WeBIOPATR2011

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

ABSTRACTS OF KEYNOTE INVITED LECTURES AND CONTRIBUTED PAPERS

Editors
Alena Bartonova and Milena Jovašević-Stojanović

Public Health Institute of Belgrade

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CONFERENCE TOPICS

ATMOSPHERIC PARTICULATE MATTER - PHYSICAL AND CHEMICAL PROPERTIES

- *sources and formation of particulate matter*
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- *abatement strategies*

SPECIAL SESSION – GRADUATE STUDENTS

For PhD and MSc students to discuss their work related to particulate matter

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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, has attracted 35 contributions, and received also media attention (newspaper article and TV coverage on national TV). It was noted, that in addition to providing information about latest research in Serbia and internationally, the workshop has contributed to the 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 with the same name 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. In addition to presenting the project results, 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 at http://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 Issue 3 (2010)

The 3rd event, the International WeBIOPATR Workshop and Conference, Particulate Matter Research and Management – WeBIOPATR2011, has attracted a wider international audience, and contains also own student workshop. For this reason, we call this event "Workshop and Conference". This book contains abstracts of all presentations. 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, 25 oral presentations, 7 poster presentations and 2 ongoing theses (1 MSc and 1PhD) 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.

Milena Jovašević-Stojanović and Alena Bartoňová

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INVITED KEYNOTE LECTURES

AIR QUALITY MANAGEMENT PLANNING (AQMP)

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The main purpose of the AQMP development process is to establish an effective and sound basis for planning and management of air quality in the selected geographic area. This type of planning will ensure that significant sources of emissions are identified and controlled in a most cost-effective manner. It is important that best tools and practices in air quality management are used in order to assure the most adequate solutions. The ultimate goal is to assure that health effects and impact on building materials and the environment will be avoided in the future.

The development of the AQMP will take into account:

- Air Quality Management System (AQMS) requirements
- Operational and functional structure requirements
- Source identification through emission inventories
- Alternative measures to achieve source emission reduction
- Mechanisms for facilitating appropriate governance, including interdepartmental cooperation, in order to assure that actions are being taken
- Institutional building and training requirements.

Important elements of the AQMP are the identification of sources and development of a complete emission inventory, the development and operations of an air quality monitoring programme and the development and application of dispersion models.

Major tasks in this work are to collect the necessary input data. The programme starts with preliminary assessments based on available data and the identification of zones into which the country will be divided. We assume that the setting of standards and regulations is already available.

This presentation will guide you through the different parts of the air quality management and planning procedures. In most large cities in the world, particulate matter is often the main problem, and as a pollutant with multiple sources (including atmospheric processes) represents a main challenge in the AQMP process.

THE EU REGULATORY FRAMEWORK FOR AIR QUALITY MANAGEMENT AND EMERGING CHALLENGES FOR PARTICLE POLLUTION CONTROL, ESPECIALLY IN THE BALKAN COUNTRIES

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Following the so-called "Air Quality Framework Directive" of 1996, the European legislator has adopted an overhauled legislative framework on air quality management, which requires the competent authorities in the EU Member States to develop emission control strategies with the aim of meeting the new air quality standards set out for different pollutants in a series of subsequent daughter Directives. The first one, adopted in 1999, defined for the first time a European standard for fine particulate matter (PM_{10}), which had to be met everywhere by 2005. After that year, the PM_{10} 24h limit value was still exceeded at more than 50% of the monitoring stations operated at urban traffic sites in the whole EU, even though many local air quality plans with control measures were drawn up in urban agglomerations. Since then the air quality Directives were revised as part of the "Clean Air for Europe" thematic strategy and most of the source-related EU regulations were tightened in order to reflect the progress in available emission control technology.

While confirming the PM_{10} limit values, additional standards for $PM_{2.5}$ were adopted. Contrary to the health relevance of the fine particle fraction, those standards lag behind the ambition level of the PM_{10} limit values, which remain still exceeded in many urban areas in Europe.

After a short insight in the EU framework on air pollution control, this paper highlights the potential reasons for the widespread non-compliance with the PM_{10} standards. Based on examples for studies on source apportionment, dispersion modelling, scenario calculations and the impact assessment of measures in Germany and other EU countries, it illustrates the reduction potential through local strategies in comparison to the barely needed scope of EU wide concerted action to bring down the large scale background levels of particulate matter.

Finally, the difficulties urban air quality management is still facing in the EU will be projected on the situation in the Balkan countries, which might even be more challenging, but where the scope for action is still larger.

PARTICULATE MATTER IN INTEGRATED ASSESSMENT: TWO EXAMPLES

(1) A. Bartonova and the (2) HEIMTSA and (3) HENVINET teams
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Particulate matter receives attention from the scientific and the regulatory community as well as from the public, as air concentrations continue to pose health hazard. Integrated assessment (IA) and Integrated assessment modelling (IAM) have contributed to development of policies and to implementation of abatement measures. In this paper, we will describe an example of IA framework helpful for visualisation of the model complexity, and an example of IAM, enhanced by subpopulation-level exposure modeling, and considering multi-sector policies. These examples were developed in the HENVINET and HEIMTSA projects.

In Europe, regional concentrations of particulate matter and associated health effects have been modelled for many years. Yet, the health effects are still by no means easy to assess. The complex nature of the atmospheric particulate matter, and of the link between environmental concentration and health, are two of the reasons.

In HENVINET, we asked "Do we know enough to evaluate what will be the effects of climate change for patients with respiratory disease?". We considered different exposures that will change with climate: extreme heat; extreme cold; dampness; $PM_{2.5}$; ozone, dust mites, molds and spores, and allergenic pollens. We have visualised the knowledge elements involved in the assessment, and carried out a survey among 14 leading experts on respiratory diseases and climate change. The experts expressed a particularly low level of confidence regarding prediction of impacts of changes in exposure to dampness, ground level ozone and $PM_{2.5}$.

HEIMTSA has reviewed the current approach to integrated monitoring for air pollution, and suggested several enhancements. We have shown how different behaviour of population subgroups can affect their exposures, and thus risk of disease, and how such knowledge can be utilized in the assessment on European level. Time-use data from European level surveys were used to determine sub-group adjustments of the ambient concentrations to better represent exposure, and to allow evaluating abatement measures with more regard to different susceptibilities in the different groups.

