Urban Air Pollutants and Their Impact on Biota

3

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Abstract

This chapter presents the results of studies of changes in the environment caused by air pollution increasement, in urban areas in the function of time, Vranje town case study, southern Serbia region. Vranje is a typical town with increasing traffic and industry and consequently increasing air contamination. Emissions of pollutants CO, nitrogen oxides, and soot were measured, as well as consequent pollution of agricultural land and biota in the town and region. Air quality measurements were carried out at two locations in the town. Three hundred sixty-five samples of sulfur dioxide, 365 samples of soot, and 365 samples of nitrogen oxides were collected and analyzed by physical chemical methods. The emission of pollutants from stationary sources, which was maximal on two representative sites, is determined by measuring and calculating the emission parameters, based on the measurement results. Measuring emissions of pollutants is done using special devices that are calibrated in accordance with EU legislation. Results of measuring emissions were compared with emission limit values, which are given by the Regulation and comply with EU environmental legislation. Impact of air pollution is analyzed on the biota within the town and in the surrounding agriculture areas. The conclusion is that pollution of air and soil is more intense in the winter. Pollution arrives even to agricultural products that are grown in the region. Findings indicate the imperative shift toward renewable energy sources and sustainable environmentally friendly technical and industrial solutions, in order to decrease pollutions in the towns and to preserve the quality of the environment.

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3.1 Introduction

The air is a gas mixture of variable composition. It consists of about 78 % nitrogen, 20.95 % oxygen, 0.93 % of argon, and very small quantities of krypton, xenon, and neon. The existing gases and particles in free and indoor spaces are important for the analysis of air pollutants. The emission and immission concentrations are measured in free space. The emission concentrations of polluting substances are found in exhaust gases before their release and dispersion into the environment. The immission concentrations are those which express the quality of the environment at a given time and space after the dispersion of gases in the surrounding area. A large number of different substances, which are present in clean air in very low concentrations or not present at all, are found in polluted air. All the polluting substances have never been found at one site, and this is the reason why they are not measured at the same location (Grsic et al. 2014). The substances which are regularly measured do not have to be measured on a daily basis.

Air protection is achieved by measures of systematic monitoring of air quality; by reducing concentrations of air pollutants below the prescribed limit values; by taking appropriate technical, technological, and other measures required to reduce emissions; as well as by continuous monitoring of the impact of air pollution on human health and the environment.

Different models for selecting the appropriate representative location for air pollution measurement control are used in the world (Mazzeo and Venegas 2000; Noll et al. 1977). The supporting specific programs for data processing, i.e., for the measured values of pollution (Tseng and Chang 2001), are carried out at the same time. Designing monitoring networks (Lanstaff et al. 1987) are particularly important in urban areas because a large number of people are exposed to air pollution in cities. Therefore, the focus of researchers on the pollution in urban areas is reasonable and clear. Besides, the monitoring network in one city (Coxford and Penn 1998; Noll and Mitsutomi 1983) is not only locally important, it is also regionally important, because of transboundaring pollutions (Milutinovic and Popovic 2001).

This chapter presents the results of research in the field of monitoring pollutant emissions of CO, nitrogen oxides (NO_x) expressed as nitrogen dioxide (NO_2), and soot in the urban environment and surrounding region. Measurements were taken at two sites and these are the Department of Public Health Vranje and the primary school "Svetozar Markovic" in Vranje. Three hundred sixty-five samples of sulfur dioxide, 365 samples of soot, and 365 samples of nitrogen oxides were collected and analyzed and examined by physicochemical methods. The emission of pollutants from stationary sources, such as these sites were, was determined by measuring or calculating the emission parameters based on the measurement results. The measurement of emissions of pollutants was conducted by using special devices that have specific legislation regulated. The measurement results were compared with the emission limit values. Table 3.3 shows the maximum allowed value of soot.

The main objective of this paper is to examine air pollution in quantitative and qualitative terms and to indicate the direction and the imperative to seek solutions for the established system of air quality monitoring in the urban environment that is in the city of Vranje. Urban areas affect the natural landscape changes and changes in the environment (Borgstrom 2009). The changes in air pollution affect the quality of the environment in the region, and these changes are reflected in people's lives. The changes in temperature, which has been varying and changing lately, also affect the changes in air pollution (Homer et al. 2010).

