 2014 and autumn, 2014, also between toluene concentrations in summer, 2014 and winter, 2014/2015, and summer, 2014 and spring, 2015. The biggest average concentrations of ethylbenzene were recorded during summer due to the impact of transport.

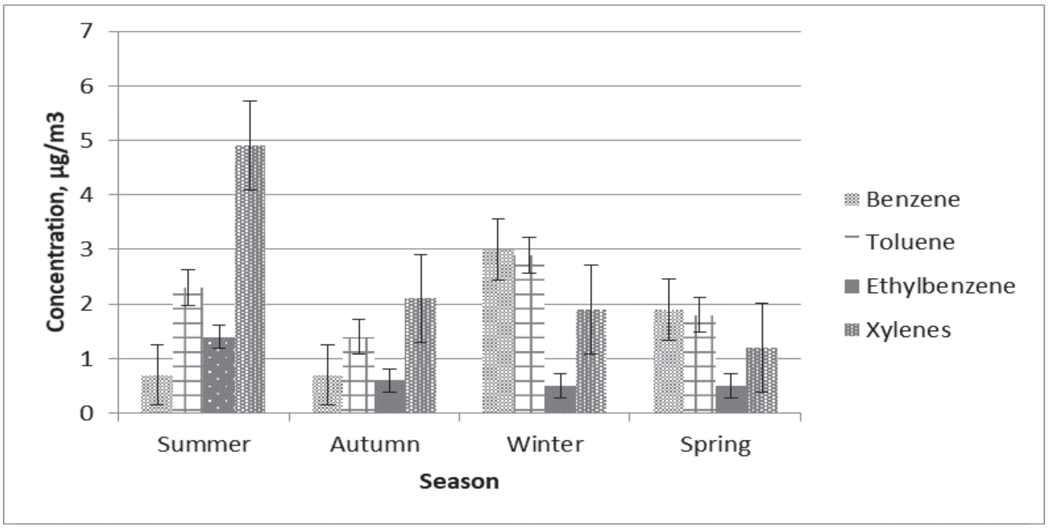

Fig. 3. Average concentrations (±std. dev.) of BTEX in Anykščiai

It was determined separate concentration of ortho–xylene, meta–xylene and para–xylene and cumulative concentration of xylenes was calculated. Xylenes concentrations in Anykščiai varied from 0.6 to 5.7 μg/m^3, average value – 2.53 μg/m^3. The minimum value of xylenes concentration was recorded 0.6 μg/m^3 (spring average value – 1.2±0.47 μg/m^3) in March 2015. The maximum value of xylenes – 5.7 μg/m^3 (summer average value – 4.9±0.89 μg/m^3) was detected in June 2014. The biggest average concentrations of xylenes were recorded during summer due to impact of transport. Overall, 100% recorded values of xylenes were found within the permissible limit for these pollutants.

3.5. Average annual concentrations of pollutants in measured points

The highest annual NO_2 concentrations in ambient air were recorded in point 5 (10.9±2.68 μg/m^3) and the smallest concentration in point 1 (5.1±1.59 μg/m^3). In other measuring points (2, 3, 4) concentrations of NO_2 were within 10.4–10.5 μg/m^3 (Table 2). The data show there are no significant differences between the NO_2 concentrations in all measuring points.

The biggest annual SO_2 concentrations in ambient air were recorded in point 3 (2.2±0.53 μg/m^3) and the smallest concentrations – in 1 and 5 points (0.6 – 0.7 μg/m^3). In other measurement points (2, 4) annual SO_2 concentrations were within 1.0 – 1.1 μg/m^3. Measurement places SO_2 concentration results show that the SO_2 level was significantly higher in 3 point comparing to 5 point and in 4 point comparing to 5 point. The data show there are no significant differences between the SO_2 concentrations in other measuring points.

The biggest annual PM10 concentrations in ambient air were recorded in point 3 (21.1±4.46 μg/m^3) and the smallest concentrations – in 1 point (16.8±8.11 μg/m^3). In other measurement points (2, 4, 5) annual PM10 concentrations were within 18.6–20.5 μg/m^3. The data show there are no significant differences between the PM10 concentrations in all measuring points. The biggest annual benzene concentrations in ambient air were recorded in point 2 (2.1±1.64 μg/m^3) and the smallest concentrations – in 1 point (1.3±0.78 μg/m^3). Average annual concentrations of pollutants in measured points are presented in Table 2.

In other measurement points (3, 4, 5) annual benzene concentrations were within 1.4–1.6 μg/m^3. The data show there are no significant differences between the benzene concentrations in all measuring points. The biggest annual toluene concentrations in ambient air were recorded in point 5 (2.6±1.53 μg/m^3) and the smallest concentrations – in 1 and 4 points (1.8 μg/m^3). In measurement points (3, 4, 5) annual toluene concentrations were within 2.2–2.3 μg/m^3. Measurement places toluene concentration results show that the toluene level was significantly higher in 3 point comparing to 4 point. The data show there are no significant differences between the toluene concentrations in other measuring points.

The biggest annual ethylbenzene concentrations in ambient air were recorded in points 3, 4 and 5 (0.8–1.0 μg/m^3) and the smallest concentrations – in 1 and 2 points (0.6 and <0.8 μg/m^3, respectively). The data show there are no significant differences between the ethylbenzene and concentrations in all measuring points.

The biggest annual xylenes concentrations in ambient air were recorded in point 5 (3.1±2.03 μg/m^3) and the smallest concentrations – in 2 point (2.2±1.03 μg/m^3). In other points (1, 3, 4) concentration of xylenes was within 2.3 –2.6 μg/m^3. The data show there are no significant differences between the xylenes concentrations in all measuring points.