IAM is often used for identification of best packages of sectoral policies and measures to reduce pollution. These policies and measures are commonly to be implemented sectorally (e.g., traffic measures), disregarding other economic sectors. A multi-sector assessment of climate related policies was made, showing the resulting changes in health effect. Of the groups of stressors considered, particulate matter was the most important constituent for total improvement of health impact, when considering standard scenarios for 2020, 2030 an 2040.

These examples illustrate some of the issues to be solved in IAM. They demonstrate one possible type of IA framework that allows to predict the effects of particulate matter in relation to different possible future developments, striving to identify and take into account factors that have decisive effect on the result. Often, extensive modeling systems are necessary for such assessments, as well as locally specific knowledge and information, but the conceptualization allows the stakeholders and investigators to communicate and to provide answers with relevance to all: the managers, the politicians, the scientists and the public.

HEALTH EFFECTS OF LONG-TERM EXPOSURE TO AIR POLLUTION: AN OVERVIEW

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Background: Health effects of air pollution are usually divided in acute and chronic, reflecting the dura-tion of exposure. Short exposures to elevated levels of air pollution over several hours or days can trigger headaches, wheeze, cough, eye irritation, and other mild health outcomes as well as exacerbate respiratory and cardiovascular disease leading to hospitalizations (Dominici et al. 2006) and death (Brook et al. 2010). Short-term exposures to air pollution have been shown to represent one of the most important triggers of myocardial infarction (Nawrot et al. 2011), but do not prove causal relationship between air pollution and disease, since they often lead to harmful effects in people that are already frail, such as elderly or people with pre-existing underlying chronic disease (angina pectoris, asthma, etc.). Studies of chronic, long-varying exposures to air pollution over many years or decades have together with results of controlled animal and human experiments, provided important data on causality between air pollution and health, for respiratory and cardiovascular disease morbidity and mortality, a lung cancer. More recently, new outcomes have been linked to air pollution, such as pneumonia, diabetes and certain types of cancer, (breast, cervical, brain, gastro-intestinal, leukaemia), but limited and conflicting data on these outcomes warrant more research. Studies of short-term exposures often utilize available administrative data from health registers (cause of death, hospitalizations) and centrally monitored air pollution data, and provide estimates on a population level (city or country). Studies of effects of long-term exposures are considerably more costly and rare as they require survey or cohort data on cross-sectional or ideally prospective assessment of disease, with individually assigned air pollution levels from modelling systems (land use or dispersion).

Methods: This talk aims to provide a short overview of the latest and most important literature based on epidemiological studies of effects of long-term exposure to air pollution and health, for following chronic diseases: chronic obstructive respiratory disease (COPD), asthma, lung cancer, pneumonia, stroke, ischemic heart disease, diabetes, overall and cause-specific mortality, breast cancer, and brain cancer.

Results: Large number of studies provided convincing evidence for adverse effects of exposure to particulate matter and gasses in urban air, and served as basis for current USA and EU Air Quality Standards and limit values. Still, new knowledge is emerging, expanding our understanding of vast effects on human health of this ubiquitous exposure affecting millions of people in urban setting.

Relevance: The burden of major and chronic and certain acute (pneumonia) diseases is projected to escalate with enhanced longevity and growing ageing population. Establishing new and better understanding of known risk factors that are modifiable and applicable in preventive efforts has thus the highest priority. Better understanding and quantification of the multiple health effects of exposure to air pollution, may be used to plan control strategies and mitigate the chronic disease burden, as well as to aid doctors to better manage chronic disease patients.

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GENE AND ENVIRONMENT INTERACTION IN ASTHMA AND ALLERGY: OVERVIEW AND PERSPECTIVES

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Over the last few decades, a dramatic increase in **chronic inflammatory diseases** is being observed, particularly in the industrialized world. About 300 million people are suffering from asthma worldwide. A cost-of-illness study by the Joint Research Centre (JRC) of the European Commission has estimated the total burden of asthma in children under the age of 15 to be €3.0 billion each year. This is at least twice as much as the costs of adult and occupational asthma in the European Community.

Bronchial asthma and allergic rhinitis are complex phenotypes influenced by genetic and environmental factors. Based on the genetic predisposition, environmental factors to a large extent determine phenotype development. Clinical manifestations at the mucosal surfaces of the airway are of major importance in this regard. Recent research indicates that altered lifestyle conditions play an important role. An inappropriate immune response in inflammatory response against harmless environmental antigens is triggered, and/or autoimmunity of the immune system reacts against harmless own antigens. Although it is now well accepted that the immunological dysregulation is a result of a complex gene-environment interaction, the detailed nature of this dysregulation on cellular and molecular level is not yet characterized. The expression of genes in an organism can be influenced by the environment, including the external world in which the organism is located or develops, as well as the organism's internal world, which includes such factors as hormones and metabolism.

Over the last few years, multiple disease susceptibility genes have been identified. Studies of the genetics of asthma have previously been conducted using linkage designs and candidate gene associations. Recently, the association study design has been extended from specific candidate genes to an unbiased genome-wide approach: the genome-wide association study (GWAS). Genes that were identified in more than one GWAS are HLA-DQB1 and epithelial cell-derived cytokines, interleukin-33 (IL-33) and thymic stromal lymphopoietin (TSLP), and the IL1RL1 gene encoding the IL-33 receptor, ST2. This highlights the central roles for innate immune response pathways that promote the activation and differentiation of T-helper 2 cells in the pathogenesis of both asthma and allergic diseases. In contrast, variation at the 17q21 asthma locus, encoding the ORMDL3, GSDML and ZPBP2 genes, is specifically associated with risk for childhood onset asthma. Additional novel susceptibility genes identified in a single study include DENND1BI , IL2RB and the interleukin-6 receptor (IL6R) gene and locus on chromosome 11q13.5 near the leucine-rich repeat containing 32 gene (LRRC32, also known as GARP). Discovering the causal mechanism behind these associations is likely to yield great insights into the development of asthma and other immune-related diseases. To date, 12 GWAS have looked for susceptibility loci for asthma and related traits, replicated in independent populations of European ancestry and also in other ethnic groups. Similar data need to be established in our population as well. It is likely that further meta-analyses of asthma GWAS data from existing international consortia will uncover novel susceptibility genes and further increase our understanding of these diseass. However, the functional consequences in terms of altered signalling pathways in environment interaction remain to be identified. The level of gene-gene-interaction opens a new area of future research, suggesting a link between inflammatory processes and metabolic signalling pathways.