3.2 Materials and Methods

The experiment of systematic monitoring of air pollution was conducted in a small urban environment, the city of Vranje. Vranje is a city located in southern Serbia and it belongs to the Pčinja District. It occupies an area of 860 km^2 (the agricultural area covers 44,721 ha and the forest area covers 32,478 ha). Vranje has about 60,000 inhabitants. It is located in the valley of Vranje, on the banks of the Vranjska River, near its confluence with the South Morava. The climate is moderate continental with a varied soil structure. There is no significant industry in the city center, so the biggest polluters are the boiler room and traffic. The heating plant has boiler rooms which have not been operating at full capacity. Boiler rooms use convectional fuel that significantly affects the quality of the environment.

They are not equipped with modern filters which are used for air purification, and also they are not constructed in accordance with the new standards. Therefore, it can be said that during the winter period, when the heating season is underway, air pollution increases. This affects boiler rooms to operate at reduced capacity, and therefore they cannot meet the heating needs of the entire city. Since Vranje is a town that still lags behind certain metropolitan areas, the individual air pollutants which increase the air pollution in the city by their frequent and constant fuelling are commonly found.

In this paper, the two locations are shown. One of the two is excluded from industrial pollution and traffic and this is the Institute of Public Health of Vranje, while the other takes into account the individual contaminants and is also exempt from the impact of industrial pollution and traffic.

The monitoring program, or the process of air quality monitoring, determines which pollutants and by what mode (permanently or temporarily) will be measured in the area where the air quality is tested. It can be said that an increased amount of air adversely affects the urban ecosystems and the present biodiversities (Kowarik 2011). These are usually those substances that may endanger the tested area and those which are known to occur in a particular area based on experience or based on previous measurements (Fig. 3.1).

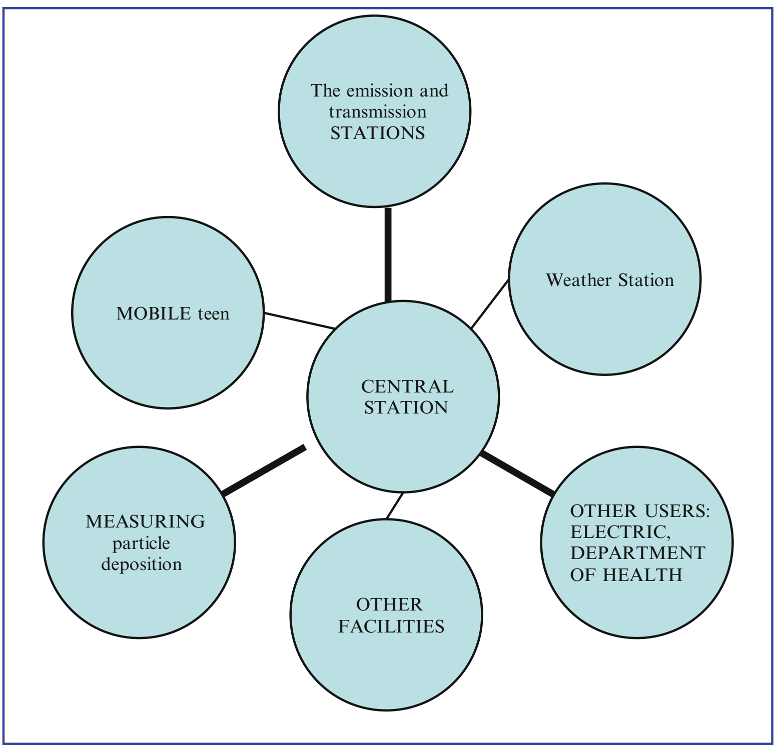

Fig. 3.1 Block diagram of the monitoring system for air quality monitoring

The concentration of gases in the air can be changed significantly in a short period of time. Therefore, the measurement of medium concentrations is common in a certain time period, usually 24 h.

One of the first measures of air quality control is an organization system for continuous monitoring and testing of the most harmful substances in the air. The system consists of a network of measuring stations and a monitoring system that, in addition to measurements, contains a subsystem for the collection, processing, storage, and distribution of data (Abellan-Nebot and Subiron 2010). The local Public Health Institute monitors air quality measurements and examines the amount of particles of SO_2, soot, and NO_2 present in the air. According to the Institute of Public Health of Vranje, regarding the examination of the amount of pollutants in the air, it can be said that air quality across the city varies. This means that air pollution changes over time. The findings reveal that air pollution has increased in recent years due to the development of industry and heavier traffic. It can also be said that the soil is exposed to pollution.

