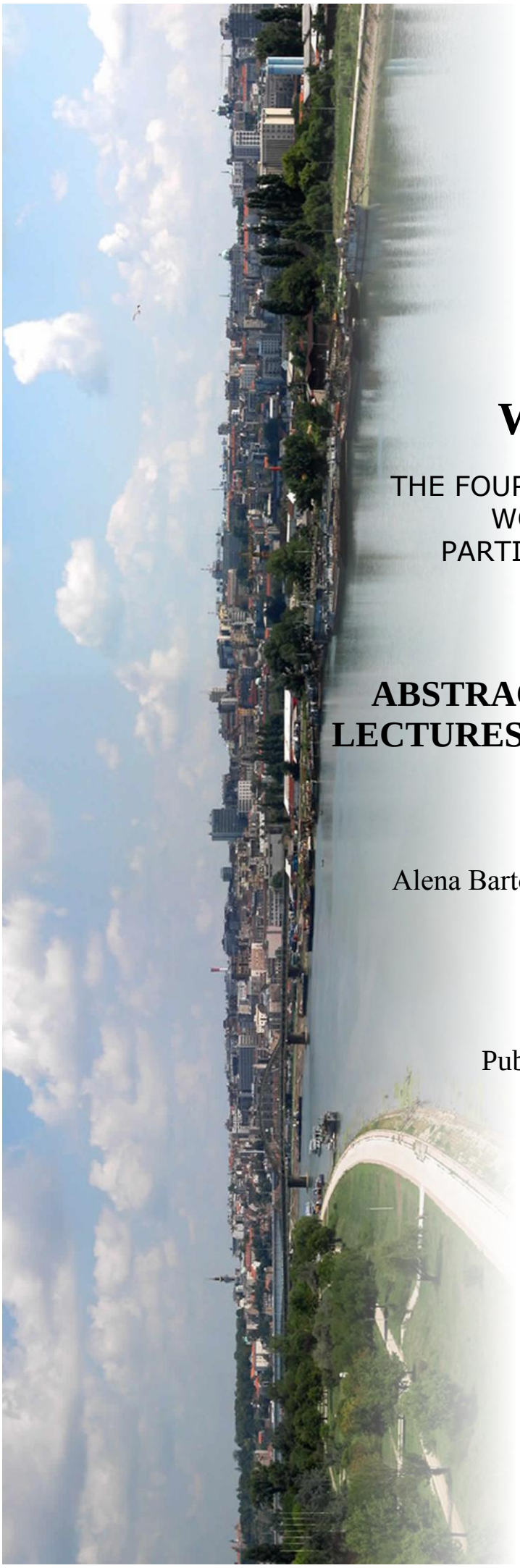

WeBIOPATR2013

THE FOURTH INTERNATIONAL WeBIOPATR WORKSHOP & CONFERENCE
PARTICULATE MATTER: RESEARCH AND MANAGEMENT

ABSTRACTS OF KEYNOTE INVITED LECTURES AND CONTRIBUTED PAPERS

Editors
Alena Bartonova andMilena Jovašević-Stojanović

Public Health Institute of Belgrade

Belgrade 2013

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CONFERENCE TOPICS

ATMOSPHERIC PARTICULATE MATTER - PHYSICAL AND CHEMICAL PROPERTIES

- *sources and formation of particulate matter*
- *particulate matter composition and levels outdoors and indoors*
- *environmental modeling*
- *nanoparticles in the environment*

PARTICULATE MATTER AND HEALTH

- *exposure to particulate matter*
- *health aspects of atmospheric particulate matter*
- *full chain approach*

PARTICULATE MATTER AND REGULATORY ISSUES

- *issues related to monitoring of particulate matter*
- *legislative aspects*
- *abatement strategies*

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PREFACE

The International Workshop and Conference, Particulate Matter: Research and Management – WeBIOPATR is a biennial event held in Serbia since 2007. The conference rationale stems from the fact that particulate matter is the air quality constituent that currently is responsible for most instances of non-compliance with air quality directives in Europe. Particulate matter, arising both from primary emissions and as a result of secondary formation in the atmosphere, is also one of the least well understood issues.

The 1st WeBIOPATR Workshop "Particulate matter: Research and Management" was held in Beograd, 20.-22. May 2007. The workshop was attended by more than 70 participants presenting 35 contributions, and received media attention (newspaper article and TV coverage on national TV). In addition to providing information about latest research in Serbia and internationally, the workshop has contributed to communication within the research community in Serbia, and between the research community and the responsible authorities (Ministry of Health, Ministry of Environment, and the Serbian Environmental Agency).

The 2nd WeBIOPATR workshop was held in Mecavnik, Serbia, 28.8.-1.9. 2009. It has attracted over 40 participants, notably also participants from the neighboring countries and EU. The participants discussed air quality issues, research needs and management tools and strategies that are currently used in Serbia. As a new element, the workshop also had a section on health issues related to particulate matter, recognizing that the legislation is based on health considerations, and that the PM are an important health determinant in adults and in children. Proceedings are available athttp://www.nilu.no/index.cfm?ac=publications&folder_id=4309&publication_id=24659&view=rep).Selected extended contributions are published in CHEMICAL INDUSTRY & CHEMICAL ENGINEERING QUARTERLY Vol: 16 No 3 (2010).

The 3rd event, the International WeBIOPATR Workshop and Conference, Particulate Matter Research and Management – WeBIOPATR2011, had a wider international audience, and had own student workshop. Forty three presentations were given (for book of abstracts see http://www.vin.bg.ac.rs/webiopatr/3rd-workshop/). Selected extended contributions are published in CHEMICAL INDUSTRY & CHEMICAL ENGINEERING Vol 18, No 4/II (2012).

This book contains abstracts of all presentations of the WeBIOPATR-2013 workshop and conference, the fourth event of the series. In each session, invited keynote speakers will give lectures that will present the most recent results and studies in their field. In all, 9 invited keynote lectures, 20 oral presentations and 20 poster presentations will be presented. We hope that this event will continue to be an important forum for the Serbian scientists and other professionals to meet and discuss, and for the Serbian professional community to meet with professionals dealing with similar issues elsewhere.

We hope that this year's event will continue the success from the past. We hope that it will again provide the professional community from West Balkans region with a suitable meeting platform, and the global professional community with an arena where we can draw on each other's experiences and scientific insights.

Milena Jovašević-Stojanović and Alena Bartoňová

Contents

INVITED LECTURES

MEASUREMENTS OF PARTICLES IN URBAN AREAS AROUND THE WORLD, A COMPARISON OF LEVELS AND CAUSES

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Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. PM_{10} particles (the fraction of particulates in air of very small size (<10 μm)) and $PM_{2.5}$ particles (<2.5 μm) are of major current concern, as they are small enough to penetrate deep into the lungs and so potentially pose significant health risks. The principal sources of airborne PM_{10} and $PM_{2.5}$ matter in urban areas are mainly from road traffic emissions, particularly from diesel vehicles. However, also, windblown dust, re-suspended dust from the surface, emissions from various industries, power plants, agricultural activities and fires are causing high PM concentrations. As presented in this paper the main sources strongly varies from one region to another.

Data from a few selected urban monitoring programmes have been selected for this presentation, mainly based upon studies performed by NILU. References to other investigations performed in similar urban areas have also been included. The presentation covers a range of PM levels from the relatively clean capital of Norway, Oslo, to the highly polluted city of Dhaka Bangladesh. Some of the causes to the high PM concentrations may be easy to track, while other are based on rather complicated compositions. In data collected from the Middle East cities such as Abu Dhabi and Cairo, windblown dust from the desert areas is causing the highest PM_{10} concentrations, while brick factories in Dhaka seem to be the main source for PM_{10} in Dhaka. There is also a clear regional component of smaller particles, $PM_{2.5}$, as demonstrated from satellite images. In European urban areas traffic seems to be the main source for PM.

HEALTH IMPACT ASSESSMENT OF LONG-TERM EXPOSURE TO PARTICULATE AIR POLLUTION: METHODOLOGICAL AND PRACTICAL CONSIDERATIONS

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Air pollution damages public health. As documented frequently, and very recently in the REVIHAAP project of WHO, this involves a wide range of pollutants and a wide range of health outcomes, mostly – though not only – cardio-respiratory effects. Evidence on causality varies, from very strong to suggestive, across the many pollutant-health combinations potentially affected. Under these circumstances, policy makers and others want to know big is the public health problem caused by outdoor air pollution (the burden question) and what are the health benefits of policies and measures that reduce air pollution (the impact question) – or indeed the adverse health effects of developments that (unintentionally) lead to higher levels of air pollution. The associated methodology of quantification is known generally as Health Impact Assessment (HIA). HRAPIE, a sister project to REVIHAAP, is developing recommendations for what pollutant-health pairs might best be used for HIA of air pollution in Europe.

This talk will draw on over 20 years' experience of working with others using HIA to provide answers for policy makers and others. That experience includes EU research projects from ExternE through NEEDS and HEIMTSA to current projects such as TRANSPHORM and URGENCHE; cost-benefit analysis 2005-06 for CAFE and other work for DG Environment;; work for the UK Government's Advisory Committee on the Medical Effects of Air Pollutants (COMEAP); and as part of the English health service's localisation agenda.

The main aim of the talk is to overview the strengths and limitations of current practice, and draw attention to some long-standing issues and emerging themes. The talk will focus on the effects on mortality in adults of long-term exposure to air pollution, especially particulate matter (PM). This is because our experience, like that of other groups involved in HIA, shows that this is the pollutant-health combination which dominates overall results for the burden of air pollution, and for the health effects of most policies. HIAs based on mortality usually rely on the application of life-table methods to predict changes in life expectancy, but burden calculations require many assumptions, and predictions about the future many more. Some of the issues involved will be illustrated in the context of case studies of the health effects of transport policies on cities, within the current EU project TRANSPHORM. The talk will refer also to other (i.e. morbidity) effects of PM, and to effects of other pollutants, especially insofar as they may be additive (or not) to the effects of particulate matter.

PARTICLE EMISSIONS FROM DIESEL ENGINES - LOOKING BEYOND CARBON SOOT EMISSIONS

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Particulate matter (PM) emissions from combustion sources involve a complex mixture of solid and liquid particles suspended in a gas. Out of all the combustion sources PM emissions from diesel engines are a major contributor to the ambient air pollution problem in urban environments. Whilst epidemiological studies have shown a link between increased ambient PM emissions and respiratory morbidity and mortality, studies of this design are not able to identify the PM constituents responsible for driving adverse respiratory health effects. Some recent toxicological studies indicate that PM related reactive oxygen species (ROS) and the resulting oxidative stress they engender may be implicated in the instigation of the adverse health effects. Other studies show that there is strong evidence that organic compounds are most responsible for the toxicity of airborne particles. Toxicological studies have also pointed to the particle surface area as a potential metric for assessing the health effects of PM. The surface area of a particle provides a measure of the ability of toxic compounds (such as PAHs or ROS) to adsorb or condense upon it. Therefore, a particle's surface area can be viewed as a "transport vector" for many compounds deleterious to human health and requires more detailed analysis. Taking all this into account we have explored the correlation between DPM physical properties, DPM particulate organic material and the potential of diesel PM to cause oxidative stress, as measured by the concentration of ROS. We find that the oxidative potential of diesel PM although proportional to the total organic content in certain cases shows a much higher correlation with the oxygenated organic fraction. The documented role of semi-volatile organic compounds in the potential of diesel PM to cause oxidative stress has far reaching consequences on the regulations of particulate emissions from combustion sources. It also sheds a light onto new aspects of diesel particulate emissions that should be taken into account when establishing relevant metrics for health implications of emissions from various future fuels.

THE ROLE OF AIR QUALITY MODELLING IN PARTICULATE MATTERMANAGEMENT IN CITIES

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The quality of the environment in urban areas is of vital importance. It is one of the main factors that determine whether a city is a healthy place to live in. Europe is the most urbanized continent in the world: at present over 80% of its population lives in towns and cities. At the same time car use in Europe is growing, and a further doubling of traffic is predicted by 2025 (EC DG ENV). Traffic is the dominant urban source per today along with domestic combustion (which has been growing over the last few years) (EEA, 2013b). Persistent air quality exceedances of the limit or target values for particulate matter are observed in urban areas across Europe (Sundvor, et al. 2012). Furthermore, in 2011 33% of the urban population in Europe was exposed to concentrations of PM_{10} in excess of the EU daily limit value and 15% was exposed to $PM_{2.5}$ concentrations above the EU target value (EEA, 2013b).

In 2011, the European Commission and the EEA agreed to reinforce efforts to improve knowledge on implementation of air quality legislation through a joint pilot project. The Air Implementation Pilot lasted for 15 months and was finished in June 2013. It aimed to better understand the challenges cities faced in implementing air quality policy (EEA, 2013a). Twelve cities were selected and invited to join the project: Antwerp (Belgium), Berlin (Germany), Bucharest (Romania), Dublin (Ireland), Madrid (Spain), Malmö (Sweden), Milan (Italy), Paris (France), Plovdiv (Bulgaria), Prague (Czech Republic), Vienna (Austria) and Vilnius (Lithuania).

One of the issues addressed in the pilot was to examine the model practices in these cities, to assess the strengths and weaknesses of such applications and to further identify needs for guidance in the use of air quality models (Castell et al., 2013).

A description of the model applications addressed by the twelve cities across Europe was conducted, illustrating the type of models applied, the input data employed and the strong and weak points encountered in the application of air quality models.

All the cities applied models for air quality management except the city of Dublin. The models have been used for different purposes, as for instance, reporting of air quality compliance, long term planning, population exposure estimation or source apportionment. More than 20 different models were applied and most of the cities have applied a different model depending on the purpose. The main types of models employed are Gaussian, Eulerian, Lagrangian and Street canyon. All the cities have found models helpful and the outputs have been used in air quality management in the cities, including the evaluation of strategies to reduce PM ambient levels.

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THE USE OF HYBRID RECEPTOR MODELS AND GROUND-BASED REMOTE SENSING OF PARTICULATE MATTER FOR IDENTIFICATION OF POTENTIAL SOURCE REGIONS

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Suspended particulate matter (PM) in the atmosphere, commonly known as aerosol, plays an important role in air quality, climate change and long-range transport of pollutants. The complexities of aerosol processes in the atmosphere are so great that they lead to large uncertainties in quantitative understanding of their role in many environmental issues. Aerosols originate from a wide variety of natural and anthropogenic sources, thus determining the quantitative relationship between ambient air quality and pollutant sources as one of the main difficulties in air pollution management. **Receptor modeling**is an application of multivariate statistical methods for identification and quantitative apportionment of air pollutants to their sources. Using chemical composition data for airborne particulate matter samples, it is possible to identify pollution source types and estimate their contributions to the observed PM concentrations. For pollutant sources that are unknown, hybrid models that incorporate air mass trajectories (Residence Time Analysis, Potential Source Contribution Function, Concentration Weighted Trajectory) can be used to resolve potential source locations.