HEALTH EFFECTS OF PARTICULATE AIR POLLUTION WITH SPECIAL REFERENCES TO THE NEEDS OF SOUTHERN EUROPEAN COUNTRIES

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Exposure to air pollution, especially from particulate matter, is generally accepted to be one of the most important public health problems in Europe and worldwide. The effects caused in the general population are associated with relatively small relative risks, but if the ubiquity of exposure is considered, the attributable number of events is very large. Furthermore, there is evidence that the effects in sensitive population subgroups (such as the elderly, those with chronic diseases and children) are much stronger.

Within large EU funded collaborative projects (APHEA), effect modification by geographical characteristics has been investigated and it was found that in warmer countries, in locations where particles come from traffic and where the proportion of the elderly is greater, particle toxicity is increased. These characteristics are particularly relevant to Southern European locations. From other projects we know that meteorological, climatic, environmental and socioeconomic factors are effect modifiers of the effects of specific air pollutants.

In this presentation we will show the evidence on the short and long-term health effects of particulate and gaseous air pollutants and emphasize particularly results concerning southern Europe and potential effect modifiers.

The gaps in knowledge and the need to study air pollution in Southern European countries more extensively will be demonstrated.

UBIQUITOUS SENSING FOR AIR POLLUTION EXPOSURE ASSESSMENT

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Background

Exposure assessment has and continues to be a major weakness in air pollution epidemiology. Due to the financial and logistical cost of personal monitoring, most epidemiologic studies have relied on surrogate estimates of exposure, usually assigned to the home location of study subjects. The errors in these exposure assignments probably bias results toward the null.

Methods

This paper provides a commentary and conjecture on the impact that ubiquitous sensing will have on exposure assessment in Environmental Epidemiology. This paper relies on reviews of the literature undertaken from 2008 to the present. Specifically, I review novel developments in ubiquitous sensing that will lead to much greater ability to estimate the dose, rather than just the proxies for exposure to air pollutants.

Results

Many of the important opportunities that will guide exposure assessment for Environmental Epidemiology in the 21st century arise from innovations in related science and technology. Cell-phone technologies increasingly contribute to improving diagnostics and patient care through telemedicine. The major societal investments occurring in telemedicine will have beneficial spin offs for exposure assessment in epidemiological studies. Innovations from telemedicine are now spurring fields known as “ubiquitous”, “embedded” and “participatory” sensing. Working prototypes based on cell-phone technologies have already demonstrated capacity to measure physical activity, geographic position, lung function, and pollution exposures. Such technologies can also be woven into social networking systems to voluntarily capture and share data on environmental conditions and the human response while in the exposure field.

Discussion

Ubiquitous sensing offers tremendous promise for improved exposure assessment. Protection of personal privacy, analysis of the voluminous data generated by the sensors, and integration with other emerging methods from molecular epidemiology represent critical areas for research and development.

CALCULATIONS OF PARTICULATE MATTER WITH THE EMEP/MSC-W MODEL: ASSESSMENT OF EUROPEAN LEVELS AND CHEMICAL COMPOSITION, COMPARISON WITH OBSERVATIONS

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The EMEP/MSC-W model is operationally used for assessment of regional levels and transboundary fluxes of Particulate Matter (PM) in Europe, and also pre-operationally for chemical weather forecasting (EMEP, 2003; Tsyro, 2008a, b). Accurate model calculations of PM_{10} and $PM_{2.5}$ are essential for reliable assessment of the compliance with regulatory target values. Furthermore, correct representation of PM chemical composition is necessary for trustworthy calculations of PM source allocation and the impact of emission reductions, and also in order to facilitate health effect studies of different PM components.

The EMEP/MSC-W model is a chemical transport model, calculating acidification and eutrophication pollutants, ozone and PM, which operates in flexible grids at regional to global scales. The model describes PM_{10} and $PM_{2.5}$ as consisting of anthropogenic primary PM and secondary inorganic aerosols (SIA), i.e. sulphate, nitrate and ammonium, secondary organic aerosols (SOA), and natural aerosols of sea salt and windblown dust. We present the most recent model calculations for Europe for 2009 (Tsyro et al., 2009). There is a pronounce north to south gradient in PM concentrations, with the annual mean PM_{10} varying from 1-5 $\mu g/m^3$ in Northern Europe to 10-25 $\mu g/m^3$ in southern Europe, while the corresponding increase is $PM_{2.5}$ is from 0.5-3 $\mu g/m^3$ to 5-20 $\mu g/m^3$. On average, PM levels in 2009 are slightly lower than in 2008, following the decreasing trend the previous years. Year-to-year PM variations are discussed in terms of emission changes and inter-annual meteorological variability. Calculated for 2009 PM_{10} and $PM_{2.5}$ levels are compared with EU standards and WHO Air Quality Guidelines. Furthermore, source-receptor calculations for PM are demonstrated for 2009 for Serbia.

Regarding PM chemical composition and thus contributing sources, the levels of SIA exceed those of primary particles in PM on average. For instance, SIA accounts for more than 30 % of $PM_{2.5}$ in most of Europe. Its largest contribution to $PM_{2.5}$ of 50-60% is calculated for Central and Eastern Europe, whereas on the easternmost part of the EECCA region it is substantially smaller (10-20%). However, the relative importance of primary PM increases significantly in the vicinity of major urban agglomerates due to substantial emissions from traffic and residential heating. The relative contributions of SIA and primary PM to PM_{10} and $PM_{2.5}$ vary in a course of the year, and shows different geographical distribution in different months.

Finally, we consider the reliability of EMEP/MSC-W model calculations with respect to PM. The performance of the model is evaluated through comparison with EMEP observational data from the monitoring network and from intensive measurement periods. At present, PM concentrations are underestimated by the model by 40-50% on average. Uncertainties in modelling of PM_{10} and $PM_{2.5}$ are discussed and outlooks for further model improvement are presented.

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MEASUREMENTS OF OXIDATIVE CAPACITY OF COMBUSTION GENERATED NANOPARTICLES

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Particulate pollution has been widely recognised as an important risk factor to human health. Despite the availability of a huge body of research, the underlying toxicological mechanisms by which particles induce adverse health effects are not yet entirely understood. Oxidative stress caused by generation of free radicals and related reactive oxygen species (ROS) at the sites of deposition has been proposed as a mechanism for many of the adverse health outcomes associated with exposure to particulate matter (PM). In addition to particle-induced generation of ROS in lung tissue cells, several recent studies have shown that particles may also contain ROS. As such, they present a direct cause of oxidative stress and related adverse health effects.