The purpose of monitoring is to determine the concentration of substances in the air and to compare the obtained values with the quality standards or with the ILV values (limit values of immission) and ELV (limit values of emission). The limit value of immission represents the maximum allowable concentration value of pollutants in waste gases from stationary and mobile sources of pollution that can be released into the air in a given period. The substance to be measured is decided on the basis of knowledge about the degree of influence of certain substances to the area of interest. Pollutants are most commonly measured in the area of interest. Concentrations of some specific pollutants are measured within the framework of local monitoring. Local monitoring networks provide information on:

- Existence of characteristic point source emissions (large energy facilities)
- The temperature regime of space (local overheating, ventilation)
- Meteorological parameters
- Characteristics of relief
- Traffic density
- Previous measurements

All the measurements of pollutants were carried out in the laboratory for testing emissions, noise, and wastewater into the environment at the Institute of Public Health in Vranje. The methods of chemical and physical tests were applied.

The limit value of emission (ELV) is the mass expressed in the form of specific parameters of concentration and/or level of an individual emission that is not allowed to be exceeded during one or more periods of time in accordance with special regulations (Law on Environmental Protection Official Gazette of RS 135/04. The limit value of emission is determined on the basis of characteristics of the installation, the geographical location, and the local environmental conditions.

Figure 3.2 presents the measuring points in the city of Vranje, the development of which has increased pollution in the environment of the entire region of South Serbia, Fig. 3.3.

The measurement and analysis of carbon monoxide (CO) and nitrogen oxides (NO_x) expressed as nitrogen dioxide (NO_2) were carried out within the framework of the conducted research; and the automatical determination of the smoke number and the contents of certain organic compounds were also conducted.

Based on the tests, it was shown that the concentration of nitrogen oxides (NO_x) expressed as nitrogen dioxide (NO_2) is a key component of phytotoxic emissions (Gupta et al. 2015) and it highlights the potential for adverse effects of vehicle emissions in urban ecosystems (Bell et al. 2011).

The following must be done in order to assist the measurement of air pollutant emissions: identification of all stationary sources of emissions in the air owned by the operator, identification of all discharges (emitters) at stationary sources, identification of pollutants and state parameters of waste gases to be measured at each discharge, identification method of measuring the emission and immission, and identification of the limit values of emission.

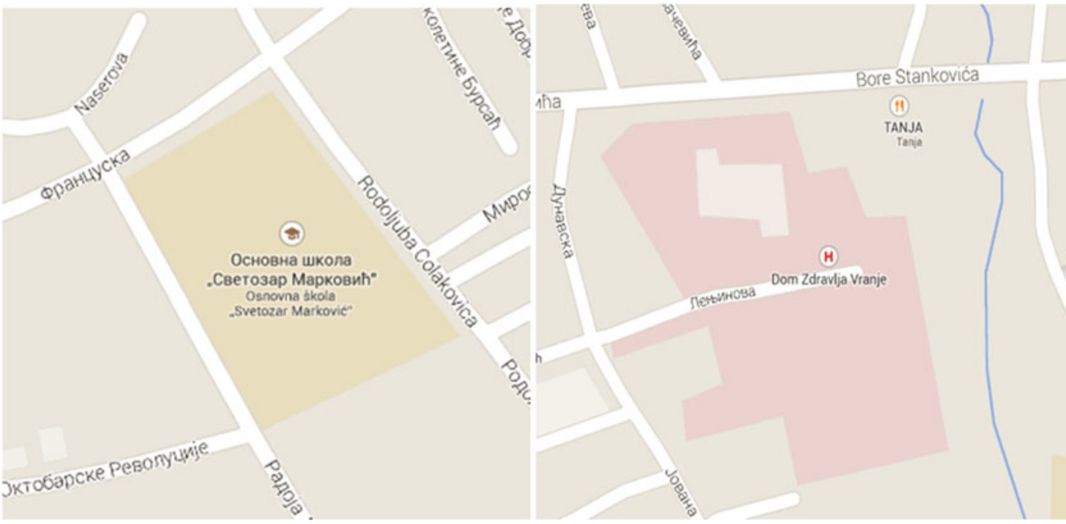

Fig. 3.2 The measuring points, the city of Vranje

Fig. 3.3 Illustration of sites with the highest level of air pollution within the territory of Vranje in the region of South Serbia

The sampling of gaseous pollutants is conducted by Proekos brand devices (type AT-401) for air sampling, by absorption of contaminants from a known volume of air in the proper absorption solution.