While for monitoring of the air quality at street level, i.e. where people are in direct contact with aerosols, in situ measurements are most adequate, the attribution of concentrations in receptor areas to emissions from distant sources, as well as the assessment of the role of transport and transformation processes, requires observations of the vertical distribution.The requirement for improved observations of the aerosol vertical distribution is related to the fact that practically all long-range transport occurs at elevated layers of the atmosphere. LIDAR (LIght Detection And Ranging) techniques represent state-of-the-art active remote sensing tool which provide aerosol measurements with high spatial and temporal resolution. The basic LIDAR system is the elastic-backscatter LIDAR that allows the direct determination of the altitude and thickness of aerosol layers. High vertical resolution profiles measured with a Raman LIDAR allow the optical characterization of atmospheric aerosol layers in the planetary boundary layer, as well as in the free troposphere. The aerosol characterization can be further improved by the use of multi-wavelength Raman LIDAR equipped with depolarization channels. These data can be inverted to provide information about aerosol microphysical properties such as size, shape, refractive index. The information obtained from the LIDAR measurements can be used as input to different aerosol transport models to enhancetheir predictions.LIDAR networks are fundamental to study aerosol on large spatial scale and to investigate transport and modification phenomena. EARLINET (European Aerosol Research Lidar Network)is the first aerosol LIDAR network, with the main goal to provide a comprehensive, quantitative, and statistically significant database for the aerosol distribution on a continental scale.

This paper presents the most popular receptor models that have been applied to solve the general aerosol mixture problem and link ambient PM with their sources, with emphasis on results obtained by applying some of these models on PM_{10} data sets in Belgrade.In addition, contemporary LIDAR methodology will be described and case studies of LIDAR observations and complementary prediction of vertical concentration profiles of Saharan dust aerosols will be also carried out.

CITI-SENSE: HOW VIABLE IS THE CITIZEN'S CONTRIBUTION TO PARTICULATE MATTER SCIENCE?

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Involving citizens as active partners in environmental monitoring, and their ability to contribute to decision-making, is seen as one way towards better protecting and enhancing our environment. The EU FP7 collaborative project CITI-SENSE (www.citi-sense.eu)aims to support citizens to contribute to environmental governance, providing a range of tools and services related to the environment, and developing participatory sensing tools and methods. This is possible due to recent technological advancements in technologies for monitoring and for information and communication. It is also in line with recent activities within "citizen science" and "ubiquitous participatory sensing". But while seen as desirable and even game-changing by some, such approaches also generate new issues to address. In this paper, we discuss the different perspectives, and provide examples of how we intend to complement the different information gathering methodologies and perspectives.

There is a difference in information content and properties between (1) what information may be useful to citizens or their group, (2) what is appropriate for legislation and air quality management, and (3) what information is sought by scientists (and for what purpose). Taking example of particulate matter, what are the issues that may be of interest to these three groups? Particulate matter is one of the air pollutants that possibly poses most health problems, and where complying with the current legislation is currently the largest challenge for air quality managers.

Perhaps easiest is to answer how can the new technologies benefit research. Technologies enabling ubiquitous monitoring are available for several metrics related to chemical composition or physical properties: size-distributed mass in several fractions, total mass, visibility-related particles concentrations being the most obvious ones. From the point of view of (external) exposure assessment related to ambient air and spatial and temporal representativity, the metrics that are used range from central site or interpolated monitoring data, regional pollution levels predicted using air pollution dispersion models or measurements combined with air quality models, models that include satellite data, to statistical approaches combining modelling and measurement data. Ubiquitous sensing can provide highly temporally and geographically specific information. Scientists will be able to use these data provided we put in place appropriate quality control and assurance systems.

For regulators and air quality managers, ensuring compliance may not be directly affected by ubiquitous sensing as at this moment, compliance monitoring is subject to rigorous quality control and assurance procedures not applicable to ubiquitous sensing. However supplementary information leading to identification of areas where health may not be adequately protected (health being the main driver of the current legislation), is of importance.

What is the direct benefit to citizens, can they contribute to gathering data of value to science and to management or are there other plausible reasons for their involvement? Both top-down, and grassroot or bottom-up activities have been known to succeed in involving citizens, indicating that they saw value in the involvement. In CITI-SENSE, we will use several methods to involve citizens and to provide them with means to both gather and retrieve information. By comparing a number of different situations (localities), we will have a better possibility to derive vital parameters of the information received from citizens, and will be able to further complement the current knowledge related to air pollution.

Supported by CITI-SENSE, EU FP7-ENV-2012 (# 308524).

THE USE OF BIOMARKERS FOR THE RISK ASSESSMENT FOR EXPOSURE TO PAHs

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The methods of molecular epidemiology were widely used in studies on the impact of air pollution to genetic damage in the Czech Republic. The effect of exposure to carcinogenic polycyclic aromatic hydrocarbons (c-PAHs) adsorbed on respirable air particles (PM2.5, <2.5 μm) on biomarkers was repeatedly studied on city policemen and bus drivers in Prague, and city policemen and volunteers in the Ostrava Region. Ambient air particles (PM10, PM2.5) and (c-PAHs) were monitored using VAPS sampler, personal exposure was evaluated using personal samplers for 48 hrs. DNA adducts were analyzed in lymphocytes by ^{32}P-postlabeling assay, chromosomal aberrations by conventional cytogenetic analysis, fluorescent in situ hybridization (FISH), and micronuclei, DNA breaks by Comet assay, oxidative damage to DNA by 8-oxodG in urine, lipid perixidation by 15-F_{2t}-isoprostane in urine and lymphocytes, DNA fragmentation in sperm by flow cytometry, cotinine in urine, plasma levels of vitamins A, E and C by HPLC, cholesterol and triglycerids using commercial kits.All discussed studies indicate, that DNA adducts, Comet assay and DNA fragmentation in sperm are sensitive biomarkers of exposure to c-PAHs in polluted air, chromosomal aberrations by FISH and micronuclei as biomarkers of effect, and 8-oxodG and 15-F2t-IsoP as biomarkers of oxidative damage.Studies in the Czech Republic suggest that personal exposure to concentrations higher than 1 ng B[a]P/m^3 represent a risk of DNA damage as indicated by an increase in DNA adducts and an increase in translocations detected by FISH, increase of micronuclei as well as the increase of DNA fragmentation in the mature sperm. It seems that using these biomarkers the dose-effect is seen only in a certain range, probably up to 10 ng B[a]P/m^3.It is important to identify simultaneously the gene susceptibility, especially the genetic polymorphisms of metabolic genes and genes encoding DNA repair enzymes. DNA damage may be further affected by life style as smoking, ETS, diet – intake of vitamins A, C, E, oxidative metabolism by lipid metabolism (triglycerides, cholesterol, HDL, LDL) – it is therefore pertinent to analyze all these endpoints in the biological material in the course of molecular epidemiology studies.

Supported by CITI-SENSE, EU FP7-ENV-2012 (# 308524) and Grant Agency of CR (#P30113-13458S).

EVIDENCE ON HEALTH EFFECTS OF PARTICULATE MATTER IN SUPPORT OF THE REVIEW OF THE EU AIR QUALITY POLICIES: THE WHO REVIHAAP PROJECT

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The World Health Organization (WHO) is coordinating two important international projects to provide the European Union (EU) with information on the evidence of health aspects of air pollution, in support of the comprehensive review of EU's air quality policies scheduled for 2013. The advice provided is formulated in the form of responses to 26 key policy-relevant questions asked by the European Commission (EC). The questions cover general aspects of importance for air quality management, as well as specific topics concerning health aspects of individual air pollutants. The text in response to the questions was developed by a large group of invited experts from top institutions across the world. The responses are directed at policy makers, and they are therefore short and concise in order to be useful during the policy process. Specifically, they discuss new findings regarding health effects, concentration-response functions and thresholds, as well as air pollution constituents and sources. The review also provides an integration of the evidence and present implications for future revision of the WHO air quality guidelines (AQG), as well as policy considerations for the EU. In addition, the document highlights critical data gaps.

Specifically for particulate matter, the results from the evidence review conclude that a considerable amount of new scientific information on health effects, observed at levels commonly present in Europe, has been published in the recent years. This new evidence supports the scientific conclusions of the WHO AQG, last updated in 2005, and indicates that the health effects in some cases occur at air pollution concentrations lower than those serving to establish the 2005 Guidelines. It also provides scientific arguments for taking decisive actions to improve air quality and reduce the burden of disease associated with air pollution in Europe. The material developed as part of these projects is equally relevant to all Member States, in their development and implementation of effective strategies to reduce air pollution with the shared objective of protecting public health.

EVIDENCE ON HEALTH ASPECTS OF PM SIZE FRACTIONS, SOURCES AND COMPONENTS

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A review of the literature on the size fractions, sources and components of particulate matter was conducted as part of the jointly funded World Health Organization (WHO)/European Commission (EC) project "Review of evidence on health aspects of air pollution – REVIHAAP", in support of the comprehensive review of the European Union (EU) air policies to take place in 2013.Specifically for particulate matter, the review discusses new findings regarding health effects, concentration-response functions and thresholds, as well as air pollution constituents and sources. The review also provides an integration of the evidence and present implications for future revision of the WHO air quality guidelines (AQG), as well as policy considerations for the EU. In addition, the document highlights critical data gaps.

A considerable number of new studies have been published, which provide evidence on the health effects of size fractions, components or sources of PM. There are three important components – black carbon, secondary organic aerosols, and secondary inorganic aerosols – for which there is substantial exposure and health research which finds associations and effects. They each may provide valuable metrics for the effects of mixtures of pollutants from a variety of sources. As well, short-term exposures to coarse particles (including crustal material) are associated with adverse respiratory and cardiovascular effects, including premature mortality. There is increasing, though as yet limited, epidemiological evidence on the association between short-term exposures to ultrafine (<0.1 μm) particles and cardio-respiratory health, as well as the central nervous system. A variety of air pollution sources have been associated with different types of health effects. Most evidence is accumulated so far for an effect of carbonaceous material from traffic. A more limited number of studies suggest that traffic-generated dust, including road, brake and tire wear, also contribute to the health effects.

The health effects of particulate matter are observed at levels commonly present in Europe. The REVIHAAP project provides scientific arguments for taking decisive actions to improve air quality and reduce the burden of disease associated with air pollution in Europe. It further recommends that the EC ensures that the evidence on the health effects of air pollutants and the implications for its air quality policy are regularly reviewed.

ORAL PRESENTATIONS

PARTICULATE MATTER: EFCA VIEWS ON POSSIBLE METRICS AND THE ONE ATMOSPHERE APPROACH

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Particulate matter is presently regulated by the metrics PM_{10} and $PM_{2.5}$, in Europe and elsewhere. The legitimation for this is their correlation with a number of short term and long term health endpoints as recently confirmed by WHO Europe (WHO, 2013). Such 'container metrics' ignore the complexity of the atmospheric mixture of particulate matter which varies with respect to source, size, shape, optical properties, chemical composition, atmospheric behaviour, interaction with gaseous pollutants and, therefore, with respect to impacts on health, environment, climate and weather.

Effective air quality policy requires that sources of pollutants are well defined; this condition is not met for particulate pollution and is in fact impossible for metrics like PM_{10} and $PM_{2.5}$. By selecting a source-specific fraction of PM which is more precisely defined with respect to properties, more effective policies become possible, in particular for fractions with a higher health risk than average PM. In the discussion on possible metrics two options are presently receiving attention: particle numbers (PN) and Black Carbon Particles (BCP); for bothcombustion processes are important sources.

The atmospheric environment, however, hosts a second problem with high impacts for men and ecosystems: climate change. Unfortunately, it has hitherto been addressed separately at the more relevant policy levels. An integrated policy approach, however, may generate co-benefits and also help to avoid trade-offs which result from present separate policies (EFCA, 2010; EFCA, 2012).

Effective climate policy should address all components which contribute to global warming. The contribution of aerosols (solid + liquid particles) has for long been a major challenge in climate research. In recent years, however, black carbon, contrary to white aerosols, has been recognised as one of the so-called short-live climate pollutants (SLCPs: also ozone and methane) and options to reduce its emissions have been recommended (UNEP/WMO, 2011).

Arguments for additional metrics of PM will be summarised and a synthesis for an optimal approach will be presented.

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DAILY VARIATIONS OF PARTICULATE MATTER PM10 CONCENTRATIONS DURING WINTER AND SUMMER PERIOD IN BELGRADE

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Particulate matter PM10 have a dominant influence on the air quality in urban areas of Republic of Serbia. Several reports on the state of air quality in the Republic of Serbia confirm this conclusion. Particulate matter with aerodynamic diameter <10μm consist mainly of aerosolas formed in combustion processes in individual furnaces and small heating plants. Significant sourceare traffic emissions as well as PM resuspension from roads.

The aim of this paper is to present information about the typical values of hourly concentrations of PM10 in summer and winter at two different urban locations in Belgrade. Daily variations of hourly average values of PM10 mass concentrations may be used for indicating the major sources of PM10.

This paper presents the results of the analysis of PM10 reference concentrations daily variations at the measuring points Beograd_Stari grad (B-SG) and Beograd_Novi Beograd (B-NB). B-SG sampling site was located in the central part of the city, at heally terran, where there are still number of local combustions sourcesduring heating seasion. In vicinity of B-SG there isn't good ventilation due to dominantly narrow streets of canoon type. B-NB is located at so call New Belgrade at the left bank of Sava river, where terrain is flat and streets are wide, well-ventilated and free of local domestic heating combustion sources. For both sites were available data obtained by gravimetric and automatic method. Gravimetric data were obtained by analysis of samples from Tecora SKYPOST sampler. Automated measurements were performed with Continuous PM Mass Grimm Instrument Model 180.For both sites, it was calculated correlation between daily values of PM10 obtained by gravimetric method,reference method, and daily values of PM10 recorded with automatic monitoring(0,91 and 0.97 for B-SG and B-NB, respectively). Obtained functional relationships were used to correct automatic measurement data. Automatic data were taken to the reference level. Analyzed data were for the winter 2011/12 (November, December 2011, January 2012) and summer 2012. (June, July, August 2012.)

At both urban sites during winter and summer mass concentration of PM10 during the day have two maximums At the location B-SG average concentration of PM10 in winter is 63.6μm/m3. Hourly average concentrations have maximums of 71.7μm/m3 (19h) and 66.47μm/m3 (09h). Summer concentration of PM10 was 36.5 μm/m3, with maximums of 49.7μm/m3 (08h) and 41.6μm/m3 (21h).At the location B-NB average concentration of PM10 in winter was 58.8μm/m3, with hourly average concentrations maximums of 70.9μm/m3 (23h) and 59.1μm/m3 (09h). Summer concentration of PM10 was 26.9 μm/m3 with maximums of 37.9μm/m3 (21h) and 31.0μm/m3 (08h).

In the winter morning minimum occurs around 7 am at both locations. For B-SG it is primary for B-NB it's secondary. In B-SG PM10 after morning minimum increases rapidly. This can be attributed to local emissions from furnaces and surrounding traffic. Increase, after a morning minimum, is registered also in B-NB, but to a much lesser extent. It can be attributed primarily to traffic. During the midday and afternoon concentrations decrease. This decline in value occurs in a part of the day, on average, when are the best conditions for the diffusion of atmospheric pollutants. Faster and more concentrations of PM10 decrease in B-NBwhich is a consequence of the orography and type of settlement and better ventilation conditions. In both locations evening increase of concentration begins at sundown. It lasts until the late evening hours, when it reaches its maximum.Daily flow during the summer season is basically similar. In B-SG morning maximum is primary. Evening, secondary, smaller in intensity compared to the winter is better expressed than in neighboring terms.