Cellular responses to oxidative stress have been widely investigated using various cell exposure assays. However, for a rapid screening of the oxidative potential of PM, less time-consuming and less expensive, cell-free assays are needed. Recently, a new profluorescent nitroxide molecular probe (bis(phenylethynyl) anthracene-nitroxide; BPEAnit) [1], developed at QUT was applied in an entirely novel, rapid and non-cell based assay for assessing the oxidative potential of particles (i.e. potential of particles to induce oxidative stress). Profluorescent nitroxides have a very low fluorescence emission, but upon radical trapping or redox activity, a strong fluorescence is observed. The technique was applied on particles produced by a number of different combustion sources (i.e., cigarette smoke, wood smoke and various diesel engines and fuels) [2-4].

One of the main findings from the initial studies undertaken at QUT was that the oxidative potential per PM mass significantly varies for different combustion sources as well as the type of fuel used and combustion conditions. However, possibly the most important finding from our studies was that there was a strong correlation between the organic fraction of particles and the oxidative potential measured by the PFN assay, which clearly highlights the importance of organic species in particle-induced toxicity [3, 4]. This correlation was further explored by looking at particle emissions from various alternative diesel fuels and engines [5-6]. A detailed discussion of these results will be presented. In addition for certain type of fuels a significant decrease in the observed particle mass emissions was observed while at the same time an increase in the particle oxidative capacity was measured [3,5-6].

Our results have implications for the regulation of PM using only physical properties such as mass, surface or even number based metric. Regulating purely the particle surface area or mass would not be able to detect results such as these, as the surface chemistry of particles is not explicitly considered. Therefore, not only the raw surface area of particles but also the surface chemistry of particles is important for assessing the health impacts of DPM.

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ORAL PRESENTATIONS

IMPACT ASSESSMENT OF PM10 ON THE AIR QUALITY IN SEBIA

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The newly established automatic air quality monitoring in the Republic of Serbia, within the national network for air quality monitoring, for the first time enabled larger amount of valid data on ambient concentrations of particulate matter PM_{10} in Serbia.
Air quality is assessed in accordance with domestic legislation which transposed the EU legislation in this area.

The assessment of influence of particulate matter PM_{10} on air quality in Serbia was done by analizing daily concentration of PM_{10} in 2010 using the AQI Index SAQI_11.
Comparison of partial impact of certain pollutants on air quality indicates that the influence of particulate matter PM_{10} on air quality in Serbia is dominant.

SYSTEM FOR AUTOMATICALLY PREVENTING THE RAISING OF ASH FROM DEDICATED LANDFILLS

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The paper presents a system for automatically preventing rising of ash from dedicated landfills, based on a simple mathematical model that has a modest entrance requirements for meteorological data. Such an approach is efficient enough and enables fast information retrieval or zones with different concentrations of dust in the air, which enables quick activation of counter measures to reduce emission of ash into the air.

System's hardware, in addition to computers, microprocessor elements for local acquisition and management of executive elements and systems for wireless data transfer, consists of an automatic weather station, set of meters that determine moisture of ash and set of remotely managed sprinklers.

Original software application for system management has been developed. Module that allows you to enter all the information necessary to configure the system, as well as information about the sensors and sprinklers is a part of the software.

A special software module uses meteorological input data and measured moisture content of ash, based on a set of functional dependencies, to operate water sprinklers for wetting the surfaces from which ash is emitted into the air, in order to eliminate these emissions. The system also has a software module that, based on the developed mathematical model, enables prediction of the dispersion of ash in the air as well as dry and wet deposition, in real time. All data are automatically being memorized, which enables reconstruction of the situation for the time and date selected.

The system was designed and implemented as a modular and open. Communication between the system and people is accomplished by using a specially developed graphical user interface. Using TCP / IP connection this system can connect with other information systems to exchange data.

TWINNING PROJECT ASSISTING SERBIA IN IMPLEMENTATION OF AIR QUALITY MANAGEMENT SYSTEM

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Twinning projects are important instruments of European Community to help countries in accession to harmonise and adopt necessary legislation as well as other implementing areas. Twinning projects are designed to deliver specific results on implementing areas of the acquis in the beneficiary countries based on the priority areas identified in the monitoring and Regular Reports prepared in view of enlargement. Twinning not only provides technical and preferably administrative assistance, but also helps to build long-term relationships between existing and future Member States and brings all beneficiary countries into wider contact with the diversity of practice inside the EU.

The twinning project 'Strengthening Administrative Capacities for Implementation of Air Quality Management System' started at the end of November 2009. Overall objective of the twinning project is to upgrade the system for Air Protection in Republic of Serbia in line with EU standards with an ultimate goal to contribute to improvement of air quality and quality of life in general in Serbia.

The Beneficiaries are the Ministry of Environment and Spatial Planning, Sector for the protection of natural resources, Department for the Air Protection and the Agency for the Environmental Protection, and other Serbian institutions and partners involved in air quality protection. On the assistance provider side the project team is formed from the Ministry of Environment of the Czech Republic, the Czech Hydrometeorological Institute, Czech Academy of Science, and staff from the Ministry of the Environment, Nature Conservation and Nuclear Safety, and several other institutions in Germany. Project duration is two years.

Specific project objectives are assessment of air quality in accordance with the applicable European regulations, exchange of information and contemporary trends in the area of protection and air quality, transfer of knowledge, experience and assistance to institutions and experts in Serbia in legislation implementation on air quality, air quality monitoring and procedures.

Expected results (Project Components) of the project as defined in the project fiche are:

1. Revision of Subsidiary legislation, drafting and adoption of Ambient Air Protection Strategy and improvement of implementation of Air Quality legislation.
2. Improvement of Institutional capacity and cooperation between state bodies.
3. Upgrade of Air quality monitoring system.
4. Establishment of Air quality zones assessment and management.

With the aim of achieving the stated results, within the project there are organized numerous seminars, workshops, trainings, study tours, all with the active contribution and support from the experts from EU member states (the Czech Republic and the Republic of Germany), and also from the beneficiary country stakeholders (SEPA, Provincial Secretariat for Environment Protection and Sustainable Development of Vojvodina, Public Health Institutes and others).