The samples of soot are obtained by filtering a known volume of air through a filter paper. Refractometric measurements of soot index are performed on a device called a refractometer.

3.3 Results and Discussion

3.3.1 Results of Monitoring

The control of air quality in the city of Vranje is performed on two sites. One of these two is the Institute of Public Health of Vranje, which is located near the city center so the results would represent the air quality mainly from traffic impact. This measurement point is located within the health center, in close proximity to several busy roads. In order to monitor the degree of air pollution, the Institute of Public Health of Vranje measures the emission concentration of certain parameters of air pollution on the basis of the contract on the regulation of rights and obligations in performing air quality control and monitoring of the impact of air pollution in the city of Vranje. The second measuring point is within the primary school "Svetozar Markovic" in Vranje. This measuring point is in the direction of the dominant northeast wind in relation to the industrial zone, so that the results can maintain the impact of the industrial zone during the wind flow and the impact of local furnaces and local roads. The school is located in a residential area dominated mostly by individual residential buildings of low level, so air pollution occurs from individual furnaces and means of transport (Vosniakos et al. 2008).

The process of the measuring point selection took into account the following: the position and type of pollution, population density, topography, and meteorological conditions.

Air quality control is performed three times: after a month, after 3 months, and after a year (12 months). Daily systematic measurement of basic pollutants SO_2, NO_2, and soot and analysis of aero sediments in monthly precipitation samples are performed at both measuring points. The analysis of aero sediments determines the following: total sediment matter, pH, specific conductivity, sulfates, chlorides, ammonium ion, nitrate, nitrite, calcium, dissolved solids, combustible part, and the ash content. All the collected and analyzed samples of SO_2 and soot and the total sediment matter for 2013 were statistically analyzed and presented in accordance with the Law on Air Protection "Official Gazette of RS" No. 36/09, the Regulation on conditions and requirements for air quality monitoring "Official Gazette of RS" No. 11/10, and Regulation on elections and amendments and Regulation on conditions and requirements for air quality monitoring "Official Gazette of RS" No. 75/2010.

Three hundred sixty-five samples of sulfur dioxide, 365 samples of soot, and 365 samples of nitrogen oxides were collected and analyzed at the two measuring points, at the Institute of Public Health Vranje and the primary school "Svetozar Markovic" during 2013.

Table 3.1 shows the results of individual emission measurements of gaseous substances (CO, C_4H_{10}, C_8H_{18}, C_6H_{12}, C_7H_8, C_8H_{10}, C_2H_4O, C_2H_6O, C_3H_8O, $C_4H_{10}O$, $C_6H_{12}O$, CHOH, C_3H_6O, HF, C_5H_{12}, C_4H_8, and organic substances, expressed as total carbon), as well as the limit values of emission (ELV).

Based on measurements of emissions, which are shown in Table 3.1, it can be concluded that the measured values of pollutant emissions (CO and NO_2) and the smoke number are within the

Table 3.1 Measurement of gas emission concentrations of CO and NO_x is expressed as concentrations of NO_2

Measurement parameters	The unit of measurement	The measured value ± measurement uncertainty			ELV
		The 1st measurement	The 2nd measurement	The 3rd measurement	
Concentration of CO	mg/m^3	832,50 ± 2,2 %	968,75 ± 2,2 %	925,00 ± 2,2 %	1000
Concentration of nitrogen oxides (NO_x)[a]	mg/m^3	8,20 ± 3,2 %	8,20 ± 3,2 %	10,25 ± 3,2 %	250
The smoke number		1 ± 0,2	1 ± 0,2	1 ± 0,2	≤1

[a]Expressed as nitrogen dioxide (NO_2)

permitted emission limits. Also the concentration of CO, individual organic matter, and organic substances expressed as total carbon are within the permissible limits of normal. Tables 3.2 and 3.3 show the results of the limit values and tolerance values of pollutants SO_2, NO_2, and the maximum permissible value of soot and total sediment matter.