THE INFLUENCE OF DIFFERENT BIODIESEL FEEDSTOCKS ON THE OXIDATIVE POTENTIAL OF DIESEL PARTICULATE MATER

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Generally, the magnitude of pollutant emission from diesel engines running on biodiesel fuel is ultimately coupled to the structure of respective molecules that constitutes the fuel. The presence of oxygen inside the biodiesel molecules leads to significant levels of oxygenated toxic species. In addition, the carbon chain length and the degree of unsaturation influence the biofuel combustion chemistry and these are all dependent on the feedstock. To gain an insight into the relationship between the molecular structure of the esters present in different biodiesel stocks and their respective oxidative potentials, measurements were conducted on a modern common rail diesel engine. Tests were designed to present emissions differences due to changes in fuel, speed and load settings, which included usage of three blends for every biodiesel feedstock (B20, B50 and B100). To establish the oxidative potential of diesel particles the concentration of reactive oxygen species (ROS) was measured using the profluorescent nitroxide probes developed at QUT. The results indicate that there is a strong correlation between the measured concentration of reactive oxygen species (ROS) and carbon chain length as well as the degree of saturation and to a smaller extent engine operating conditions.

Volatility measurements indicating the overall organic coating on particles correlated well with measured oxidative potential. This indicated that ROS content is a function of organic particle composition. However, it does not always exhibit a simple linear trend with volatility data and depending on a particular combustion source may show a much higher correlation with the oxygenated organic fraction.

This highlights the importance of knowing the surface chemistry of particles for assessing their health impacts and reinforces the further investigations to explore this correlation.

COMPARISION OF SOURCE APPPORTIONMENT OF URBAN AMBIENT PARTICLE BOUND PAH BETWEEN SUMMER 2009 AND 2012 MESAUREMENT CAMPAINGS IN BELGRADE, SERBIA

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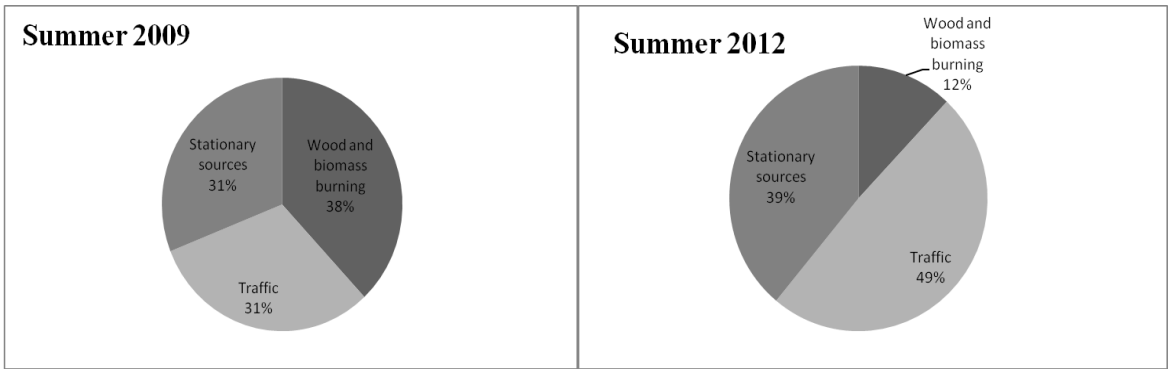
Concentrations of polycyclic aromatic hydrocarbons (PAHs) are associated with adverse health problems and specifically with carcinogenic and mutagenic effects. The major PAH sources outdoors are: stationary sources (industry, residential heating, power plants, incineration), mobile emissions (motor vehicle exhaust, diesel and petrol engines), biomass burning and agricultural activities (open burning of brushwood, straw, stubble, etc.). PAH concentrations in summer are influenced by higher degrees of atmospheric photo degradation and evaporationwhen semi-volatile PAHs change statetogas phase, and thus whileconcentrations are much higher during cold periods, PAHs are still present during the warm period.

The aim ofthis study was to identify differences in PB-PAHs levels and sources contribution between 2009 and 2012 sampling campaignsdone at one sampling site during summer period. Sampling location is mixed residential, business and industrial area of New Belgrade under rapid development.

24h PAHs were collected and analyzed in PM_{10} aerosol fraction during spring-summer period : (1) in 2009, 53 were samples taken(2) in 2012, 8 samples per month of non-heating session, in all 55 samples. PM_{10} were collected using LVS, Leckel, reference sampler equipped with appropriate size selective inlet and quartz filters and analyzed with Agilent GC/MS (type 6890N GC with 5973N MSD**).** The contribution of sources to the total PAH concentration in PM_{10} was identified using Positive Matrix Factorization analysis (PMF), EPA PMF3.1 software.

Mean 24h PB-PAHs were higher in 2012 than 2009, 3.48 and 2.36 ng/m^3 respectively.Average 24h PB Phenanthrene, Pyrene and Fluoranthene, were higher during campaign 2009, while all other congeners were higher in 2012 (e.g. BaP was 0.09 and 0.27 in 2009 and 2012 respectively). Figure below shows a percentage contribution of emission sources to the total PAHs.



Traffic and stationary sources were more intensive in 2012than three years earlier. This may be due to overall rapid urban development. Lower contribution of wood and biomass burning in 2012 may be due to removing Gypsy camp that was nearby the sampling location in 2009.

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DATA ASSIMILATION: ADDING VALUE TO THE CITIZEN'S OBSERVATORY

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The CITI-SENSE project (http://citi-sense.nilu.no) is funded from the 7th Framework Programme for Research and TechnologicalDevelopment of the European Communities, under the theme "Environment (including Climate Change)".The main objective of CITI-SENSE is ***to develop "Citizens' Observatories" to empower citizens andcitizens' groups***: (i) to contribute to and participate in environmental governance; (ii) to support andinfluence community and policy priorities and the associated decision making; and (iii) to contribute toEuropean and global monitoring initiatives. By Citizens' Observatories we mean communities of diverseusers that will share technological solutions, information products and services, and community participatorygovernance methods using appropriate communication solutions (e.g., social media), and who will by theseactivities complement established environmental data and information systems and improve local decisionmakingabout environmental issues.

The main objective of the CITI-SENSE project will be accomplished by developing and testing an environmental monitoring andinformation system based on innovative and novel Earth Observation (EO) capabilities and applications focusedon the citizen's immediate environment. Although the focus of this proposal is on atmospheric pollution (which contributes to air quality) incities and agglomerations, monitoring of a wide range of environmental issues is envisaged. The project isplanned for four years.

A particular application to EO which will be used in the CITI-SENSE project is data assimilation (e.g., Lahoz et al., 2010). This will be a novel application of data assimilation. In this presentation, the method of data assimilation is introduced as a way of combining observational and model information, and take account of their characteristics. It is shown how data assimilation adds value to both observations and model. We then provide examples of the application of data assimilation, including the design of the observing system for monitoring air quality, an environmental indicator of interest to citizens and on which the citizens' observatories can provide information. We then provide an outlook for data assimilation in the context of the citizens' observatories concept, and provide details of how the method will be applied in the CITI-SENSE project.

Lahoz, W.A., B. Khattatov and R. Ménard (Eds.), 2010: *Data Assimilation: Making sense of observations*, Springer, 718 pp.

PARTICIPATORY AND UBIQUITOUS SENSING RECENT ADVANCES

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There are two primary goals of exposure science: to understand how stressors affect human health, and to prevent or reduce human contact with harmful stressors (e.g., air pollution exposure) or to promote contact with beneficial stressors to improve public health (e.g., contact with park areas and green spaces). Here we use a framework for exposure science adapted from the U.S. National Academy of Science report "Exposure Science in the 21st Century". This framework reflects a broader view of the role of exposure science in human-health protection that identifies the major elements of exposure science and the role of upstream human and natural factors and the roles of both external and internal environments within exposure science

Exposure assessment is a major component of environmental epidemiology yet it has been and continues to be a major weakness in epidemiology. Most epidemiologic studies have relied on surrogate estimates of exposure, usually assigned to the home location of study subjects. Reliance on proxy methods may impart large exposure-measurement error. Depending on the exposure-error type, health-effect estimates may be attenuated and biased toward a null result, obscuring the true benefits of control measures. Innovations from telemedicine are now spurring fields known as "ubiquitous", "embedded", and "participatory" sensing that may transform exposure science in epidemiological studies. We define ubiquitous sensing as a network of embedded sensors, such as a dense array of air pollution or water contamination monitors that would have wide spatial coverage in urban areas. Similarly, a ubiquitous system may rely on remote-sensing instruments that continuously supply information on particular phenomena, such as surface temperature or aerosol optical depth, which has virtual global coverage. Participatory sensing is defined as a means of obtaining detailed information on personal and population exposures via volunteers who supply this data often in exchange for useful information that might allow them to better understand and prevent harmful exposures.

We conclude with discussion of future challenges and trends. Participatory and ubiquitous sensing offer tremendous promise for improved exposure assessment, yet many challenges remain before these advances fundamentally change the way exposures are assessed in epidemiology. Protection of personal privacy, analysis of the voluminous "big" data generated by the sensors, and integration with other emerging methods from molecular epidemiology represent critical areas for research and development. These are active areas of research that will require extensive work to resolve over the next five to ten years.

AVAILABILITY OF SMALL AND CHEAP SENSORS FOR INDICATIVE CITIZEN-BASED CONTINUOUS MONITORING OF RESPIRABLE PARTICULATE MATTER

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In order to protect the environment and health of citizens, it is required to obtain the levels of Respirable Particulate Matter (RPM) in the ambient air with high temporal and spatial specificity. Current air quality monitoring networks consist of limited number of stations that are expensive, large in size and usually operated by the state and local government agencies. Reference and other ambient PM and gaseous monitor units that are in use by communities and research studies are neither usable to cover large areas nor as personal monitors for widespread measuring of location-specific level of pollutants. Small and cheap sensors represent a big opportunity for building the sensor networks for monitoring indicative levels of the ambient PM and gases covering large geographic areas. Together with appropriate infrastructure, the sensors offer unique opportunities for citizen-participated sensing.

This presentation gives an overview of cheap miniature RPM sensors currently commercially available that offer indicative information about RPM. Furthermore, an analysis of sensors characteristics is presented, in particular with respect to the limit of detection compared to the current EU legislative and WHO recommendation regarding the levels of particulate matter.

There are a numerous commercially available expensive regulatory, regulatory-equivalent and non-equivalent but less expensive handheld monitors for continuous monitoring of RPM. The cheapest devices fall in range of from 10 to 1000 EUR in price and are about one tenth in size of the largest. The sensor technology utilized within RPM detection is based on the light scattering principle. Up to now, commercial optical sensors manufacturers claim to detect and count PM of size above 0.5 μm and even 0.3 μm, and then covert the count to mass. Prior to using sensor devices in practice, their properties need to be assessed. This was attempted already in a number of studies. For citizen-based continuous monitoringit may be necessary to perform complex procedure of calibration prior to deployment, involving various parameters such as detection limit; concentration range; temperature range; humidity influence; concentration differences and correlation coefficient between sensor device and reference PM monitor. Results of Northcross et al (2013) proved that accurate calibration of cheap RPM sensors, e.g. a particle counter, may enable them to accurately estimate particle mass in a wide range of settings. Recently published results by Paprotny et al (2013) about novel, portable MEMS PM monitor (with Film-Bulk Acoustic Resonator – FIBR) are pawing the way to create a low cost low power air quality monitoring system that may effectively detect a wide range of PM including even fractions smaller than what currently available commercial sensor devices can detect.

Suitable sensor technologies available today can be used by the public and provide highly time-and-space specific results of known quality, comparable to reference methods. We need however to develop appropriate infrastructure and quality systems to support acquisition and use of such data.

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A WEB-BASED TOOL FOR ACTIVE COMMUTERS TO MITIGATE THEIR EXPOSURE TO PARTICULATE MATTER IN URBAN ENVIRONMENTS; A COMPONENT OF THE CITI-SENSE BARCELONA CASE STUDY

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In Barcelona, levels of traffic-emitted pollution, including particulate matter (PM), are among the most highly-concentrated in Europe. Meanwhile, the local government of Barcelona is introducing initiatives to increase the commute modal share of bicycles, such as extending the bicycle lane network and supporting a public bicycle sharing scheme. Therefore, poor air quality conditions for the expected increased number of bicycle commuters may pose a public health risk.

The aim of this initiative is to provide a smartphone and web-based information service for bicycle commuters to make an informed route choice in regards to air quality with consequential reduced exposure and health impacts.

Forty static sensor nodes will be strategically deployed around the city of Barcelona. Dynamic land-use regression (LUR) modeling will be performed to create a near-real-time map layer of urban environmental health indicators, including PM and other motorised traffic emissions such as CO_2, NO_2, NO_X, and noise. Citizens that frequently bicycle commute will be engaged to identify and evaluate contemporary environmental health issues, such as in-commute exposure to traffic-emitted PM.

The static sensors will facilitate LUR modeling, temporally-adjusted (hourly) and complementing existing air monitoring network information, to produce advice for citizens via software applications. The web-based tool will be created using the Google Map engine and a temporally-adjusted LUR model map layer to inform bicycle commuters of the cleanest route (e.g. as an alternative to the quickest route). Citizen enquiries with the online tool may be anonymously-logged to evaluate the amount of exposure reduced, and the time added, between commute route choices of the quickest and cleanest route for evaluation of the tool's efficacy. The bicycle commuter user groups, Barcelona city council and bicycle advocates will assist the development, and long-term sustainment, of the final product via sought feedback.

Bicycle commuters utilising the web-based tool may reduce their exposure to air pollution such as PM by identifying a bicycle commute route that may be of higher air quality than their typical/fastest route, consequentially making an informed-decision to mitigate their exposure to PM in while performing the daily bicycle commute to their place of study or work.

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FINE AND ULTRAFINE PM EFFECTS AND ACTION MECHANISMS ON IN VITRO SYSTEMS.

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Particulate matter (PM) related air pollution is still one of the main concerns in highly populated urban areas for its human health adverse effects. However the causal relation between PM properties and biological effects, and the molecular mechanisms activated at cellular level are still poorly understood. Fine (FP) and ultrafine (UFP) fractions have recently received great attention for their role in eliciting pulmonary and cardiovascular diseases. These fractions are mainly generated by combustion processes andare composed by agglomerates of nano-sized particles [1]. In Milano vehicular traffic is the most important source of these particles, followed by domestic heating during winter.

Here the biological effects of such FP and UFP are investigated; FP (PM2.5) were sampled during summer and winterin Milano,in a representativebackground site for air quality, while samples of organic UFP (NOC), derived from experimental combustion processes, were obtained in laboratory [2]. These particles have been tested on in vitro systems representative of the human lung epithelia (A549 and BEAS-2B cell lines). The effects on cell viability, inflammatory response, ROS and DNA damage formation and cell cycle alteration have been investigated by means of common biochemical and microscopy techniques; the mechanisms of action involved in these effects have been studied using proper inhibitors (NAC, α-naphtoflavone).