One of the main goals of the project is assistance to selected cities – agglomerations Belgrade, Novi Sad and Bor in development pilot plans to improve air quality in these cities aiming to reduce adverse impact from air pollution on public health in these cities.

INITIATIVE "STOP DUST" AS AN EXAMPLE OF THE FUNCTION OF AN AIR QUALITY MANAGEMENT PROGRAM

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The initiative STOP PRACH (Stop Dust) may serve as an example of a well-functioning air quality management program for the region around brown coal open pit "lom Bílina". The program is based upon a partnership of eight municipalities around the pit, the mining company Severočeské doly a.s., local NGOs and the ministry of environment. Based upon detailed analysis, eight local action plans have been created in collaboration with all existing partners - one for each of the eight surrounding municipalities. The plans focus on the reduction of households and transportation contribution to local air pollution by particles. In parallel, the mining company Severočeské doly a.s. has prepared a complex "Dust Reduction Project".

Territory of the basin area of the northern Czech Republic is affected both by local sources of pollution and by sources of pollution located in regions of Ústí nad Labem and Karlovy Vary. Sources contributing to remote transfer of pollution are mainly large incineration facilities - power plants and heat energy plants (for industry and households). Local sources of air pollution include mainly mining activity at the Mine of Bílina and households, road transportation and particle resuspension related to road transportation. The share of individual groups of pollution sources in individual locations is significantly different.

During the process of evaluation of the impact on environment within the "Plan of opening, preparation and mining in the Mine of Bílina in 2010 – 2030", each residence in the vicinity of this mine was evaluated for the emission impact of the mine as well as for the (upper limit) impact of other pollution sources (both local and remote). It is obvious that there are also other significant stationary and mobile air pollution sources beyond the mining activity at the level of air pollution by particles with impact on residences in the vicinity of the Mine of Bílina.

The initiative STOP PRACH (Stop Dust) was created in the fall of 2009 as the response to this finding. It includes eight municipalities around the mine, the Severočeské doly a.s. company and a team of experts in the area of air protection.

The main goal of the Stop Dust initiative is to reduce the air pollution of residences around the Mine of Bílina by particles from local pollution sources, mainly from households and road transportation (including resuspension). Implementation of suitably selected measures for these pollution sources would lower expenses at the magnitude of order compared to additional measures implemented within the mining activity (Mine of Bílina). The implementation of such measures would result in less expensive, faster and better reduction of the air pollution level in the area of interest.

The Stop Dust initiative is an exceptional example that the base of the air quality improving program can be both functional and effective, if it is not limited only to formal fulfilling of the program content and structure. Basic features, we consider important to achieve the success, are:

- The Stop Dust initiative is primarily a process of communication, negotiation and decision.
- The key prerequisite of this process is the interest of all stakeholders in the area.
- Active participation of representatives of affected municipalities.
- Participation of the public.
- Support of experts with main emphasis on risk communication.

PARTICULATE MATTER IN THE MAIN EUROPEAN INTERNATIONALLY BINDING DOCUMENTS AND RECOMMENDATIONS- TRANSPOSITION AND CHALLENGES IN THE REPUBLIC OF SERBIA FROM THE PUBLIC HEALTH PERSPECTIVE

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Addressing current challenges in environmental health in Serbia, with the emphasis on PM in the sense of legislative background as well as in the implementing activities related to attributable health risk assessment and the overall strategic approach, requires the understanding of wider political set up during past several decades. The transition from the old so called "SANEPID" approach which was applied from the mid-fifties in the past century in Serbian public health, experiencing years of UN sanctions and after that transition to the system which is aimed, at the final stage, to be harmonized with relevant EU legislation and state of the art, are the main milestones for the analysis.

In this paper is given an overview of main strategic international documents (e.g. Directive 2008/50/EC, WHO Air Quality Guidelines for PM, ozone, nitrogen dioxide and sulfur dioxide, WHO Resolution EUR/RC60/R7, Ministerial Parma Declaration etc.) as well as comparative analysis of Serbian legislation and strategies (e.g. Law on Air Protection, Law on Public Health, Law on health protection, CEHAP etc.)

Special emphasis was put on the comparison of the definitions and terminology (e.g. "alert threshold" vs "concentration harmful for health" etc.)

The analysis of the role of Serbian the network of 22 public health institutes and the National Public Health Institute is pointed out that they represent a solid basis with the excellent tradition in public health and especially environmental health approach, more before this approach was applied in other countries and EU countries. On the other hand, there is the fact that this area was developing fast during past two decades and scientific knowledge on PM health impacts which was transferred to the international legislation and relevant international documents is not fully implemented in health risk assessment performed by the institutes, nor in the programmes of local air quality monitoring performed by the institutes. Serbian health system with the main functions of providing stewardship, resource generation, service delivery, finances, leaderships and governance, management and partnerships was not developing so fast and not in the direction of main internationally legally binding documents related to PM. So, the biggest challenge is to use the existing resources in order to develop application of contemporary approach.

The fact that PM_{10} and $PM_{2.5}$ health effects are predominantly to the respiratory and cardiovascular systems is not taken into account in the overall analysis of the burden of diseases, nor in the epidemiological studies.

The fact is that annual average take precedence over the 24-hour average since, at low levels, there is less concern about episodic excursions, but in Serbia public health addressing to the issue is limited by the already mentioned definition of "concentration harmful for health" in the Law on Air Protection.

We may conclude that a lot of challenges is posed to Serbian public health in addressing health risks caused by the exposure to PM, from legal and strategic limitations, to the constraints of specific professional expertise.

LEVELS OF PM IN AMBIENT AIR OF SURROUNDING VILLAGES IN THE VICINITY OF THE COPPER SMELTER PLANT IN BOR, SERBIA

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Air pollution is one of the most important environmental problems in Bor Municipality area, situated in the eastern part of Serbia. The main source of air pollution with SO_2, and toxic metals and metalloids in particulate matter is the Copper Smelter Plant Bor, which has been in operation for more then 100 years [1]. Air pollutant concentrations in the city and surrounding areas have a close relationship with meteorological parameters and topography. Distribution of pollution substances emitted from the Copper Smelter is strongly influenced by meteorological parameters: wind speed and wind direction [2]. The main aim of this paper is to present the results of measurements of PM in ambient air of surrounding villages in the vicinity of the Copper Smelter Plant in Bor. Also one of the goals is comparison of PM levels in surrounding villages with those measured in the city of Bor.