Sulfur dioxide (SO_2) is a mandatory component of polluted air in urban areas. It is the product of the combustion of fossil fuels and other fuels, especially those that are rich in sulfur. It can be found in the air as a gas or dissolved in water droplets. In conditions of increased humidity, sulfur dioxide oxidizes and it partially transfers to the sulfuric or sulfurous acid. The concentration of sulfur dioxide in the air depends on temperature, air movement, humidity, and atmospheric pressure. The process of combustion of fuel is accompanied by the appearance of smoke (black smoke), which, depending on the efficiency of combustion, may contain more or less solid particles. Soot contains a large number of organic polycyclic aromatic compounds, whose particle size is around 5 μ and they remain in the air in the form of aerosols.

Based on the obtained results, it can be concluded that the total concentration of the above pollutants does not exceed the limit value allowed by the current Regulation.

These tables show that the averaging time was 24 h, and the results are shown as mean monthly, mean annual, and minimum and maximum values. Results in Tables 3.2 and 3.3 show that the measured emission of pollutants is within the acceptable limits, but there were days when the measured values exceeded the limit value, tolerance value, and the maximum allowable value. This occurs mainly in winter due to increased concentrations of soot obtained by fuelling.

Data source from the Table 3.4 marked by number 1 indicates that the data were obtained from the Institute of Public Health in Vranje. The methods of measurements marked by M in the Table 3.4 mean that they were carried out manually, and those marked by A mean that they were carried out automatically.

Table 3.2 Limit values and tolerance values of pollutants SO_2 and NO_2

The pollutant	The averaging period	Limit value (μg/m^3)	Tolerance value (μg/m^3)
SO_2	1 day	125	125
	Calendar year	50	50
NO_2	1 day	85	125
	Calendar year	40	60

Table 3.3 Maximum permissible value of pollutants (soot and total sediment matter)

The pollutant	The averaging period	The maximum allowed value (μg/m^3)
Soot	1 day	50
	Calendar year	50
Total sediment matter	1 day	450
	Calendar year	200

Table 3.4 Mean annual concentration of soot, SO_2, and NO_2, the number of days when the daily values exceeded the ELV and categories of air quality in 2014 determined on the basis of mean annual values

	Soot(μg/m^3)	SO_2(μg/m^3)	NO_2(μg/m^3)
The measuring point	Vranje IPH	Vranje IPH	Vranje IPH
The mean value	13	14	25
The number of days	7	1	2
Max daily value	89	79	86
Data source	1	1	1
The method of measurement	M	A	A
Availability (%)	96	87	97

The measurements obtained in accordance with the Art. 21 of the Law on Air Protection show that the concentration of air quality in Vranje is classified into the first category – slightly polluted air or clean air.

However, changes in the concentration of soot, nitrogen oxide, and sulfur dioxide greatly disturb the soil quality, as well as plants. Although the concentration of sulfur dioxide is within the normal range, these studies show that even small changes in the concentrations have a negative effect on the soil. Analyses carried out in the Institute of Agriculture, concerning the concentration of sulfur dioxide, have shown that gas negatively affects the quality of the soil because of the discoloration of plants within this period followed by a collapse of leaves and their eventual dying off.

The concentration of nitrogen oxides in the air, which is most commonly a result of exhaust gases, also adversely affects the quality of the soil. Since nitrogen is an important component of plants, and they absorb it mostly from the soil, polluted soil will cause the plants to be of poor quality.

The concentration of soot, which is here within the range of allowed values, reflects negatively on the flora and fauna especially in the fall due to stubble burning after which the soil is covered in soot in a greater degree. Table 3.5 shows the values of the emission concentration of soot, nitrogen oxide, and sulfur dioxide, which are harmful to the soil or disturb the quality parameters, which are in fact indicators of the unpolluted soil.

Increased urbanization in South Serbia has had a negative effect on the change of air temperature as well. Urbanization, which has increasingly become dominant in recent years, constitutes a major source of anthropogenic carbon dioxide emissions from the burning of fuels for heating purposes, from industrial processes, and from transportation. The magnitude of urban warming is highly variable in terms of time and space (Mitchell et al. 2002). Urban air temperatures are on average by 1–3 °C warmer although air temperatures in winter warm up to 10 °C due to constant fuelling when compared to rural areas. Air temperatures differ across the urban city. Temperatures from one to the other side of the street, from the park to the industrial zone differ significantly (Svirejeva-Hopkins et al. 2004). The largest intra-urban differences are associated with the open sky and reduced velocity of the wind, and they are spotted 2–3 h after sunset. Table 3.6 shows the changes in air temperature per years. It can be seen that the temperature has risen along with the growth of urbanization, industry, and transport, and it is shown graphically in Fig. 3.4.