Winter FP generated ROS, DNA damage and alteration of the mitotic process; these effects were not produced by summer FP. The analysis of the action mechanisms revealed that the organic compounds of winter FP were responsible of the biological effects, through the activation of CYP enzymes pathway and the alteration of the mitotic spindle organization.

Moreover NOC were able to induce cell death, inflammation and ROS formation. These effects were related to the fuel used in the combustion process, and biofuel-derived NOC resulted to be the most cytotoxic.

These results outline that the compounds adsorbed on FP and UFP have a great significance in the induction of the different cellular effects. Moreover the results on NOC toxicity underline the need of further investigation to improve the knowledge of the biological effects produced by UFP generated by combustion processes.

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PERSONAL EXPOSURE TO CARCINOGENIC POLYCYCLIC AROMATIC HYDROCARBONS BOUND TO PM2.5 IN THE CZECH REPUBLIC

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Personal exposures to carcinogenic polycyclic aromatic hydrocarbons (c-PAHs) boud to airborne PM2.5 (particulate matter ≤ 2.5 μm) were measured in the context of a large-scale molecular epidemiological study in order to identify the impacts of air pollution on human health. Sampling was carried out in 3 industrial cities in the Czech Republic: Ostrava, Karvina and Havirov. The city of Prague, served as a control. The first monitoring campaignes were held in winter and summer 2009. The active personal monitors PV1.7 for PM2.5 bound c-PAHs were used. Only adult non-smokers participated in the study (N=160); city policemen from Prague, Karvina and Havirov, and office workers from Ostrava city. All participants completed a personal questionnaire and a time-location-activity diary. The average personal winter exposures to c-PAHs (sum of the eight PAHs - benz[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, benzo[g,h,i]perylene, benzo[k]fluoranthene, chrysene, dibenz[a,h]anthracene and indeno[1,2,3-c,d]pyrene) was highest in Karvina, 39.1, followed by Ostrava at 15.1 and Prague at 4.3 ng/m3. The winter levels were significantly higher than the summer values ($P<0.001$): 4.3 in Karvina, 3.0 in Ostrava, 1.6 in Havirov and 1.0 ng/m3 in Prague. The average personal benzo[a]pyrene winter/summer exposures were: 6.9/0.6 in Karvina, 2.5/0.4 in Ostrava, 0.8/0.1 in Prague and 0.2 ng/m3 in summer in Havirov. In this part of the study, we examined personal exposure to c-PAHs and tested it for associations with potential predictor variables collected from questionnaires, addressing life style factors and day-to-day activities. We found outdoor concentration, environmental tobacco smoke exposure, home heating fuel of coal, wood or gas, frequency of exhaust fan use, cooking and commuting by a car to be the main determinants of personal exposure.

HEALTH RISK ASSESSMENT OF POLLUTANTS (PAHS AND HEAVY METALS) ASSOCIATED WITH PM_{10} IN URBAN PARKING GARAGES

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Urban particulate matter (PM) is highly chemically complex mixture, consisting of various organic and inorganic compounds. Some toxic elements and PAHs, adsorbed on the PM surface, determine its toxicological characteristics and have been associated with adverse effects on human health. Concentration of these pollutants is expected to be elevated in parking garages due to intensive traffic flow and poor air conditions. In this study, twenty-four hour air samples of PM_{10} were collected in two Belgrade parking garages (Masarikova-M and Pionirski park-PP) for ten weeks during the autumn of 2012. PM_{10} mass concentrations were measured by gravimetric method; concentrations of 16 US EPA priority PAHs were measured by GC-MS and concentrations of Al, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Mg, Mn, Na, Ni, Pb, Sr and Zn were determined by ICP-OES. The carcinogenic health risk of employees' occupational exposure to four heavy metals (Cd, Cr, Ni and Pb) and six PAHs (B[a]A, Cry, B[b]F, B[k]F, B[a]P and DB[ah]A) was estimated according to US EPA health risk assessment model, using toxicity information from Risk Assessment Information System database. It was assumed that the exposure time of employees is 8 hours per day with the exposure frequency of 235 days per year and the exposure duration of 30 years. The average PM_{10} mass concentrations were about 117 and 104 μg m^{-3} in M and PP, respectively, which is above the daily air quality value of 50 μg m^{-3}set by EU Directive 2004/107/EC. Although the prescribed value is related to outdoor air quality, it could also be applicable to indoor spaces. Cumulative cancer risk obtained as sum of incremental lifetime cancer risk (ILCR) values for individual chemicals – $4.51 \cdot 10^{-5}$ and $3.75 \cdot 10^{-5}$ in M and PP, respectively, are higher than acceptable limit of 10^{-6}. Heavy metals can be considered as the major contributors to assessed cancer risks (about 98% in both M and PP). ILCR values obtained for Cd, Cr, Ni and Pb indicate that heavy metals originated from vehicle emissions are those with higher cancer risk. On the other side, ILRC values of studied PAHs are below the acceptable limit. Comparing the results from both garages, it becomes apparent that cumulative cancer risk values are quite similar, but lower in PP. Although PP is completely underground garage as opposed to M, the lack of appropriate ventilation system with filters in M is a possible cause of this result. The obtained results indicate the need for health risk impact evaluation and setting indoor air quality guidelines.

BLACK SMOKE AND DAILY MORTALITY OF CARDIOVASCULAR DISEASES IN NIŠ, SERBIA

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Air pollution is associated with increased cardiovascular hospitalisation and mortality. A variety of biological mechanisms responsible for adverse cardiovascular outcomes associated with particulates have been described, including the release of pro-oxidative and pro-inflammatory mediators from the lungs into the circulation, autonomic nervous system imbalance, and the direct actions on the heart and vasculature of ultrafine particles translocated into the systemic circulation.

The aim of our paper was to investigate the association between ambient concentrations of black smoke (BS) and daily total non-accidental cardiovascular mortality in Niš.

Daily cardiovascular mortality data between 2001 and 2005 were obtained from the Republic Institute for Statistics of Serbia in charge of coding the medical causes of death according to the International Classification of Diseases-10th Revision (I00-I99)among person 19-64-yrs-old. Air pollution data were provided by the Public Health Institute of Niš. Daily concentrations of BS and SO_2, was monitored in the local monitoring network. BS (μg/m^3) was measured by the refractometry method and SO_2 (μg/m^3) by spectrophotometer.. The sampling was preformed by the means of a pump operating with a flow rate of 1 L/min through Whattman No1 paper filters. Missing air pollution values for 6% days of the period were treated as being missing completely at random and were dropped from the analyses.The daily mean temperature, the mean relative humidity and the mean barometric pressure values for the same period were obtained from Republic Meteorological Department.Generalized linear model extending Poisson regression was applied. This model used mortality counts as the response variable, the natural cubic splines of the calendar time, temperature, relative humidity and barometric pressure, the day of week and season as indicator variables, and black smoke pollution as predictor variable.The effects of time trend, seasonal variations, day of week, temperature, relative humidity and barometric pressure were adjusted.

During the 5 years, there were 4818 all age cardiovascular mortality in the city of Niš, and 812 cardiovascular mortality among person 19-64-yrs-old. The daily mean number of all age cardiovascular mortalitywas 2.64±1.69 (0 to 10) and 0.44±0.66 (0 to 3) among person19-64-yrs-old. The daily mean level for BS was 22.83±21.82 μg/m^3, minimum 1.00 μg/m^3 and maximum 225.00 μg/m^3.Estimated OR of unipolutant regression model for among person19-64-yrs-old was 1,001118 (95% CI: 0,97188 to 1,05208), and estimated OR of bipolutant model was1,001107(95% CI: 0,96991 to 1,05398)per 10μg/m^3.

This mortality time series study have shown, that all age cardiovascular mortality and among person 19-64-yrs-oldare not related to ambient air pollutants concentrations. There is a risk of cardiovascular mortality with increase of 10μg/m^{3}black smoke, but it is not statistically insignificant. However, in response to air pollution exposure, different age groups may respond differently. It will also be important to determine whether other groups of population are more susceptible to air pollution.

AIR POLLUTION AND ADVERSE BIRTH OUTCOMES

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Air pollution is associated with a range of adverse health effects, including adverse birth outcomes.

Aim is to provide an overview of the latest developments on air pollution and adverse birth outcomes

We conducted a literature of the studies on air pollution and adverse birth outcomes and reviewed some ongoing studies.

Recent meta and pooled analyses suggest associations for a range of air pollutions and adverse birth outcomes. The evidence is stronger evidence for (low) birth weight than for other outcomes such as pre-term birth, congenital anomalies and still births. Risk estimates differ, possible as a result of different methodologies used, bias and possible confounding.

Recent studies suggest that there associations between air pollution and adverse birth outcomes. Further work is needed to understand the mechanisms through which the adverse outcomes occur.

BREAST CANCER AND AIR POLLUTION: AN OVERVIEW

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Breast cancer is the most common cancer type among women worldwide and the leading cancer killer of nonsmoking women, and second to lung cancer among women who smoke (WHO). Attributable risk percent for the established breast cancer risk factors is about 30%, and these factors are not easy modifiable for prevention efforts. The relevance of environmental risk such as air pollution for breast cancer has been suggested by studies showing higher incidence of breast cancer in urban than in rural areas (7). Given that air pollution is causally related to lung cancer, and possibly brain, liver, and bladder cancer (raaschou), it is plausible that at least one of the many carcinogenic constituents of polluted air, may affect breast cancer risk (2). Polycyclic aromatic hydrocarbons (PAHs), constituents of ambient particles, have been linked to breast cancer in both toxicological and epidemiological studies (2), whereas ultrafine ambient particles which contain PAHs are able to translocate from the lung to circulatory system, adipose, mammary and other tissues (8). Still, epidemiological evidence linking traffic-related air pollution to breast cancer incidence is sparse and mixed (1,3-6,9). Based on the same case-control study from the New York state, USA, Bonner et al. detected association with traffic-related air pollution exposure at early life (air pollution levels at residence at birth), (1) whereas Nie et al. detected associations with exposure to traffic emissions at first-birth, but none with other exposure windows: menarche, 10 or 20 years prior to interview (6). In the case-control study from Montreal, Canada levels of nitrogen dioxide (NO_2), proxy of traffic-related air pollution, were linked to postmenopausal breast cancer (4). Two ecological US studies showed that breast cancer incidence time trends over last 30 years correlated well with time trends in emissions of nitrogen oxides (NO_x) as well as motor vehicle density data (3), and found higher breast cancer incidence rates in high industrial and traffic emission regions and in metropolitan areas (9), bot suggestive of relevance of air pollution for breast cancer risk. No prospective cohort study to date has been conducted on the association of air pollution with breast cancer incidence.

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HEALTH RISK ASSESSMENT OF TRACE METALS ASSOCIATED WITH PM_{10} IN BELGRADE DISTRICT

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Estimation of the levels of atmospheric particulate matter (PM) and its chemical composition is very important in air quality monitoring. Inhalable PM with aerodynamic diameter less than 10 μm (PM_{10}) can have harmful effects on human health due to the presence of toxic species. In this study, 24-h mass concentrations and trace metal content (As, Cd, Cr, Mn, Ni, Pb) of PM_{10}were obtained by the Institute of Public Health of Belgrade. Samples were collected and analyzed during the 2012 at three automatic monitoring stations (Slavija, Lazarevac and Grabovac) in Belgrade district. Slavija represents a typical urban traffic station, located at the very center of Belgrade city. Lazarevac is placed in the namesake city near the Kolubara coal basin, while location of Grabovac is about 10 km from the two biggest thermal power plants in Serbia. Health risk assessment associated with inhalation of PM_{10} was conducted using the US EPA health risk assessment model. It was assumed that the bioavailability of trace metals is 100%.Toxicity data were obtained from Risk Assessment Information System Database.

Average annual PM_{10} mass concentrations at Slavija, Lazarevac and Grabovac were 52, 48 and 32 μg m^{-3}, respectively, meaning that the annual air quality value of 40 μg m^{-3}, set by EU Directive 2008/EC/50, was exceeded at Slavija and Lazarevac. The 24-h PM_{10} mass concentrations, at Lazarevac and Grabovac, exceeded the value of 50 μg m^{-3} for more than 35 days (frequency limit according to EU Directive 2008/EC/50). Average annual concentrations of Pb, Mn, Cr and Ni, elements characteristic for vehicle and industrial emissions, were higher at Slavija than at the two other stations mostly due to heavy traffic. Concentration of As, which is characteristic for coal combustion, was much higher at Lazarevac than at Slavija and Grabovac due to the proximity of coal mine and the thermal power plant.

Cumulative cancer risks, determined as a sum of individual incremental lifetime cancer risks (ILCR), were $1.06 \cdot 10^{-4}$, $1.24 \cdot 10^{-4}$ and $4.45 \cdot 10^{-5}$ at Slavija, Lazarevac and Grabovac, respectively, which are higher than acceptable limit of 10^{-6}. Individual values of ILCR were exceeded for Ni, Cr and As at Slavija and Lazarevac, and for Cr and As at Grabovac. The major contributor to obtained cancer risks was Cr - about 90%, 60% and 80% at Slavija, Lazarevac and Grabovac, respectively. Knowing that its sources are mainly anthropogenic (industrial processes, fuel combustion, etc.), this indicates the need for reduction in emissions of this metal. Contribution of As at Lazarevac was very high (32%) comparing to Grabovac (about 15%) and Slavija (0.8%). Non-cancer risk was estimated by calculating the hazard quotient (HQ) for each trace metal. Hazard index, obtained as a sum of HQ values of individual elements, was lower than 1 at all three stations, indicating no adverse non-cancerogenic health effects.

THE INFLUECE OF AMBIENT PARTICULATE MATTER ON HEALTH OF PRE-SCHOOLCHILDREN IN CITY CENTER OF NIS, SERBIA

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This paper is a study of causality between ambient air pollution with PM 2.5 particles and health risk in the subpopulation of children up to the age of 6. Based on the statistical analysis of the measured concentration of pollutants, in the City of Nis from 1995 to 2011, it can be concluded that there is a need to establish the relationship between the exposure to pollutants emitted from motor vehicles and the occurence of health effects in the exposed population. Since detailed analysis of the impact of PM 2.5 particles on the health of the exposed population is not carried out in the vicinity of roads in the City of Nis, an automatic measuring station was placed in the area of a kindergarten located on a busy crossroads. The measurements of PM 2.5 particle concentrations showed exceeding limit values ranging from 43,11% to 107,4%. PM 2.5 particles represent a significant health risk for preschool children, which is shown in the paper by calculating individual health risk and reviewing respiratory diseases in the exposed children.