The analyses were undertaken on data collected in the past few years. The mass concentrations of particulate matter presented in this paper are monitored by means of direct reading, airborne dust monitors Turnkey Osiris [3] and the GRIMM EDM 180 [4]. Dust monitors are based on the optical light scattering technology where each single particle is sized and counted. Both devices were designed for the simultaneous real time measurement of PM (PM_{10}, $PM_{2.5}$ and PM_1). The EDM 180 is the only worldwide approved PM monitor providing PM_{10} and $PM_{2.5}$ simultaneously in real-time [4]. The ambient concentrations of PM were measured at 4 nearby villages: (1). Slatina (6 km, south-east); (2). Ostrelj (4 km, east); (3). Krivelj (6 km, north) and (4). Brezonik (3 km, north). Ambient PM_{10} and $PM_{2.5}$ concentrations were higher during the cold (heating) period (October-March) than during the warm period (April-September) at all measuring sites. The exceeding of the daily limit value for ambient PM_{10} and $PM_{2.5}$ concentrations was observed at measuring sites in urban area of Bor and all villages. On the basis of the data analyses, it is possible to perform certain results and conclusions about levels and trends of PM in villages in surrounding of Bor and Copper Smelter complex:

The fraction of days above the daily limit value for ambient PM_{10} (50 $\mu g/m^3$) and $PM_{2.5}$ (25 $\mu g/m^3$) depended on season and measuring site locations, within the range from 11% to 25 % and 10% to 22 % for PM_{10} and $PM_{2.5}$, respectively. A greater number of exceeding of the limit values is detected in the cold period.

The daily mean $PM_{2.5}/PM_{10}$ ratios were determined within range from 0.52 to 0.82 and 0.30 to 0.37 during the cold and warm period respectively. These results indicate that there are significant seasonal changes in level, content and source of fine particles at all measuring sites.

The daily mean $PM_{2.5}/PM_{10}$ ratios in the villages were 6% to 10% higher during the cold period compared to such ratios measured in the city of Bor. In addition, the daily mean $PM_{2.5}/PM_{10}$ ratios in the villages were 3% to 9% lower during the warm period compared to $PM_{2.5}/PM_{10}$ ratios observed in the city of Bor. PM concentrations in the city of Bor is under more influence of Copper Smelter Plant than villages in surrounding where PM concentrations were greatly influenced by the presence of domestic heating.

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SEASONAL INDOOR AND OUTDOOR PM CONCENTRATIONS AT THE KINDERGARTEN LOCATED IN URBAN-INDUSTRIAL AREA OF BOR, SERBIA

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Particulate matter, especially the fraction with diameter less then 2.5 μm, can pose harmful effects on human's health. The probability of such effects rises with elevation of PM levels. Health risk from particulate air pollution is greatest among vulnerable population, including children and older persons. Children may be sensitive to lower levels of respirable particulate matter than adults. Present study is one attempt to determine connections between indoor and outdoor PM levels during heating and non-heating season in the kindergarten in the city centre of Bor, Serbia. The kindergarten is located 0.8 km from the Copper Smelter Complex Bor.

The measuring campaign was conducted from September 2009 to July 2010. Simultaneous indoor (**I**) and outdoor (**O**) measurement of PM_{10} and $PM_{2.5}$ mass concentrations were conducted by the use of gravimetric and continuous samplers. The influence of meteorological parameters (temperature, wind speed, wind direction, rainfall and relative humidity) on PM_{10} and $PM_{2.5}$ concentrations was considered.

Daily average I and O PM_{10} levels during non-heating season were 34.4 μg/m^3 and 34.1 μg/m^3, respectively and 46.4 μg/m^3 and 53.4 μg/m^3, respectively during heating season. In addition, daily average I and O $PM_{2.5}$ levels during non-heating season were 26.0 μg/m^3 and 22.8 μg/m^3 and 36.2 μg/m^3 and 42.5 μg/m^3, respectively during heating season.

Daily average PM_{10} outdoor concentrations exceeded the EU limit value in non-heating and heating season during 15 % and 53 % of sampling days, respectively. In addition, daily average PM_{10} indoor concentrations in non-heating and heating season above limit value were observed in 22 % and 36 % of sampling days, respectively.

Thus, higher PM levels together with larger number of days with PM_{10} levels over limit value were observed during a heating season, in both indoor and outdoor environment. This fact should be partially attributed to the presence of central and individual heating in city of Bor. Also the influence of meteorological conditions such as temperature inversions and copper smelter plant operations should not be ignored.

Strong correlation between $PM_{2.5}$ and PM_{10} particulate fractions was found during non-heating season, in both indoor (R^2 = 0.82) and outdoor (R^2 = 0.86) environment. In addition, strong correlation between $PM_{2.5}$ and PM_{10} particulate fractions was also found during heating season indoors (R^2 = 0.94) as well as outdoors (R^2 = 0.92). Above findings suggested that both PM fractions originated from the similar sources.

The results of particle size analysis for indoor environment show that share of $PM_{2.5}$ in PM_{10} level during non-heating period is 76.4 % compared to 88.9 % during heating period. Further, the share of $PM_{2.5}$ in PM_{10} level in outdoor environment during non-heating period is 68.3 % compared to 78.9 % during heating period.

Coefficient of determination (R^2) between indoor and outdoor PM_{10} levels during non-heating period was 0.75 compared to 0.64 during heating period. In addition, R^2 between indoor and outdoor $PM_{2.5}$ levels during non-heating period was 0.74 compared to 0.67 during heating period.

All abovementioned facts prove existence of additional sources of PM inside kindergarten. Beside influence of PM pollution from outdoor environment there is additional increase of PM levels in indoor space caused by movement of children and activity of personnel such as cleaning and food preparation.

TRAFFIC INDUCED LEAD AIR POLLUTION TREND LINE AT REPRESENTATIVE MEASURING POINTS IN BELGRADE

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Traffic induced lead air pollution monitoring is conducted in Serbia only in two cities, Belgrade and Novi Sad. Actually, Pb is measured together with carbon monoxide, sulphur dioxide, nitrogen dioxide and volatile organic compounds. Until 2010, according to national legislation in Serbia, annual mean limit value for lead was 1.0 μg/m^3 [1]. New by-law was approved in 2010, with new annual mean of 0.5 μg/m^3 [2]. At the same time, Serbia was one of last sixteen countries worldwide which did not phase out leaded petrol.