Table 3.5 Parameter values of the emission concentration of soot, nitrogen oxide, and sulfur dioxide, which are harmful to the soil

Pollutant	The concentration of gas emissions from traffic expressed in %	The concentration of gas emissions from furnaces expressed in %	Changes in soil quality in values from 0 % to 100 %
SO_2	53	46	78
NO	27	21	56
NO_2	39	32	63
Soot	20	40	58

Table 3.6 Changes in the value of air temperature (average) per year from 2003 to 2014

Year	Temperature (°C)
2003	18,9
2004	19,05
2005	20,3
2006	20,9
2007	23,5
2008	24,04
2009	25,18
2010	27,9
2011	28,37
2012	28,78
2013	29,45
2014	30,23

The magnitude of the temperature range within the city can be very large, according to the season and depending on whether these are surface or air temperatures. The temperature range is larger in surface air temperatures, while air temperatures are of smaller scale because of their tendency to mix and collide with other surrounding air temperatures.

Figure 3.5 illustrates that increased urbanization leads to the increased concentrations of SO_2, NO_2, and soot, and thus the air quality becomes worse, that is, the air is more polluted. So the first three columns, marked with no 1, show that the air is heavily polluted, while the last three

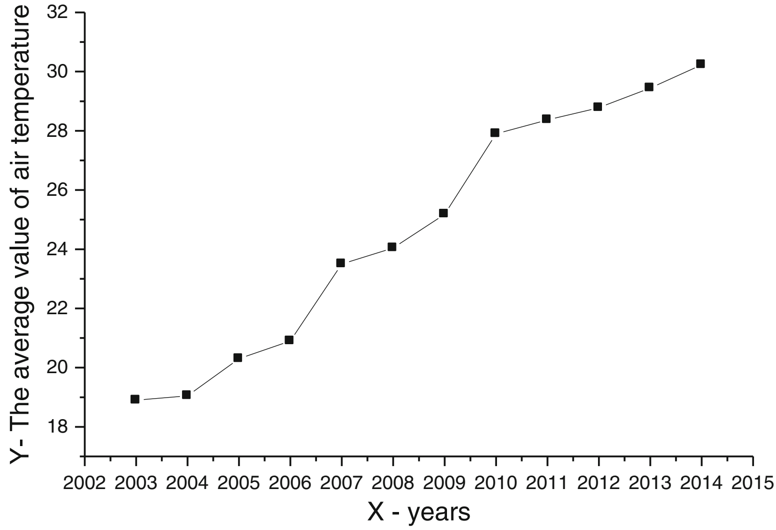

Fig. 3.4 Graphical representation of temperature changes per years from 2003 to 2014

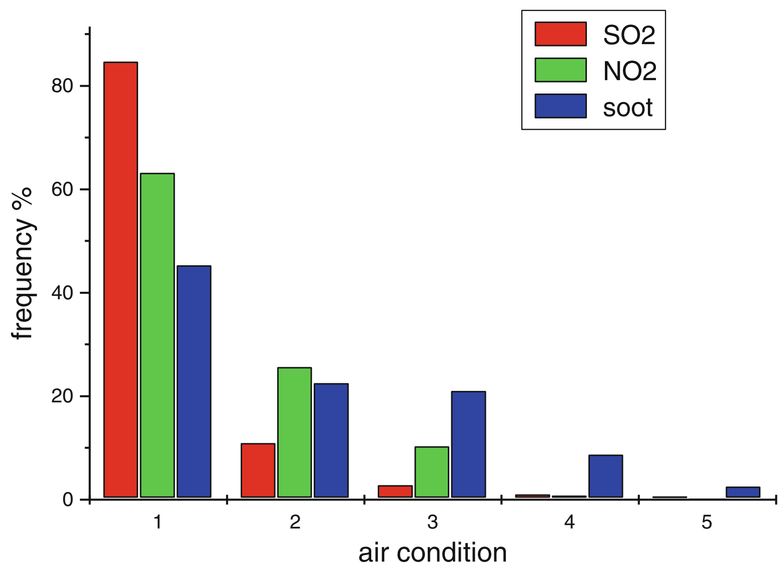

Fig. 3.5 The air quality in Vranje measured in 2010 under the influence of SO_2, NO_2, and soot

columns,marked with no 5, that is hardly noticeable, which means that the air is good (excellent), almost no pollution. The last three columns show the period before the start of global urbanization in the southern region. The numbers 1, 2, 3, 4, and 5 on chart 5 show how the air is polluted. Listing 1 shows that the air is highly polluted, number 2 the air is polluted, number 3 the air is acceptable, number 4 the air is good (no major pollution), and number 5 the air is not very polluted (it is excellent).