CHEMICAL CHARACTERISATION OF RESPRABLE PARTICULATE MATTER IN AMBENT AIR OF THE TOWN OF BOR

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Hazardous air pollutants released from industrial sources may have a serious impact on the population as well as on the surrounding area. In order to assess the relationship between outdoor and indoor air pollution in the vicinity of Copper Smelter Complex in the town of Bor the simultaneous sampling of both particulate matter fraction, PM10 and PM2.5, indoor and outdoor, were conducted during heating and non-heating seasons in 2009. and 2010. In the town of Bor, there have been historically measured concentrations of SO_2 and arsenic concentrations in excess of the National Ambient Air Quality Standard (NAAQS) for TSP at monitoring locations.

This study showedthat the average outdoor PM10 and PM2.5 concentrations were 34 % and 45 % higher during heating season in comparison to non-heating season. Similar results were recorded for particulate fraction in indoor microenvironment, the average indoor PM10 concentrations were 33.8 μg/m^3 and 44.0 μg/m^3 during non-heating and heating seasons, respectively. The average indoor PM2.5 concentrations were 25.8 μg/m^3 and 36.6 μg/m^3 during non-heating and heating seasons, respectively.

The concentrations of 21 target elements were determined using ICP AES and GF AAS. The percentage ratio of all analyzed elements in outdoor ambient were higher during non-heating season for both fractions, while the percentage ratio of trace elements measured outdoors (that are presented at ng/m^3) were higher during heating season, 1.63 % of PM10, and 1.56 % of PM2.5. The same situation were observed for concentrations in indoor microenvironment.

Calculated EF values varied widely between 0.7 and 25627.3 during non-heating season, and between 1.1 and 1118266.9 during heating season. The EF values for most of the elements of indoor PM2.5 were higher than those of the outdoor PM2.5. Most of the measured elements have high EF that confirm that they originate from anthropogenic sources.

In addition, 12 different elemental ratios were used as tracer of main pollution sources in the vicinity of copper smelters.

The positive matrix factorization (PMF) was applied to the PM10 data sets to identify the diverse sources of pollution of the town of Bor.. Source appointment and chemical characterization of outdoor PM10 particles in Bor, town located in the vicinity of copper smelter facilities, have been conducted for the first time in this region. For both campaigns, heating and non-heating, seven sources have been identified.

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COMPARISON OF PAHs LEVELS IN GAS AND PARTICLE -BOUND PHASE IN SCHOOLS AT DIFFERENT LOCATIONS

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Polycyclic aromatic hydrocarbons (PAHs) are a class of organic compounds produced by incomplete combustion processes of organic material such as biomass and fossil combustion, vehicular emissions, industrial processes etc. The PAHs consist of two or more fused benzene rings containing only carbon and hydrogen. Although the list of priority PAHs varies in different countries, US EPA list of 16 priority PAHs is most often used.

The aim of this paper was to investigate the seasonal variation of PAHs and their partitions between the gas (G) and particulate-bounded (PB) phases in the indoor (I) and outdoor (O) air for schools situated at different representative locations in urban and rural area.

Indoor samples were collected during December 2011 and Jun 2012in classrooms in the 4 schools in Serbia. The sampling sites were selected to match four types of representative locations: urban (school U), urban/traffic (school U/T), urban/industrial (school U/I) and rural (school R). The sampling campaigns were conducted simultaneously indoor and outdoor during one week successively in each school in both heating and non-heating seasons. Samples were collected using low volume sampler (LVS) for 24h period. The air was drawn by LVS reference sampler (Lackel) through a quartz filter to collect total suspended particles (TSP) and then through polyurethane foam (PUF) to collect gas phase of pollutants. Collected samples are prepared and analyzed according to EPA Compendium Method TO-13A using Gas Chromatography coupled with Mass Selective Detector (GC-MS).

As usual, significant seasonal variations of gas (G) and particle-boinded (PB) phase PAH concentrations were observed with higher levels during heating season. The maximum of total PAH concentrations, expressed as the sum of the individual PAH concentrations (ΣPAH), was highest in school U/T during heating season for both phase (52.96 ng/m^3 for PB and 913.42 ng/m^3 for G phase).During non-heating period levels ranged 1.19 - 12.07 ng/m^{3}for PB phase and 35.46 – 254.14 ng/m^3 for G phase,The lowest PAH concentrations was in school U during non-heating season. In general, Nap, Ace, Ane, Flu and Phe were common gas-phase PAHs, whereas BbF, BkF, BaP, InP, DbA and BgP formed most of the particulate phase.The phase distribution of the PAHs depends on the vapor pressure, the atmospheric temperature, the PAH concentration and the affinity for suspended particles. The highest total PAH values were associates with the gas phase in both sampling periods, especially in heating seasons.

The volatile PAHs (2 and 3 rings) were most abundant at all four schools. The highest presence ofthesePAHswas observedat the school U/I inthe gas phaseduringboth seasons. The heaviest PAHs (5 and 6 rings) were dominant in the particulate phase, while in the gas phase they are generally not detected. The 4-rings PAHs (Fla, Pyr, BaA and Chy)werepresent inboth phases. In the school R 4-ring PAHs were distributed almost equally between the two phases during both seasons.

The I/O ratios for G phase were slightly above 1 for non-heating season at all sampling locations. Most of the I/O ratios for PB phase for both seasons and G phase during heating season were less than 1.0 which indicated that the indoor PAHs were mostly from outdoor sources.

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PARTICULATE MATTER IN CLASSROOM INDOOR AIR OF PRIMARY SCHOOLS IN BELGRADE IN FRAMEWORK OF SERCH PROJECT

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Over the last few decades, indoor air quality (IAQ) has been rated as a problem of great significance. However, much less is known about indoor particulate matter (PM) concentrations and associated health risks. In particular, data are needed on air quality in schools, since children areassumed to be more vulnerable to health hazards, while spending a large part of their time in school. Such need was formulated through implementation of the SEARCH (School environment and respiratory health of children), conducted in Serbia, as well as in Albania, Bosnia and Herzegovina, Slovakia, Hungary, during a two-year period (2007-2009).

As in each participant country, 10 primary schools were chosen for the research in Belgrade. Key criteria for making a choice of a particular school were its allocation, according to the distance from the core central urban zone of the city: periurban settlement without busy roads, wider urban area with busy traffic, city proper zone with busy traffic. In ten Belgrade primary schools research was implemented on children attending 44 classrooms, meaning that in some schools 4 classrooms participated, while in others 5. Key criterion for the choice of a designated classroom in each school was its orientation, either towards the street with heavy traffic, or towards the school yard.

Children were chosen to participate in the research by using random sampling method, and according to the classroom they are attending. All in all, 746 children have participated in the research.

Assessing level of exposure to school environment in children was done by measuring of school indoor air pollutants, school building status evaluation (assessment of its maintenance practices), and home environment evaluation (questionnaire). The study protocol included a standardized questionnaire for school characteristics, filled in by the school administrator, and one standardized questionnaire for classroom characteristics, filled in by the teacher. The following measurements have been undertaken in all chosen classrooms: Combination of diffuse sampling during a 4-day exposure period for formaldehyde (HCHO), nitrogen dioxide (NO_2), BTX, and continuous 24h measuring for carbon monoxide (CO), carbon dioxide (CO_2) and PM10, during school hours. Parallel to these IAQ monitoring activities, outdoor air quality was followed for the same specific pollutants, close to school.

Measuring results for PM_{10} were significantly most frequent in the interval of 80,1µg/m^3 and higher, namely, in the interval above 50 µg/m^3. Mean value for PM10 was 82,24±42,43 µg/m^3, ranging from minimum 32,00µg/m^{3}to maximum value of 197,00µg/m^3, with the median of 70,00 µg/m^3.

INVESTIGATION OF PARTICULATE MATTER IN A MUSEUM IN SHANGHAI, CHINA

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Simultaneous monitoring particles parameters was conducted in a museum located in Shanghai, including particle number concentration, particle mass concentration,water soluble organic carbon, organic carbon, element carbon, morphology and main elemental properties. The aim was to investigate the impact of floor level, particle size and flooring on particle characteristics. Size fractionated particle number concentration in each display hall belongs to the same level exhibited similar daily variation. The results showed particle in the range of 0.3-0.5 μm was an important contributor to the total amount, which was due to that flooring, carpet easily causedparticle resuspension withinthe large size. Multi-lognormal fitting was firstly applied in museum to simulate the particle number size distribution.The modeling results showed an accumulation mode of 0.17 μm and a coarse mode of 3.87 μm. It was observed from SEM photomicrograph that soot aggregates and mineral matter accounted for the majority of coarse particles plus a small section of coal fly ash, in comparison with only soot aggregates dominated on fine particles. The corresponding results obtained from Scanning Electron Microscopy with Energy-Dispersive X-ray (SEM-EDX) showed enriched elements appeared on coarse particles, including Ca, Si, Al, Na, C, O, S and Mg, but only S detected on fine particles. It needs to be stressed that PM0.1 reached up to the value of 220 $\mu m/m^3$ in the hall measurement. It was found enhanced OC partially brought in by tourists and partly originated from secondary carbon formation by comparing the relationship between organic carbon and element carbon, as well as organic carbon and water soluble organic carbon. In addition, a series of suggestions were proposed according to the corresponding findings.

POSTER PRESENTATIONS

TO SONICATE OR NOT TO SONICATE: THE INFLUENCE OF SONICATION ON CHEMICAL COMPOSITION OF PARTICULATE MATTER

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A common means for particle collection is sampling onto filters. If further chemical or toxicological analysis is desired in most of cases the particulate matter (PM) needs to be extracted from the filters. Ultrasonic agitation (sonication) is very commonly used method for extraction of PM from the filters. Sonication can be performed either by immersing a sonication probe into the sample solvent mixture or placing the sample solvent mixture into a sonication bath. Extraction times are generally between 10 min and 1 hr. The energy of ultrasonic waves causes formation and collapse of tiny cavitation bubbles or cavities in the solution. Inside the collapsing cavities the temperature can reach close to 5000 K and pressure can reach several hundred atmospheres. Such conditions lead to pyrolysis of the molecules present inside the cavitation bubbles (gases dissolved in the liquid and solvent vapours), which results in production of free radicals and new compounds formed by reactions with these free radicals. For example, sonication of water will result in generation of hydroxyl radicals in water, which is the main oxidant in the atmosphere. Therefore, extraction of PM off the filters using sonication technique could result in chemical changes as well as thermal degradation of PM collected onto filters.

In this presentation, a review of sonication technique and its radical-generating capacity will be given, as well as an overview of implications it could have on organic PM. It will also provide recent evidence demonstrating radical generation upon sonication and chemical change of organic PM caused by sonication.

PRELIMINARY STUDY OF CHARACTERIZATION OF WATER-SOLUBLE ORGANIC CARBON IN $PM_{2.5}$ FOR ITS BEHAVIOR IN AMBIENT AIR

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Particulate matter (PM) with an aerodynamic diameter ≤2.5μm ($PM_{2.5}$) was collected from Sept. 2008 to July, 2009 in Shanghai, China. Organic carbon (OC), elemental carbon (EC), water-soluble organic carbon (WSOC) and ionic compositions in $PM_{2.5}$ were measured. The WSOC concentration ranged from 1.11±0.033 to 12.42±0.37μg/m^3 and was the highest in winter and lowest in spring WSOC/OC ratios ranged from 0.21 to 0.85, but the average value approximated to 0.45 and changed less with seasons. Strong correlations of WSOC to TC , OC, EC, OC1, and OC2 were found. The volatile-OC was 36 % of the total OC with no significant seasonal differences. According to comparison with SOC, char-EC/soot-EC and ionic compositions, it was implied that the WSOC at sampling site originated from both primary sources and gas-particle chemical transformation. VOCs control in Shanghai should be considered to reduce ground ozone level as well as to decrease aerosol concentrations simultaneously.

TRAFFIC-RELATED TRACE ELEMENT CONCENTRATIONS IN PM10 AND HORSE CHESTNUT LEAVES

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Urban environment is heavily impacted by airborne particulates originated from fossil fuel combustion, traffic, industry and other anthropogenic activities. Trace elements, attached to PM10, can be toxic and may have dangerousimpacts on human health. The assessment of the trace element content of PM10 gives important information for development of risk assessment strategies. In the past decades, biomonitoring of air quality using plantshas been widely usedto detect and monitor trace and other element atmospheric contamination (Bargagli 1998; Markert, 1993).Previousstudies have shown that horse chestnut leaves could be valuabletools for monitoring trace elementsin the atmosphere (Aničić, 2011; Šućur, 2010; Tomašević, 2011). The objective of this study was to obtain data of the temporal variability of PM10 mass concentrations and traffic-related trace element contentin PM10 and tree leaves samples collected from year 2006 to 2012. It was a transition period when gasoline with lead-alkyl additives was replaced with unleaded kind, with the complete ban of the leaded gasoline in the beginning of 2011.

The PM10 and leaves were sampled from two representative locations from urban area of Belgrade, exposed to high traffic influence, during the multy-year period from year 2006 to 2012. The PM10 measurements were done by using an automatic station for continuous atmospheric particulate monitoring.The concentrations of As, Cd, Ni and Pb were measured from the digested samples by inductively coupled plasma mass spectrometry. The principal component analysis was applied to assess the trace element emission sources.

The decrease of PM10 mass concentrations were observed during the first years of the study, and increased from the year 2009, probably due to some new sources of airborne particulates. Although official ban of leaded gasoline was put into effect at the beginning of 2011, a decreasing tendency of lead concentration in PM10 and in leaf samples was evident even in years before due to increasing number of the new types of vehicles, using the unleaded kind. However, the concentration of Pb after the 7-years period was almost 3 times lower then at the beginning of the study period. The PCA showed that the main source of trace elements in PM10 and leaves was traffic-related emissions.

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DIURNAL VARIATION OF PARTICULATE MATTER AND CARBON DIOXIDE IN OCCUPIED AND UNOCCUPIED SCHOOL ENVIRONMENT

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Air quality is of the great importance for children's health as they are particularly sensitive to the presence of pollutants in ambient air. The main factors that contribute to air quality in school are: outdoor air pollution, the way of interior ventilation, number of children in classrooms and their activities, etc….

The objective of the study was to analyse the indoor air quality in the classrooms with special emphasis on particulate matter (PM) and carbondioxide (CO_2) and their level, diunal variation, and corelation in occupied and unoccupied indoor environment.

The concentrations of PM presented were monitored with the portable direct reading airborne particle monitor OSIRIS. In this study, OSIRIS readings PM_{10} and $PM_{2.5}$ were corrected with calibration factor on the daily bases. Parallel 24h samples were collected with the reference gravimetric samplers, Sven/Leckel LVS3, provided with appropriate sampling heads. CO_2 was measured using the Testo 435 devices (precision of ± 50 ppm, range 0 - 5000 ppm). This study was performed in two naturally ventilated schools located in the same municipality, first in urban area, at residental-industial site, and second in rural area. The distance between the schools was about 15 km. In order to evaluate indoor air quality, set of measurements were conducted indoor and outdoor school environment at four measuring points: indoors, in three classrooms and outdoor, outside the school. The measurements were performed during heating, in winter(W) and non-heating (S), during summer, period.