A significantly decreasing trend-line of lead air pollution is noted at all intersections. The given period in which the measurements were taken could be divided in two, the first before the by-law, and the second after it was adopted. Although results at all intersections show a down-slope of trend lines, if we analyse them according to new standards, urban air in Belgrade is still polluted with traffic-induced lead.

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PRELIMINARY ASSESSMENT OF SEASONAL VARIATION OF PM10 AND PM2.5 IN NIŠ URBAN AREA, SERBIA

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The city of Niš, located at the crossroads of Balkans to Europe, and Europe to the Near East, is center of the Southeastern region of Serbia and the second biggest city in country with about 350,000 inhabitants. The city area is in the valley closed from three sides, at height of 194 m above sea level. The dominant sources of air pollution were local heating, transportation and industry. The main aim of this paper is to present the seasonal variation of PM_{10} and $PM_{2.5}$ in ambient air of Niš urban area. One of the goals is to determine the relationship between indoor and outdoor PM_{10} concentration level. This paper analyzes the data collected at Faculty of Occupational Safety in the past two years.

The European reference low volume samplers, LVS3 (Sven/Leckel LVS3) with size-selective inlets for PM_{10} and $PM_{2.5}$ fractions were used to collect particulate matter in indoor and ambient air.

Also, the GRIMM EDM 180 dust monitor, based on the optical light scattering technology is used for the simultaneous real time measurement of ambient PM (PM10 and PM2.5) levels, according to European Standards EN 12341 (for PM_{10}), and EN 14907 (for $PM_{2.5}$).

On the basis of the data analyses, it is possible to present next results and perform certain conclusions:

- The daily mean ambient PM_{10} and $PM_{2.5}$ concentrations during the cold (heating) period, (October-May) were 50.7 $\mu g/m^3$ and 42.5 $\mu g/m^3$ respectively. The daily mean ambient PM_{10} and $PM_{2.5}$ concentrations during the warm period (April-September) were lower, 31.8 $\mu g/m^3$ and 23.8 $\mu g/m^3$ respectively.
- The daily mean ambient $PM_{2.5}/PM_{10}$ ratio during the cold period was calculated equal to 0.82 (range from 0.46 to 1.00). The daily mean ambient $PM_{2.5}/PM_{10}$ ratio during the warm period was calculated equal to 0.74 (range from 0.32 to 0.95). High $PM_{2.5}/PM_{10}$ ratio points to considerable influence of pollution sources of anthropogenic origin, such as fossil fuels combustion and traffic.
- The exceeding of the daily limit value for ambient PM_{10} concentrations was occurred during 34% of measuring days in the cold period. During the warm period, such exceeding wasn't detected. It indicates that local heating is one of the main sources of PM pollution in Niš urban area.
- The exceeding of the daily limit value for indoor PM_{10} concentrations was occurred during 39% of measuring days in cold period. In warm period, such exceeding was detected during 28% of measuring days. The excursions over daily limits detected indoors were in close connection with PM_{10} ambient levels (r=0.57) as well as due to particle resuspension during intense movement and activity of occupants.
- The daily mean $PM_{10\ INDOOR}/PM_{10\ OUTDOOR}$ ratio in cold season was 1.07 (range from 0.49 to 1.82), while in warm season it was 1.31 (range from 0.67 to 1.99). This show strong contribution of particle resuspension during intense movement and activity of occupants during warm session and additional influence of ambient air during local heating in cold session.

RESPIRATORY HEALTH AND AIR-POLLUTION IN CHILDREN

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Respiratory symptoms and allergic disorders are common throughout Europe and represent a substantial burden of health service cost. They are the most frequent among preschool children while exacerbations of preexisting asthma and chronic lung diseases are the most frequent in school age children. Symptoms of the upper and lower airways are equally represented in both age groups. For the last couple of years, strong evidence is reported on risk factors from the indoor and outdoor environment contributing in development of respiratory symptoms.

Studies of school environment and related health effects in children have been performed in Europe, especially in northern countries, although mostly on small samples. A European Union (EU)-funded project developed by the European Federation of Asthma and Allergy Associations found that the right of breathing clean air at school was not widely respected throughout Europe. The European Commission, through the Directorate General for Health and Consumer Affairs (DG SANCO, Luxembourg,), funded the study on Health Effects of School Environment (HESE) carried out in different European countries. Levels of some pollutants can be several folds higher indoors than outdoors; even low concentrations of indoor pollutants may have adverse biological effects when exposures are prolonged. Several reports underline the role of indoor pollution in affecting respiratory health in both children and adults. Since children spend a large part of their time at school, nationwide initiatives to evaluate such indoor air quality (IAQ) were developed.

The study, approved by the Ethic Committee of Medical Academy – US Medical School, will be carried out in winter season 2011/2012, during the heating season. The study protocol includes: 1) one standardized questionnaire on school characteristics and IAQ policy completed by the teachers; 2) two standardised questionnaires derived from the International Study of Asthma and Allergies in Childhood (ISAAC) questionnaire on characteristics of children (i.e. health conditions, lifestyle, home environment), one filled in by the pupils and the other by their parents; 3) school environmental assessments; and 4) noninvasive clinical tests on a subsample of pupils.

Noninvasive clinical tests - spirometry, break-up time and tear film analysis will be performed on all pupils in selected schools while exhaled nitrogen oxide will be performed on five to ten randomly selected pupils in each class. The relationships between the environmental biological measurements and data from questionnaires and clinical tests will be statistically analyzed. Previous studies revealed that pupils exposed to an elevated level of indoor PM_{10} and CO_2 showed higher prevalence of all respiratory disorders than those exposed to a low level, significantly so for dry cough at night, and, as regards CO_2, also for rhinitis. The prevalence of dry cough significantly ($p<0.001$) decreased with decreasing mean indoor levels of PM_{10} and CO_2.

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HEALTH IMPACT ASSESSMENT OF AIR POLLUTION IN THE CITY OF NOVI SAD

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Aim of the work: The aim was to determine the concentration of total suspended particulate mater (TSP), particulate matter with diameter of 10 μm and less (PM_{10}) and particulate matter with diameter of 2.5 μm and less ($PM_{2.5}$) in the environment, and to determine whether the current levels of particulate matter can be associated with adverse health outcomes of the population, by applying the "DPSEEA" methodology.