3.3.2 The Influence of Air Pollution on Plants

In this study it was shown that increased urbanization affects the increased concentration of harmful gases in the environment. These harmful gases, primarily SO_2, NO_2, and CO_2, reflect harmfully on plants that grow in this environment. Considering an urban environment, where no vegetables are grown, but it has woody and decorative plants, the consequences of harmful effects of these gases are not so noticeable. The tops of tall trees that grow in the city almost cannot feel the adverse effects caused by polluted air.

Exhaust gases and particles pollute the atmosphere of a narrower or broader area, to a lesser or greater extent, sometimes with critical consequences. The spread of pollutants around the sources of pollution depends on many elements: the type and strength of the wind, the position of the pollutants, the quality of particles, the character of buffer zones, etc. If the distance from the source of pollution increases, the amount of polluting particles in the air will reduce.

Plants are very important for the biotope and play an important role in the performance of photosynthesis. The process of photosynthesis that plants carry is multiplex, and the most important is that with the process of photosynthesis, plants produce food and prolong the life of other living organisms. Plants are a source of oxygen on the planet earth. If you disturb the natural balance, and that can happen with a variety of contaminants that are more and more frequent, it comes to many changes that reflect poorly on wildlife and mostly on plants. Air pollution today is the biggest problem. Nowadays there is less pure and more polluted air. Those are the consequences of increased industrialization, the development of various technologies, the increased number of vehicles, and fewer biological filters and air purifiers (Biočanin and Obhođaš 2011). The impact of air pollution on plant species has a negative impact on their quality and quantity. Air pollution is changing some of the abiotic factors such as light, temperature, humidity, the optimal amount of oxygen and carbon dioxide, as well as edaphic (soil) factors, which can indirectly change. Air pollution affects the anatomical and morphological structure, growth, development, and production of organic plants.

Air pollution reflects on plants in two ways

1. Sedimentation of solid particles on the surface of the leaves and minimize the doping of light and perform the process of photosynthesis, thus also minimizing the gas exchange.
2. Harmful gases together with CO and oxygen enter the internal structure of the leaves through the pores of plants, which causes the damage to the plant cells. Plants are less exposed to the danger at night in the summer and much more in a period of vegetation and during the day.

As the air is more polluted in winter due to increased smog, it can be said that in this period the plants are “protected” because they are in the phase of hibernation, and the great amount of harmful gases cannot affect them “badly.” Deciduous plants, as well as annuals, are more at risk of the effects of air pollution than conifers and perennial plants. Deciduous and annuals cannot fight against the impact of harmful substances and gases contained in the air, because they have more delicate leaves, softer tree trunks, more open pores than evergreen and perennial trees ((Biochanin and Obhodjash 2011). Tests show that the needles of conifers retain up to 30 times the amount of particles than certain broadleaf species. In addition, there is the certain regularity in the content of pollutants under the crowns of trees, depending on the season of the year.

The greatest reduction of particle feels in September (38 %) and the lowest in May (about 20 %). During the period of vegetation, the low content of polluting elements in the air is 42 % lower than in the surrounding area. The sanitary importance of trees in the collection of particles is very important in the winter. The canopy of trees without leaves retain contaminants in great numbers (on average 37 % of their total amount in the air).

Based on the research, it has been calculated that during one vegetation period, adult specimens of trees and bushes can retain the following amounts of mechanical particles: elm tree, 28 kg mechanical particles per vegetation period; weeping willow, 38 kg; horse chestnut, 16 kg; jelly, 28 kg; maple, 33 kg; Canadian poplar, 34 kg; and black currant, 0.5 kg.

The accumulation of contaminant particles on the leaves of trees and bushes is even more important if the green space is larger.