In the Table bellow there are shown 5 days average concentrations of CO_2, PM_{10} and $PM_{2.5}$ in indoor and outdoor environment in schools in urban and rural area.

ambient	CO_2 (ppm)				PM_{10}/ $PM_{2.5}$ (μg/m^3)			
	urban		rural		urban		rural	
	W	S	W	S	W	S	W	S
indoor	812	767	1305	973	45.32/21.50	43.09/15.76	50.08/27.19	47.55/38.40
outdoor	424	516	524	583	56.62/44.58	16.61/13.55	48.87/34.57	20.62/15.03

The results show that during school day, PM and CO_2 concentration increased from the time when students entered the classroom, and reached its maximum value at the end of the morning shift. Then, during a break between shifts, the concentration of CO_2 decreased, while in some classrooms PM concentration increased. After beginning of afternoon classes in Bor, PM and CO_2 concentration started to rise again. At the end of the school day, the value of the internal PM and CO_2 concentration started to decrease. The results also show that concentration of PM and CO_2 for period when children occupied school were high. The increased PM concentrations during school day and their correlation with high CO_2 concentrations indicate that inadequate ventilation plays a major role in establishing of poor indoor air quality.

The analysis of collected data showed high correlation between the PM respirable fractions and CO_2 concentration. Presented data was sufficient to indicate the need for improving the ventilation and cleaning practice in the selected schools. This study demonstrate a solid basic for implementation of the fresh air supply strategy in naturally ventilated schools and for designingfurther investigations in the aim of ensuring improved indoor air quality.

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FLUCTUATIONS OF THE NUMBER OF ADSORBED MICRO/NANOPARTICLES IN SENSORS FOR MEASUREMENT OF PARTICLE CONCENTRATIONIN LIQUID ENVIRONMENTS

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Detection of micro/nanoparticles in liquid samples is very significant for environmental protection, agriculture, public healthcare and other fields. Different platforms exist for both detection of particles and measurement of their concentration in a solution. The principle of operation of a large group of sensors is based on selective adsorption of target particles (atoms, ions, molecules, microorganisms) on a functionalized sensor surface, occurring in the sensor's reaction chamber and causing a change of some of the measured parameters (mechanical, optical, electrical) [1, 2]. In this paper we examine micro/nanosensors with a flow-through reaction chamber (e.g. plasmonic, FBAR - *thinFilmBulkAcousticwaveResonators*, QCM - *QuartzCrystalMicrobalance*, microcantilever sensors etc. [3]). We also observe the case of reversible adsorption of target particles. The value of the sensor's response is determined by the number of adsorbed particles. Unavoidable fluctuations of the number of adsorbed particles cause fluctuations of the sensor's output signal and thus affect the sensor's ultimate performance (noise, minimal detectable signal). Theoretic modeling and analysis of fluctuations are important for estimation of the sensor's ultimate performance as a function of both the relevant sensor's parameters and the measurement conditions.

In this paper a theoretic model of fluctuations of the number of adsorbed micro/nanoparticles in environmental sensors for particle concentration measurement in liquidsis presented. We derive the analytical expression for the fluctuations spectral density, taking into account transport processes (diffusionandconvection) that move the target particles in the reaction chamber to and from the adsorption sites located on the sensing surface. The approximations used in the model derivation are applicable for transport-reaction regimestypical forthe mentioned types of affinity-based sensors with a flow-through reaction chamber [4-6]. A characteristic of such regimes is the formation of a thin layer depleted of target particles, adjacent to the functionalized sensor's surface.The expression for the fluctuations spectral density, which is of Lorentzian type, yielded expressions for the parameters that determine it completely, i.e. the maximal value of the spectral density (the so-called plateau), and thefrequency at which the spectral density reduces to the value $2^{1/2}$times lower than the plateau (usually called the cut-off frequency). Statistical parameters of the fluctuation process (the mean value and the variance) are also determined.

The presented theory is applied for the analysis of the influence of transport processes on the plateau value of fluctuations spectral density. It can also be used to estimate how significant this influencecan be at different values of transport coefficients,target particles concentrations, and functionalization sites densities, as well as different values of both adsorption and desorption rate constants.Significant differences have been observed in the maximal value of the fluctuations of the number of adsorbed particles at different values of these parameterschosen to correspond to real conditions. The results of the analysis provide the guidelines foroptimization of sensor design and experimental conditions (the flow rate of the liquid sample through the reaction chamber, the surface density of the functionalization sites etc.) in order to decrease the influence of the transport processes, thus decreasing fluctuations and improving the ultimate performance of sensors for particle detection in liquids.

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ASSESSMENT OF PM LEVELS AND INDOOR-OUTDOOR RELATIONSHIPS OF PM_{10} AND $PM_{2.5}$IN THE SELECTED PRIMARY SCHOOL IN NIŠ, SERBIA

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The main aim of this paper is to present the levels of PM_{10} and $PM_{2.5}$ in ambient air and inside the selected primary school in the city of Niš. The city of Nišis the center of Southeastern Region of Serbia and the second biggest city in thecountry. The dominant sources of air pollution were transportation, local heating and industry. The school is located in the city center, on a busy street. Another goal is to determinethe relationship between indoor and outdoor PM levels in the school. Further, we compared PM levels measured by the standard gravimetric method with the PM levels obtained by the automatic monitoring devices. The paper analyzes data collected during the heating season in the time interval from March 20th to April 5th in 2013.

The European reference low volume samplers, Sven/Leckel LVS3, with size-selective inlets for PM_{10} and $PM_{2.5}$ fractions, were used to collect particulate matter in indoor andin ambient air.Also, GRIMM EDM 180 dust monitor, based on the optical light scattering technology is used for simultaneous real time measurement of ambient PM (PM_{10} and $PM_{2.5}$) levels, according to the European Standards EN 12341 (for PM_{10}), and EN 14907 (for $PM_{2.5}$).

Based on data analyses, it is possible to present the following results and conclusions:

- The daily mean PM_{10} and $PM_{2.5}$levels in ambient air during the measurement campaign, were 47.9μg/m^3 and 41.4μg/m^3, respectively. The daily mean PM_{10} and $PM_{2.5}$levelsin the school during the measurement campaign, were 54.6μg/m^3 and 38.5μg/m^3, respectively.
- The daily mean PM_{10}I/O ratio during weekdays was 1.38 (1.25 including weekends). The daily mean $PM_{2.5}$I/O ratio during weekdays was 1.07 (1.00 including weekends).
- The daily mean$PM_{2.5}/PM_{10}$ratio in ambient air was 0.87. The daily mean$PM_{2.5}/PM_{10}$ratio in the school was 0.70. High $PM_{2.5}/PM_{10}$ratio points to considerable influence of pollution sourcesof anthropogenic origin, such as fossil fuels combustion and traffic.
- The exceeding of daily limit value (50 μg/m^3)for PM_{10}in ambient air occurred during 35% of measuring days. The exceeding of daily limit value (25 μg/m^3)for $PM_{2.5}$ in ambient air occurred during 71% of measuring days.
- The exceeding of daily limit value for PM_{10}in the school occurred during 59% of measuring days. The exceeding of daily limit value for $PM_{2.5}$ in the school occurred during 88% of measuring days. The exceeding over daily limits for PM_{10} and $PM_{2.5}$detected indoors were in close connection with PM_{10} ambient levels (r=0.82 between $PM_{10\ INDOOR}$ and $PM_{10\ OUTDOOR}$) as well as with $PM_{2.5}$ ambient levels (r=0.91 between$PM_{2.5\ INDOOR}$ and $PM_{2.5\ OUTDOOR}$) and particle resuspensionduring intense movement and activity of pupils.
- The average ratio between daily mean PM_{10} levels obtained by the automatic monitor and PM_{10} levels obtained by gravimetric method was 0.70 (range from 0.55 to 0.89,r=0.96). The average ratio between daily mean $PM_{2.5}$ levels obtained by the automatic monitor and $PM_{2.5}$ levels obtained by gravimetric method was 0.73 (range from 0.48 to 0.90,r=0.89). The automatic PM monitor underestimated the$PM_{10}$and $PM_{2.5}$ levels by approximately 30% and 27% respectively, relative to the reference LVS3 sampler.

FREQUENCY ANALYSIS OF PM_{10}TIME SERIES AND ASSESSING SOURCE REDUCTION FOR AIR QUALITY COMPLIANCE IN SERBIA

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According to World Health Organization (WHO), ozone,particulate matter (PM), heavy metals and some organic compoundspresent the priority pollutants in the troposphere. Numerous studies have shown that acute and chronic health effects are related to the inhalable PM_{10}(aerodynamic diameter less than 10 μm) exposure in the urban environment. European Union air quality standard (Directive 2008/50/EC) established the PM_{10}annual limit values of 40 μg m^{-3} and daily average concentration of 50 μg m^{-3} not to be exceeded more than 35 days per year.

Despite the implementation of different emission abatement strategies high PM_{10} concentrations are still frequently occured. Weekly cycles of mass concentrations of anthropogenic aerosols have already been observed in many urban regions with significant contribution to particle levels of the primary sources, industry, fossil fuel combustion and traffic. In order to reveal underlying physical processes and the influence of emission sources on time variability of PM_{10} concentrations spectral analysis was used. The periodogram of PM_{10} time series, strength of the signal as a function of frequiences, was calculated using the fast Fourier transform algorithm (FFT). The power spectrum contains a background value determined by "red noise" fit to the spectrum. The power spectrum with a red noise background was used because most of the geophysical time series tend to have larger power at lower frequencies. Since the PM_{10}concentrations are random variables influenced by the emission levels, meteorological conditions and topography it is further important to determine corresponding frequence distribution function. If the PM_{10} distribution function is known the risk of exceeding air quality objective can be assessed and required emission reduction tomeet Air Quality Standard (AQS) could be estimated.

In the present study daily average mass concentrations ofPM_{10}sampled at two urban sitesin Belgrade and Niš during the 2011 were analyzed. Data were obtained from the Air Pollution Measurement Network that operates under the supervision of the Serbian Environmental Protection Agency.

From statistical weekday-weekend variations of PM_{10} concentrations existence of phenomenon known as the "weekend effect" is obtained. The results of FFT analysis revealed the high spectral power peak corresponding to 7 days period for both sites.During the stable weather conditions highPM_{10}concentrations are distinguished, which indicates the existence of local sources. Since the traffic is one of the major anthropogenic emission sources that followed weekly pattern, its contribution to PM_{10} level could be significant. Average annual concentrations of PM_{10} during 2011 were 52 μg m^{-3} in Belgrade and 67 μg m^{-3} in Niš. Both concentrations exceeded prescribed limit values and further emission decrease is required. Different types of probability distributions (lognormal, Weibull, gamma) have been used to fit PM_{10} concentrations for each sampling site. The distributional parameters were estimated by the maximum likelihood method and the goodnes of fit was evaluated using non-parametric Kolmogorov-Smirnov statistical test. Based on the fitted results, lognormal distribution was chosen to fit the PM_{10} data for both sampling sites and required emission reduction in order to meet current AQS was estimated using rollback equation. The results suggested the need of PM_{10} emission reduction of about 61% in Niš and 49% in Belgrade urban area.

INFLUENCE OF PARTICULATE MATTER ON AIR QUALITY IN THE AUTONOMOUS PROVINCE OF VOJVODINA

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Particulate matter and ground-level ozone, according to the EEA report „Air quality in Europe-2012“, represent the most problematic pollutants in terms of harm on human health, envoronment and climate.

With its complex structure and origin, particulate matter represents local, regional and transboundary problem. Tackling particulate matter pollution is the highest priority task aiming at improved air quality across Europe.

In order to improve ambient air quality in AP Vojvodina the automatic air quality monitoring network was established in 2008 (except in Pancevo where the network was established in 2005). According to the legislation, air quality monitoring is provided by the state network (managed by the Serbian Environmental Protection Agency-SEPA) and two local networks (managed by the Provincial Secretariat for Urban Planning, Construction and Environmental Protection-PSUPCEP and the City of Pančevo-Town Municipality, Secretariat for Environmental Protection-CP).

The data gathering and quality control is done according to the Regulationon the conditionsfor monitoring andrequirements of theAir Quality (RS Official Gazette, no.11/2010, 75/2010). Based on the suspended particles PM_{10} and $PM_{2.5}$ fractions data from 8 automatic stations of different type, in AP Vojvodina, in 2009-2012, statistical analysis and air quality assessment were performed according to the air quality legislation. The analysis was done separately for the air quality zone „Vojvodina“ (7 stations: Beočin-Centar (2009); Sombor(2009), Kikinda(2009), Zrenjanin(2009, 2011, 2012), Pančevo-Vojlovica(2009-2012), Pančevo-Vatrogasni dom(2012), Pančevo-Starčevo (2012)) and aglomeration „Novi Sad“ (Novi Sad-Dnevnik (2010-2012)).

Analyzing the four-year results, it was concluded that the suspended particles concentrations are above the daily limit values at all measuring points. The yearly limit values are exceeded at 6 of 8 measuring points. It is concluded that a seasonal trend is corelated with a seasonal patern of particular emision sources. Therefore, in the winter there is a larger part of the smaller particles ($PM_{2.5}$) emited during the combustion processes, whilest in the summer the particles of the biogen origin with larger diameter dominate (PM_{10}).

PRELIMINARY MEASUREMENTS OF PM_{10} IN APARTMENTS IN BOR, SERBIA

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The main aim of this paper is to present a particulate matter(PM_{10})levels in theapartments in the vicinity of the Copper Mining and Smelting Complex Bor, eastern Serbia. The monitoring of sulfur dioxide, total suspended particles (TSP) andtoxic metals content of TSP has been carried out for many years in Municipality Bor within local monitoring network.The Serbian Environmental Protection Agency (SEPA) has been measuringair pollution with automatic monitors in Bor since 2007. Daily average PM_{10} levels measured in Bor, sampling site Town Park, appear to be at thesame level as in the European urbanand industrial sites, or even lower. Accordingto SEPA annual reports for 2010 and 2011 average annualPM_{10} levels measured in Bor were amongthe lowest compared with the PM_{10} levels measuredin Serbian cities. Usual PM_{10}levels in Serbian cities have been much higher in heating period, than in non-heating, At Bor in the time interval (2007-2010) PM_{10}were 10% higher in the cold periodthan in warm period, almost all buildings are connecting to central heating system.

This study was conducted on data collected in four apartments in the time interval 2010-2012. Apartments were selected to be on same direction but at the different distancesfrom the copper smelter. The nearest apartment was about 500 m and the furthest 2.5 km far from the copper smelter. Each apartment wasoccupied with 3-4 non-smoking persons. The 24-hr mean PM_{10}concentrations were monitored by using the standardEuropean gravimetric samplersSven/Leckel LVS3.In each apartmentone sampler was placedin the center of a dinning room, and other sampler at thebalcony outside the apartment. Measurements were made in the heating (October – March) and non-heating season (April - September) in duration of at least 30 days per apartment per season.

In average, indoor PM_{10}levels at all apartments were beyond the daily limit (50 $\mu g/m^3$)in less than 5% of measured days. However, outdoorPM_{10} levels exceeded the daily limit in 22% of measured days. The 24-hr mean PM_{10}indoor-to-outdoor concentration ratios (I/O) were determinedwithin range 0.47 - 0.63 during warm and 0.51 - 0.64 in coldseasons, indicating that there are no significant indoor sources of PM_{10} particles in the apartments.