Correlation between concentrations of pollutants and meteorological data

Table 3 presents the Pearson's correlation coefficient matrix for the average concentrations of BTEX, NO_2, SO_2 and PM10. There were significant statistical relationships between measured air pollutants when Pearson's correlation matrix was applied to the variables at a 95% confidence interval. A strong positive correlation (r=0.60) between PM10 and benzene indicates that they might possibly the same source of pollution.

Table 2. Average annual concentrations (±std. dev.) of pollutants in measured points of Anykščiai

Pollutant	*Annual limit value, μg/m^3*	*1 point*	*2 point*	*3 point*	*4 point*	*5 point*
NO_2	40	5.1±1.59	10.4±2.33	10.5±1.55		10.9±2.68
SO_2	20*	0.6±1.52	<1.1±0.86	<2.2±0.53		0.7±0.35
PM10	40	16.8±8.11	18.6±5.51	21.1±4.456	19.4±4.20	20.5±6.39
Benzene	5	1.3±0.78	2.1±1.64	1.5±0.94		1.4±0.85
Toluene	600**	1.8±0.38	2.2±0.95	2.2±0.51		2.6±1.53
Ethylbenzene	20**	<0.8±0.52	0.6±0.18	1.0±0.59		0.9±0.46
Xylenes	200**	2.6±1.94	2.2±1.03	2.6±1.53		3.1±2.03

Remark – annual value set for protection of plants, **– limit value of 24–hrs.*

Table 3. Pearson's correlation matrix

	NO_2	***SO_2***	***PM10***	***Benzene***	***Toluene***	***Ethylbenzene***	***Xylenes***
NO_2	1.0	-0.41	0.50	0.56	0.54	-0.12	-0.17
SO_2		1.0	-0.55	-0.41	-0.27	-0.08	0.04
PM10			1.0	0.60	0.22	-0.39	-0.57
Benzene				1.0	0.48	-0.45	-0.44
Toluene					1.0	-0.07	0.21
Ethylbenzene						1.0	0.22
Xylenes							1.0

A moderate positive correlation between NO_2 and PM10 (r=0.50), NO_2 and benzene (r=0.56), NO_2 and toluene (r=0.54) indicates that they might possibly the same source of pollution. A moderate positive correlation (r=0.48) among benzene and toluene indicates that they might originate from gasoline vehicles, petroleum filling plants, and gasoline stations. Weak positive correlation was observed for PM10 and toluene (r=0.22), toluene and xylenes (r=0.21) and ethylbenzene and xylenes (r=0.22), and very weak positive correlation was observed for SO_2 and xylenes (r=0.04). This suggests that SO_2, xylenes and ethylbenzene have different emission sources than NO_2, PM10, benzene and toluene in the investigated area.

Concentrations of the pollutants in the ambient air are affected by meteorological data. North–east, southeast, southwest and northwest wind directions were prevailing during air quality measuring in Anykščiai from 2014 to 2015. Average daily values of meteorological parameters during 2014 summer season were as follows: air humidity ranging from 65 to 88%, air pressure ranged from 99.63 to 101.52 kPa, air temperature ranged from 10.9 to 18.9 °C, wind speeds ranged from 0.7 to 2.1 m/s. Average daily values of meteorological parameters during 2014 autumn season were as follows: air humidity ranging from 62 to 94 %, air pressure ranged from 99.61 to 102.33 kPa, air temperature ranged from 7.1 to 19.1 °C, wind speeds ranged from 0.3 to 1.5 m/s. Average daily values of meteorological parameters during 2014/2015 winter season were as follows: air humidity ranging from 79 to 95 %, air pressure ranged from 97.12 to 101.83 kPa, air temperature ranged from 0.0 to 2.2°C, wind speeds ranged from 0.6 to 4.4 m/s. Average daily values of meteorological parameters during 2015 spring season were as follows: air humidity ranging from 40 to 92 %, air pressure ranged from 98.20 to 104.07 kPa, air temperature ranged from 0.0 to 10.7°C, wind speeds ranged from 0.8 to 3.1 m/s.

4. Conclusions

Air quality evaluation is important for assessing the nature of population exposure to air pollution. Assessment of population exposure is necessary for health impact assessment, which in turn is crucial for developing plans for air quality management and protecting the public health. Anykščiai has been granted status of resort territory, therefore concentrations of ambient air pollutants must meet requirements of standards or even must be lower than in other urban territory.

It is very important to evaluate concentrations level of main air pollutants in ambient air, because it is lack of data for Anykščiai city. This information is very important for tourists and local inhabitants. NO_2, SO_2, PM10 and BTEX (benzene, toluene, ethylbenzene and xylenes) were assessed at five different places within Anykščiai city (Lithuania) for a one–year period (June 2014 – March 2015). NO_2 concentrations varied from 3.1 to 14.5 μg/m^3. The SO_2 concentration was found in the range of <0.3–3.7 μg/m^3. PM_{10} concentration was found in the range of 10.0 – 29.0 μg/m^3. Benzene concentrations varied from 0.4 to 4.4 μg/m^3, toluene concentrations varied from 0.9 to 4.7 μg/m^3, ethylbenzene concentrations varied from <0.4 to 1.8 μg/m^3, xylenes concentrations varied from 0.6 to 5.7 μg/m^3. The NO_2, SO_2, BTEX and PM_{10} concentrations were below the permissible limits in Anykščiai.

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