Plants have certain mechanisms that protect themselves from the effects of polluting elements. Tests show that most of the plants can handle with no visible damage the amount of sediment of 0.75–1.50 g/m^2/day, especially if rain washes most of the deposited particles over a short period of time. The researchers of the pollution with lead come to the similar conclusions. Despite the extremely high concentrations of lead on the leaves of plants along the roads, there are no reports of their visible defects so far.

Plants filter the air using so-called vertical air purification. Wetter and cooler air above the green areas continuously replaces the air above the open space, thus taking up gas pollutions.

The choice of plants depends on local conditions, and some of the most resistant species in our country are *Ailanthus glandulosa*, *Celtis australis*, *Acer rubrum*, *Celtis occidentalis*, *Cornus mas*, *Corylus colurna*, *Platanus* sp., *Robinia pseudoacacia*, *Juniperus* sp., *Quercus*, *Rosa canina*, *Hedera helix*, *Thuja occidentalis*, *Juglans nigra*, *Acer platanoides*, etc.

The following measures are proposed for protection in cases of high air pollution: planting shelterbelts in the direction of dominant wind, combining resistant plants and plants with tenuous crown with plants that have dense and compact crown, concentrating plants as close to the source of pollution as possible, and forming wider belts, that is to say, larger green areas.

Table 3.7 shows the results of the values of parameters of concentrations of soot emissions, nitrogen oxides, and sulfur dioxide that have adverse effects on woody plants, ornamental plants, and fruit cultures.

Table 3.7 showed that the percentage of harmful gases has different effects on different plants.

Table 3.7 Values of the concentration of soot emissions, nitrogen oxides, and sulfur dioxide which adversely affect woody plants, ornamental plants, and fruit crops

Pollutant	On woody plants in %	On vegetables in %	On fruit in %
SO_2	25	61	52
NO	45	48	46
NO_2	36	46	48
Soot	10	20	18

In winter when the concentration of smog is increased in the air, the impact of smog is higher, provided that in this period the plants are at the phase of hibernation so that it cannot do much harm to them. But in the summer when the concentration of exhaust gases is increased (specifically the concentration of nitrogen is increased), the plants differently absorb the gas. Increased amounts of nitrogen oxides are differently reflected plants. Vegetable plants due to increased amounts of this gas can change the color of the leaves and can have a reduced yield, and due to increased amounts of SO2, fruits can be wizened and dry.

If you look at the surrounding arable land in the region of South Serbia, where different vegetable species can be grown as well as cereals, you can notice that there are no major changes to their trunks, leaves, and fruit when it comes to the impact of these harmful emissions. Due to the moderate continental climate that dominates in this region, there are no strong winds and no increased greenhouse effect, so that there is no large air pollution on plants. Plants grow on 80 % of healthy soil, so that the small amount of harmful gases in the environment cannot do much to change their physiognomy, unlike some cities and regions where air pollution drastically affects the quality of the plants. For example, the City of Pancevo where the refinery is located is subjected to the air pollution, and thus the quality of the plants is weaker.

3.4 Conclusion

This paper presents the research results of the conducted monitoring system of air quality and its impact on biota in urban areas such as the city of Vranje. The measurement of pollutant emissions, obtained as products of combustion and in the form of exhaust gases, was carried out. After the measurement, the averaging time was 24 h and certain limit and total values were established. It is shown in Tables 3.2 and 3.3 that these values do not differ much for CO_2 and NO_2. The most important thing is that all these values are in the range of normal. Although there are variations, these are special conditions or special periods during the year, when the measured emissions of air pollutants are increased. The increased measured emissions coincide with the winter period. The increased emissions are in direct correlation with operating of boiler rooms that use coal. The emissions from these boiler rooms which use coal reflect negatively on the quality of air, soil, and the entire city environment and on the surrounding agricultural sites within the region by reducing its quality parameters. This opens up new possibilities for testing and demonstration, as well as the conclusions about the necessity of seeking modern solutions for heating which produce less pollution to the environment, for example, from renewable energy sources. Consequently, the environment will be cleaner, and the soil will maintain the level of quality required for the cultivation of agricultural crops which is the goal of the region.

If the urbanization of cities were somehow regulated (e.g., introduction of ecological fuel), any type of pollution would be reduced, air temperatures would not also rise rapidly, the soil would not be exposed to harmful particles, and air quality would improve.

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