The PM_{10}I/O relationship was also investigated by the linear regression analysis. Pearson's correlation coefficientsbetween the 24-hr mean PM_{10}I/O concentrations were determinedwithin range from 0.54 to 0.84 during warm and within range 0.61 to 0.73 in coldseason. This confirms that the main source of PM_{10}particles, that is dominant for all the apartments observed, originates from outdoor air.

Further studies in this area should include a greater number of apartments andchemical analysis of collected samples in order to resolve origin of particular pollutants content in particulate matter and its relation with the Copper Mining and Smelting Complex Bor as well as other sources.

ENVIRONMENTAL IMPACT ASSESSMENTOF THENUCLEAR REACTORAT VINCA, BASED ON THEDATAON EMISSIONOF RADIOACTIVITYFROM THE LITERATURE - A MODELING APROACH

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In the paper is presented an assessment of impact on the environment in and around Vinca, of the assumed emissions of radionuclides in the boundary layer of the atmosphere from the ventilation of nuclear reactor in Vinca. This estimation was done taking into account characteristics of the reactor ventilation system, based on the data on emission of radioactivity from the literature, local meteorology of Vinca for the period 2001-2005 and whole 2009 years, terrain topography around nuclear reactor and corresponding dose factors for inventory of radionuclides. In the paper are also presented average annual activity concentration fields in the air and yearly activity due to dry and wet deposition, as well as annual dose received by the hypothetical resident, divided into inhalation dose, dose coming from the radioactive cloud, dry and wet deposition and total annual dose, for the period 2001-2005 and whole 2009 years. Finally total monthly doses have being presented for the same periods.

Radionuclide emissions from artificial sources should not contribute to the limit values of total dose above 1% of the dose received by an individual from natural background radiation (threshold deck 1mSv or 10^{-3}Sv for a year). In this way, the limit values for emissions of radionuclides from the reactor, "RA" was a 10^{-5} Sv or $1e^{-5}$ Sv, the total dose for the individual, to the convention on the recording format of small numbers.

Based on the results of mathematical modeling, then on the parameters of the ventilation outlets of nuclear reactor "RA", assumed emission of radionuclides, soil characteristics, meteorological data collected at automated meteorological station at 40m tall meteorological tower on the representative location at "RA" and the recommended dose factors for the observed radionuclides, only in 2002. and 2005. in two isolated locations, maximum values for the total dose were slightly higher than the limit values amounted to $1.1e^{-5}$ Sv.

On the basis of the described conservative approach and assuming that the range of appropriate meteorological data for the application of described mathematical model, of five consecutive years 2001.-2005. and 2009., enough for this kind of analysis, we can conclude that the nuclear reactor "RA" in the course of it's work from 1959. up in 1984. whatever was unable to influence it's environment above the prescribed limit 10 μSv / year.

TSP LEVELS AND ELEMENTAL CONTENT (Pb, Cd, Ni, As) OF TSP IN URBAN-INDUSTRIAL AREA OF BOR, SERBIA

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Bor is a town located in eastern Serbia, near the border with Bulgaria and Romania. It is an industrial town with intensive urbanization, developed infrastructure and copper smelter facilities less then 1 km far from the nearest residential areas. A century of copper mining and metallurgy in Bor Municipality have a large influence on the degradation of the environment, both in urban as well as in rural areas. Pyrometallurgical processing of copper concentrate in Bor causes emissions of sulfur dioxide and particulate matter emitted from diffuse and point sources: (1) Diffuse (surface) sources including the largest open pits (active and inactive) and municipal solid waste landfill (dump), (2) Point sources of metallurgical complex (especially within the copper smelter plant).

Thus, air pollution in the Bor Municipality is strongly related to the Copper Mining and Smelting Complex Bor operation. Air pollutants with levels that are often above the air quality limits are sulfur dioxide and toxic elements in suspended particulate matter (arsenic, cadmium, lead).

Air quality control in Bor Municipality is done through local and national monitoring networks: (1) Two monitoring sites for sulfur dioxide and soot, and four monitoring sites for Total Suspended Particles – TSP, in a local monitoring network operated at municipal level, (2) Three automatic stations as part of national network of automatic monitoring stations, operated by Serbian Environmental Protection Agency – SEPA.

This paper compares TSP levels and elemental content (Pb, As, Cd and Ni) in TSP during 2012 with levels of pollutants in the period 2006 -2011 at 4 locations in Bor urban area: Jugopetrol, Town Park, Technical Faculty and Mining and Metallurgy Institute (MMI) monitoring sites. The samples were collected with Sven/Leckel LVS3 sampler equipped with KAR8 filter changer successively for one week per month at each location. Chemical analyses were performed by AAS (Pb, Cd, As) and ICP-AES (Ni).Mining and smelting processes contribute somewhat to levels of Cd and Ni, and strongly to As and Pb levels in particulate matter. During 2012, similar to the 2006-2011 period, the average levels of TSP were above the annual limit (70 $\mu g/m^3$) at 3 locations (Jugopetrol,Technical Faculty and MMI). At all sites, Ni levels were under the detection limit (< 0.001 mg/l). However, average annual levels of Cd in 2012 at all monitoring sites (2 – 8 ng/m^3) were similar as in the time period 2006– 2011 (3 – 8 ng/m^3).

Theaverage annual levels of Pb in 2012 at all measuring sites (0.2 – 0.7 $\mu g/m^3$) were at least two times higher than in the time period 2006 – 2011 (0.06 – 0.2 $\mu g/m^3$). The average annual levels of As in 2012 at three monitoring locations (Town Park, Jugopetrol and Technical Faculty) were at least four times higher than in the time period 2006 – 2011 (19.5 – 22.5ng/m^3). In 2012, the average levels of As detected at Jugopetrol and Town Park were about 125ng/m^3 and at Technical Faculty 92.3ng/m^3. The average annual level of As at MMI (45.2ng/m^3) was two times higher than in 2006 – 2011 (22.5ng/m^3). Spatial variability of pollutants is mainly due to the position of the monitoring sites relative to the Copper Mining and Smelting Complex Bor, meteo conditions (wind speed and direction, atmospheric pressure, humidity and temperature). Temporal variability and occasionally higher levels of Pb and As, is due to copper smelter operation mode, type of ore and production intensity. According to the presented data,air quality in Borwas very poor during 2012, regarding levels of As in TSP. This situation warrants the need for serious steps to be taken to improve air quality, such as finalization of a new copper smelter and sulfur acid factory.

THE INFLUENCE OF AIR MASS ORIGIN AND POTENTIAL SOURCE CONTRIBUTIONS ON PM_{10} IN BELGRADE

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Atmospheric particles are some of the key components of the atmosphere, playing an important role in the energy balance of the Earth's surface, visibility, climate, human health and environment as a whole. Determination of quantitative relationship between ambient air quality and pollutant sources is one of the most significant tasks in air pollution management. Various mathematical models have been developed for atmospheric pollutant sources identification, estimation of their source contributions and identification of potential source regions. Several studies have been undertaken to quantify source contributions to PM_{10} in Belgrade by applying source apportionment techniques. The long-range transport of particulate matter, which adds to local emissions, may be an obstacle to reach air quality objectives set by public authorities. Thus, it is important to assess contribution of external sources to obtained PM_{10} concentrations.

To estimate the likely source locations for regional transported aerosols,Potential Source Contribution Function (PSCF) and Concentration Weighted Trajectory (CWT) models were applied on daily PM_{10}(particulate matter with aerodynamic diameter less than 10 μm) mass concentrationsobtained from the automatic monitoring station of the Public Health Institute of Belgrade during 2012. Air masses back trajectories were computed by the HYSPLIT (HYbrid Single Particle Lagrangian Integrated Trajectory) model through interactive READY system. Daily 72-h back trajectories, started from Belgrade (44°49' N, 20°28' E) at 12:00 and 00:00 UTC each day, were evaluated for three different heights above the starting point at ground level (500 m, 1000 m, and 1500 m). In addition, a study of airflow characteristics was performed using Trajectory Cluster (TCA) and Trajectory Sector Analysis (TSA) to reveal the major pathways of air masses.

The Results of PSCF and CWT analyses show that the main sources of PM_{10} are located in neighboring countries, as well as in Central Europe. Seasonal variations of source contributions were investigated indicating significant differences.

Trajectory clustering generated six clusters including two long-distance, from northwest and north directions, as well as four short-distance clusters. The highest frequencies of arriving air masses are associated with southwest (23%) and northwest (23%) directions, while the lowest are related to northeast (7%) direction. The results suggest that highest PM_{10} concentrations were related to two short-distance clusters - the northeast (mean values 52.23 μg m^{-3}) and south (45.37 μg m^{-3}). Since the trajectories coming from the southeast were associated with relatively low concentrations, TSA was used for determination of “local background”. In addition, the contribution of long-range transport of PM_{10} to the observed mass concentrations level in Belgrade was estimated.

RESPIRATORY AND INFLAMMATORY RESPONSES IN LOW AND HIGH LEVELS OF TRAFFIC-RELATED AIR POLLUTION WITH AND WITHOUT PHYSICAL ACTIVITY

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Short term exposure to traffic related air pollution has been associated with adverse respiratory outcomes. Moderate physical activity in polluted air may increase pollutant uptake and increase health effects.

The objective was to assess respiratory and systemic subclinical responses in a healthy population in Barcelona following short term exposure to traffic related air pollution with and without moderate physical activity.

Well controlled crossover study design comparing lung function, airway inflammation [Fraction of exhaled Nitric Oxide (FeNO)], and systemic inflammation markers in blood at baseline and up to 6 hours after exposure to traffic related air pollution, with or without physical activity. Healthy non-smoking subjects were exposed for 2 hours to contrasting pollution levels while either cycling or resting (n=28). Each volunteer participated in all four conditions (high vs. low exposure; moderate physical activity vs. resting). On-site exposure monitoring included particulate matters (UFP, PM10, PM2.5), nitrogen oxides (NOx), and elemental carbon (EC). Data were analyzed using mixed effect models for repeated measures.

Physical Activity, but not air pollution, increased statistically significantly FEV1, (Coef. 0.034, $p<0.001$), FeNO (Coef. 0.880, $p=0.047$), neutrophil counts (Coef. 18.66%, $p<0.001$), and serum interleukin-6 (Coef. 52.67%, $p=0.034$) levels. Physical activity (Coef.9.699, $p<0.001$) and PM10 and PM2.5 exposure statistically significantly increased leukocytes counts. High vs low air pollution exposure and Interquartile increases in UFP (Coef.-0.004, $p=0.001$), EC (Coef.-0.004, $p=0.003$), NOx (Coef.-0.004, $p=0.002$), PM2.5 (Coef.-0.005, $p=0.001$), and PM10 (Coef. -0.003, $p=0.002$) decreased significantly the ratio FEV1/FVC. There was no interaction between air pollution and physical activity for any of the outcomes of interest.

This study suggests that generally short term physical activity, but not short term air pollution, is an important predictor in acute systemic and local (or local) inflammation and assessed respiratory markers except for the ratio of FEV1/FVC for which air pollution showed small effects .

EFFECTS OFOUTDOOR AIR POLLUTION ON RESPIRATORY HEALTH OF SCHOOL AGE CHILDREN IN NIŠ, SERBIA

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Numerous studies have reported associations between airborne particles and a range of respiratory outcomes from symptoms to mortality(1). Children living in the urbanareas are particularly vulnerable. Studies of the impact of long-term exposure to outdoor air pollution on the prevalence of respiratory symptoms and lung function in children have yielded mixed results, partly related to differences in study design, exposure assessment, confounder selection and data analysis(2). The aim of the present study was to investigate effects of outdoor air pollution exposure on respiratory symptoms and illnesses among schoolchildren in in Niš, Serbia exposure. The effects of air pollutants (PM, SO2, NO2) were assessed in 354 primary school children (49.15 % males), aged 11-14. Exposed group of children (n=215) were attending the school located in a city area of Niš (Serbia). with a high level of air pollution, while the children (n=139), in the comparison group, designed as non-exposed group, were attending the school in the area of Niš with a lower level of air pollution. We used the questionnaire of the American Thoracic Society's Division of Lung Diseases (ATS-DLD-78-C), filled by their parents in personal interviews. Data about the prevalence of respiratory symptoms (cough, phlegm, blocked-runny nose, wheezing and dyspnea) in the last 12-month period of life and lifetime prevalence of respiratory illnesses (asthma, pneumonia and bronchitis) were obtained. In order to limit exposure misclassification, the analysis were restricted to children who were at the same adress from birth. According to the official data (3), the 10-year average concentrations of outdoor air pollutants monitored according to the Official Register Republic of Serbia 54/92(4) at the relevant background monitory stations were statistically higher near school of exposed children. A statistical package SPSS 10.0 was used for data analysis.

We found the significantly association between outdoor air pollution exposure and increased prevalence of upper respiratory symptoms and bronchitis and asthma. in the sample of examined children. In exposed children, the prevalence of asthma increased significantly [odds ratios (95% confidence interval) -1.38 (1.21–1.93), respectively]. Also, the difference of bronchitis prevalence were statistically significant among different group of children ($\chi 2$ = 4,084 >$\chi 2$= 3,841,p < 0,05).The prevalence of upper respiratory symptoms were statistically higher (p < 0,01) among exposed children (46.1%). These findings suggest that outdoor air pollution could have negative effects on respiratory health in children.It is necessary to inform parents of the risks of environmental outdoor air pollution exposure during childhood.

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EFFECTS OF ASRSENIC ON PHOSPHORUS CONTENT IN DIFFERENT ORGANSAND CHLOROPHYLL FLUORESCENCE IN PRIMARY LEAVES OF SOYBEAN

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Pollution of the soil and atmosphere by arsenic (As) is conditioned by the industry development. Copper smelters and thermal plants are great pollutants of the atmosphere. According to Smirnov and Muravin (1977) natural As content in the soil is 5 mg(As) kg^{-1}(soil). As, an analogue to phosphorus, is absorbed from the soil by P transporters. As inhibits P uptake in barley (Asher and Reay 1979) and *Arabidopsis* (Dunlop *et al*. 1997). In many of plant species, arsenates and arsenites have an affinity for thiols, such as glutathione. Furthermore, phytochelatins are formed as a response to As (Schmöger *et al*. 2000). Hartley-Whitaker *et al*. (2000a, 2000b) confirmed that As-tolerant *Holcus lanatus* L. had higher phytochelatins concentrations than As-intolerant species. Hence, similar to heavy metals, As also mobilises the socalled nonenzymic antioxidants, such as glutathione, ascorbates, and phytochelatins. In a trying to find which plant species was suitable for environmental remediation we investigated the effect of different (32-96 μM of As) arsenic concentration on the phosphorus content and Chl fluorescence in soybean (*Glycine max.* Merr.; cv. ZP015) plants. After the 5-d germination in the dark, plants of soybean were transferred into pots with the the Reid-York nutrient medium (pH 7.0). Plants were grown in growth chambers at a 12-h photoperiod, irradiance of 300 μmol m^{-2} s^{-1} and day/night temperature of 24/20 °C during ten days. Plants grown on the complete medium were the control ones. The P content in the other three variants was half or double of that in the control (0.05 and 0.1 M KH_2PO_4) or zero (without phosphorus). Plants grown with and without P were exposed to 2.4, 4.8, 6.0, and 7.2 g (As) m^{-3} (32, 64, 80 and 96 μM of As) of Na_2HAsO_4 for another 5 days. Roots, stems, cotyledons, and leaves was finally dried to the constant mass and homogenised by grinding. The P amount was determined by the official method of A.O.A.C. (Horwitz 1960). Chl fluorescence of soybean primary leaves was measured by the *PAM 101/103* fluorimeter (*Walz*, Effeltrich, Germany). Parameters of Chl fluorescence were defined after Maxwell and Johnson (2000). The analysis of variance (*ANOVA*) for all variables was carried out by the *MStat* programme. The increased concentration of As led to the decrease in P content in a plant organs. Higher molar P/As ratios reduced As toxicity in all plant organs of soybean. The P content in leaves and cotyledons of P-deficient soybean plants significantly decreased in the presence of As, indicating the P stored in these organs was used for building plant biomass. A statistically highly significant P decrease in the presence of As in plants with 0.05, 0.1 and 0.2 M KH_2PO_4 in the nutrient solution in relation to P-deficient plants pointed out that the As uptake was similar to the P uptake. Since As in higher concentrations in the nutrient solution significantly reduced the P accumulation in root, leaf and stem, in certain cases even below 0.3 %, it can be spoken about the deficiency of the phosphorus.Parameters of Chl fluorescence of soybean leaves in the presence of these As concentrations did not show significant changes. Changes of maximum quantum yield of photosystem 2 (Φ PS_2) and photochemical quenching of fluorescence (qP) under the highest As concentrations point out to the changes of the redox state of the plastoquinone pool. Non-photochemical quenching (NPQ) of fluorescence (related to photoprotective processes in antennae of chloroplast thylakoids) was not significantly modified by As application. Abadia *et al*. (1987) found out that a low phosphorus content in the leaf had only small effects on the content of pigment-protein complexes of the thylakoids and electron transport in the light reactions of photosynthesis, while Rao and Terry (1989) detected that the P deficiency in soybean reduced the photosynthetic assimilation of CO_2. We assume that certain concentrations of As caused P-deficiency without visible affecting the photochemical reactions in soybean leaves during the trial. This is in accordance with the conclusions of Abadia *et al*. (1987) about a weak influence of low leaf P content on light reactions of photosynthesis. Our opinion is that the observedphenomenon indicates an early phase of As-induced P-deficiency in soybean.

MICROBIOLOGICAL CONTAMINATION IN INDOOR AIR

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Indoor air pollution is present in virtually each and every indoor space, and the exposure is particularly significant in vulnerable populations such as children, pregnant women, elderly, ill and disabled, considering the amount of time spent indoors. There is wide range of biological contaminants in indoor air, such as house dust mites, fungi, bacteria, protozoa, and viruses. These microorganisms produce allergens, toxins, and other volatile organic chemical compounds which may affect human health. Common prerequisite condition for their growth, development, and multiplication is dampness.Considering the variety of microbes, possible synergistic effects, the characteristics of endangered population, as well as problems in detecting techniques, further investigations are needed.

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APPROACHES TO CARCINOGENIC RISK ASSESSMENT FOR PAHS

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PAHs are a large group of organic compounds with two or more fused aromatic rings made up of carbon and hydrogen atoms. PAHs do not occur in the environment as isolated entities, but primarily occur in complex mixtures generated from the incomplete combustion of organic materials such as the processing of coal, crude oil, combustion of natural gas, refuse, vehicle emissions, heating, cooking and tobacco smoking, as well as natural processes including carbonisation. Low-molecular-weight PAHs (two and three rings) were mainly distributed in the vapor phase in the atmosphere, while multi-ringed PAHs were usually present as particles. There is substantial body of evidence that some PAHs (and complex mixtures of PAHs) are tumorigenic and genotoxic in animal bioassays and genotoxicity tests.

Human data on PAHs carcinogenicity are based on exposure to mixtures like tobacco smoke, emissions from roofing tar pots or coke ovens. If risk assessment for PAHs treats a mixture as a single entity (especially in epidemiological studies), results are based on actual mixture effects. But, if composition of mixture varies (because of differences in source types or weather and other conditions), toxicity data from one mixture may not adequately represent others. However, the main problem that complicate the carcinogenic risk assessment of the complex mixtures of PAHs to which human exposure occurs is lack of knowledge to what extent the PAH fraction, as opposed to other chemicals and particulate matter, contributed to carcinogenicity.Component-based approaches involving dose addition are possible in case of PAHs, if we assume that all PAHs in the mixture act in a toxicologically similar manner. It has to be clear dose-response effect for every component which should be compared to the index chemical. The other assumption is that interactions among PAH mixture components do not occur at low levels of exposure typically encountered in the environment.

In 1993, EPA published the Provisional Guidance for Quantitative Risk Assessmentof PAHs.It recommended estimated orders of potential potency (termed EOPP) for individual PAHs that could be used in a component-based approach and 7 most common PAHs were categorized as Group B2 (probable human carcinogens). For the index chemical is chosen benzo[a]pyrene, one of the most carcinogenic PAHs, because there are robust cancer dose-response data on chronic exposures available for that substance and large database of studies in which the potency of benzo[a]pyrene is compared with the potency of other PAHs. The list of PAHs with estimated equivalency factors (named toxicity equivalency factors – TEFs, or potency equivalency factors – PEFs, or relative potency factors-RPFs), compiled from studies measuring carcinogenic potency and surrogate biomarkers, was extended by many authors over the last two decades. However, IRIS EPA in 2010 recommended RPF approach for limited number of PAHs based on either their experimentally observed RPFs and changed some previously estimated factors to higher or lower values.

Recommendations by EPA are based on widely accepted animal studies and genotoxicity tests. However, for the improvement of cancer risk assessment, TEFs for a large number of PAHs should be derived and new methods may be applied. It may include genotoxic effect measured in vitro and analyzed with mathematical models, or predictions based on molecular structure -activity relationships in the absence of detailed laboratory toxicity and long-term studies in rodents.

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THE BENZO(A)PYRENE-EQUIVALENT TOXICITY OF PARTICLES ASSOCIATED POLYCYCLIC AROMATIC HYDROCARBONS IN THE AIR OF BELGRADE METROPOLITEN

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Many organic chemicals including particle-bound polycyclic aromatic hydrocarbon (PB-PAHs) may cause wide range of adverse health effects including inflammatory responses. PAHs with 2–3 aromatic rings exist dominantly in the gaseous phase, while compounds with 4 or more aromatic rings, that are more toxic, are mostly associated with PM fractions. Studies performed all over the world demonstrated that major source of PAHs in urban areas were emission from vehicle, while in industrial area from combustion processes. Residential heating and biomass burning may contribute significantly to level of PAHs.

The aim of this study was to compare the benzo(a)pyrene-equivalent(BaPE) toxicity of particles associated with polycyclic aromatic hydrocarbonsusing Toxicity Equivalence Factor (TEF) of 16 priority PAHs (prPAHs) collected at 3 different locations with at least two of next characteristics of sites: strong city center, frequent traffic, rural area, suburban area, strong industrial surrounding of combustion processes from thermal power plant, mining facilities and ash and coal landfills.

The study was conducted at three sampling sites over Belgrade Metropolitan that belong to local automatic station monitoring network: ***urban-traffic***in the city center, one of the most frequent traffic at round intersection that is branches into eight streets ; ***suburban-industrial***far from Belgrade inner zone, but with proximity and influence of coal mine facilities and coal-fired thermal power plant "Kolubara A"and other facilities of the Kolubara mining-industrial complex; ***rural-industrial***far from Belgrade inner zone, village in vicinity of coal-fired thermal power plants "TENT A", "TENT B" and other facilities such ash and coal landfills. 24h PAHs were collected and analyzed in PM_{10} aerosol fraction during 2010 and 2011, 8 samples per month at each sites using: EU reference sampler, quartz filters and Agilent GC/MS (6890N GC with 5973N MSD).

During measuring period, prPAHs identified as BaPE so far exceeded 1 ng/m3 but vary for one-order-to-magnitude between heating and non-heating session. During non-heating period atfrequent traffic at round intersection inthe city centre BaPE was less that 1 ng/m3. In the same period, at locations in vicinity of thermal-power plans at site located in rural areaBaPe was also below limit values, while at the site in suburban location the average value of BaPe was 1.6 ng/m^3. At the same site, the highest BaPEof 12.4 ng/m during heating session was identified . At the other two locations, during the heating period, BaPE was6.1 at rural-industrial and 6.8at urban-traffic site**.**

This study confirmed that PB-PAHs in particulate matter were under strong seasonal influence, average 24h PB-PAHs as well as BaPE were between half and one order-to-magnitude much higher during heating period than in non-heating period. BaPE toxicity was similar in city center at traffic site and in rural area in vicinity coal-fired thermal power plants "TENT A" and "TENT B". BaPE was significantly higher at suburban site under influence of coal-fired thermal power plant "Kolubara A" and other facilities of Kolubara mining-industrial complex.

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IN VITRO CO-CULTURE MODELS FOR THE STUDY OF PM BIOLOGICAL EFFECTS

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The evaluation of ambient particles (PM) effect on human health is still of primary interest, consequently there is a needof improved models to study theiraction mechanisms.The alveolar epithelium is the area of inhaled material impactand the integrity of the air-blood barrier (ABB), constituted of the epithelium and the underlying endothelial cells, prevents the entrance of particlesinto theblood circulation. Thus ABB integrity is pivotal to maintain lung functions even particles, interacting with the barrier epithelium, may promote an inflammatory statusand a signal transduction tothe underlying endothelial cells. Moreover they might be internalised and translocated to the circulation, inducinglocal and systemic adverse effects.

We have previously demonstrated that Milan summer PM10 induced a release of pro-inflammatory interleukins in A549 cells [1]. To have a further evidence of such effect, more complex models of cultured cells have been set up. A co-culture system, simulating the interaction between alveolar epithelial cells and monocytes/macrophages in the alveoli, has been prepared seeding alveolar epithelial cells (A549) on the bottom of a well, and monocytes (THP-1) floating above them. This model was more suitable to analyse Milan summer PM10 in comparison to the mono-cultures of the same cell lines, as demonstrated by the release of higher levels of pro-inflammatory interleukins.

Moreover an ABB model has been prepared with alveolar epithelial cells(NCI-H441) and endothelial cells (HPMECST1.6R) cultured on the opposite sites of a transwell filter insert. NCI-H441 were cultured on the upper side and HPMECST1.6Rplaced on the lower surface of the insert [2]. This ABB model was characterized for its integrity through fluorescence microscopy and TEM analyses. Tight junctions formation among NCI-H441 cells and transepithelial resistance (TEER), measured after 11–13 days of culture, were evaluated to assess ABB functionality. Subsequently the apical compartmentwas exposed to Milan summer PM10 (10μg/cm^2) and then TEER was measured and therelease of pro-inflammatory mediators evaluated at both sides of the insert. TEER resulted to be unmodified, demonstrating that the dose used was not cytotoxic. In the mean time there was a significant increase of IL-1β in the basolateral compartment, confirminga biochemicalcrosstalk between the two sides of the insert andsupporting the efficiency of ourABB model; the apical compartment did not release IL-1β.

In conclusion,our data demonstrate that the cell lines used are ableto cross communicate influencing the response to a particular stimulus. The modelshere presented are suitablesystemsfor the study of toxicological events at the alveolarlevel, and are able to furnish more information on PM mechanisms.

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ASSOCIATION BETWEEN FINE PARTICULATE MATTER AND EXACERBATIONS OF ADULT ASTHMA AND COPD IN PATIENTS LIVING IN SMEDEREVO, SERBIA

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Smederevo is one of the most polluted towns in Serbia because of steel factory functioning in this town, majority of individual households with fossil fuel or coal combusting heating system and traffic pollution by aged vehicles. High levels of PM_{10} and $PM_{2.5}$ have been measured there over the past six years.

The aim of this study was to investigate whether average monthly levels of airpollutants, as well as the number of days per month with high levels of PM_{10} and $PM_{2.5}$ were associated withincreased number of exacerbation episodes among adult COPD and asthma patients.

This study was conducted in secondary care general hospital in Smederevo covering proximately 81 000 inhabitants who live in area of 7 km around automatic station for air quality monitoring from which the verified data were collected for year 2011. (Grimm analyzer for particulate matter, on2 m height). Study population consisted of 1580 adult patients registered and followed up for asthma and/or COPD. Data were obtained from the medical records. There were 570 moderate and severe exacerbations of COPD and asthma during 2011 which required additional therapy or hospital admittance and we investigated correlation between number of these exacerbations per month and average monthly levels of air pollutants, or number of days per month with excess of air pollutants level. Correlation between air pollution and number of exacerbations was tested in subgroups of patients classified by diagnosis, gender, smoking status and body-mass index status. Statistical methods included parametric and non-parametric Pearson's bivariate correlation tests in program SPSS.

It is shown that number of days with high levels of $PM_{2.5}$ per month was statistically significantly associated with number of both, moderate and severe exacerbation episodes among asthma and COPD female patients as well as among only asthma female patients. Further analysis has shown that there was statistically significant association between $PM_{2.5}$ and number of exacerbations in next subgroups with moderate asthmatic exacerbations: all nonsmokers, no smoking obese patients, all females, obese females, and no smoking females.

The significant association between number of days with excess of PM_{10} limit level per month and number of moderate exacerbation episodes patient of asthma is shown only in subgroup consisted of obese, nonsmoking patients.

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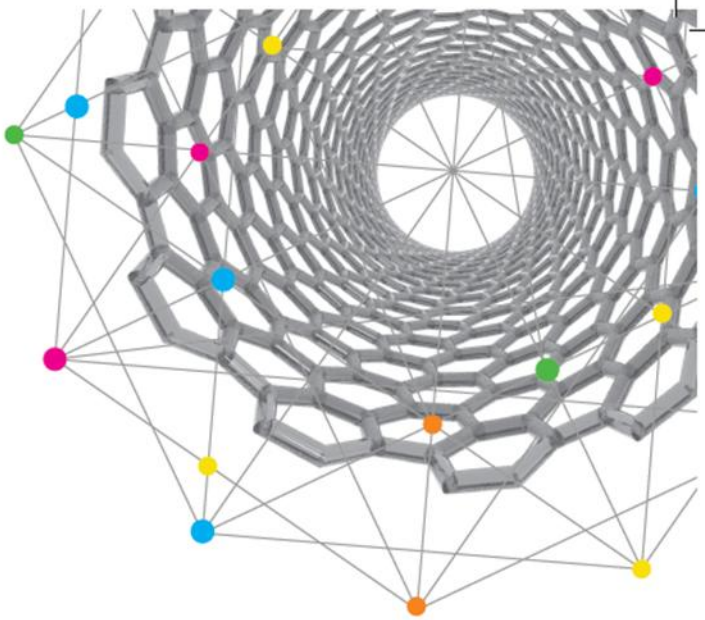

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