Methodology: The study was carried out in the City of Novi Sad, on the basis of data collected during five year period from 2006 to 2010. Average annual concetrations of TSP was determined from monitoring system, and by further calculation of annual PM_{10} and $PM_{2.5}$ concentration. In environmental impact assessment, data for total mortality, cardiopulmonary mortality of persons aged above 30 and respiratory mortality of children under five years were used. The expected number of deaths was calculated on the basis of estimated concentration of PM_{10} and $PM_{2.5}$. The linear trend was used for statistical analyses of data.

Results: Daily average value of TSP was 174 μg/m^3 in 2006, 197 μg/m^3 in 2007, 227 μg/m^3 in 2008, 148 μg/m^3 in 2009 and 160 μg/m^3 in 2010. The estimated average daily concentration of PM_{10} and $PM_{2.5}$ was 95.77 μg/m^{3}resp. 47.88 μg/m^3 in 2006, 108,35 μg/m^3 resp. 54,17 μg/m^3 in 2007, 124,85 μg/m^{3}resp. 62,45 μg/m^3 in 2008, 81,29 μg/m^3 resp. 40,64 μg/m^3 in 2009 and 88,09 μg/m^3 resp. 44,04 μg/m^3 in 2010.

The expected total number of deaths dependent on short-term presence and concentration of PM_{10} in 2006 was 131, in 2007 169, in 2008 207, in 2009 90, in 2010 11. In the period 2006-2010. a downward trend was registered (y= -12,1x + 177,7; R^2=0,1664).

Expected number of deaths from cardiopulmonary disease in people aged above 30, dependent on long-term presence and concentration of $PM_{2.5}$, in 2006 was 42, in 2007 13, in 2008 16, in 2009 6, in 2010 11. In the period 2006-2010, a the downward trend was registered (y= -6,9x + 38,3; R^2=0,5972).

Expected number of deaths from respiratory disease of children under five years, dependent on short-term presence and concentration of PM_{10} in 2006 was 0,036, in 2007 0,046, in 2008 0,232, in 2009 0,00, in 2010 0,030. In the period 2006-2010, a downward trend (y= -0,0058x + 0,0862; R^2=0,0098) was also registered.

PNEUMONIA HOSPITALIZATIONS AND LONG-TERM EXPOSURE TO AIR POLLUTION: A COHORT STUDY

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Background: Long-term exposure to air pollution has been associated with cardiovascular and chronic lung disease, but limited evidence exist on the risk for pneumonia.

Aim: To investigate the effect of long-term exposure to traffic-related air pollution (up to 38 years) in Copenhagen and Aarhus on hospital admissions for pneumonia, in a prospective study.

Methods: We followed 57053 participants of Danish Cancer, Diet, and Health cohort, aged 50-65 years at baseline (1993-1997) in Danish hospital discharge register for first hospital admissions for pneumonia between baseline and 2010. The annual nitrogen dioxide (NO2) levels were estimated at residential address since 1971 as a proxy of exposure to traffic-related air pollution. We modelled the association between mean NO2 levels and hospitalizations for pneumonia using Cox regression, in the full cohort and separately for people with and without previous hospitalizations for pneumonia and for co-morbidities defined by Charlson index.

Results: During 12.7 years' mean follow-up, 3024 (5.7%) out of 53239 eligible people were admitted to hospital for pneumonia. Mean NO2 levels were significantly positively associated with risk for first pneumonia hospitalization in the full cohort (hazard ratio and 95% confidence interval per double mean exposure: 1.25; 1.13-1.35); first-ever (incident) admission for pneumonia in 46462 people without earlier hospitalizations for pneumonia or co-morbid conditions defined by Charlson (1.23; 1.11-1.37), and for first-ever (incident) admission for pneumonia in 6292 people with history of co-morbid conditions defined by Charlson (1.22; 1.02-1.46). The highest risk was observed in 485 people with a history of pneumonia hospitalizations (1.45; 0.85-2.47).

Conclusions: Living in areas with high traffic-related air pollution increases the risk of hospitalization for pneumonia. The effect was highest in people with prior hospitalizations for pneumonia, but not limited to this group.

FACTORS AFFECTING TOXICITY OF NANOPARTICLES

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Many epidemiological and experimental studies provided reliable data connecting airborne nanoparticles with health effects (mortality and cardiovascular, pulmonary or neurological morbidity). However, there are no standard toxicology tests to characterize the potential health risks associated with nanomaterials. The diversity of the nanoparticles chemical composition and physical structure is the main reason for the impossibility to make generalised conclusions regarding their toxicity. Several reviews have attempted to estimate real and theoretical problems on nanoparticle toxicity assessment.

Toxicity of nanoparticles, as well as of the larger the particles, depends on their chemical composition and the dose, though appropriate dose/response curves are lacking for most nanoparticles. Nanoparticles might have different actions in biological systems from those of the same material at larger dimensions. They can move freely and easily penetrate cell membrane, while the same large-sized material frequently has to use specific transport systems to enter into the cell. In many cases substances having low toxicity at larger dimensions were much more toxic when administered at nano scale. Coating and surfactant materials may considerably change the toxicity of nanoparticales by changing their solubility and degradation. Additional toxicity may occur due to contamination with impurities which alter the behavior of nanomaterials. Shape and structure affect biological interactions of particles and nanomaterials of similar composition may have different ability to induce inflammatory reaction or to enter into the cells, consequently displaying different toxicity. Surface charge influence to the behavior of nanoparticles in environment but also within organism.

Having in mind many factors affecting nanomaterials toxicity, there is a need to develop efficient and rapid testing strategies in order to characterize the potential health risks. At a minimum, toxicologists should characterize influence of nanoparticles to toxicity regarding to the size including surface area, chemical composition, purity of sample, solubility, shape and aggregation, surface characteristics including reactivity, charge and coating.

ADVERSE BIOLOGICAL EFFECTS OF MILAN URBAN PM LOOKING FOR SUITABLE MOLECULAR MARKERS OF EXPOSURE

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A three year project devoted to the study of the adverse health effects of urban Milan PM has been recently concluded. The research groups involved are: 1) atmospheric chemistries for samplings and characterization of fractionated PM (PM_{10}, $PM_{2.5}$, PM_1 and $PM_{0.4}$); 2) microbiologists for the characterization of microbial communities, 3) cell and molecular biologists for the study of the cytotoxic and genotoxic effects on human lung cells; 4) biochemistries and physiologists looking at the adverse effects on lungs and other organs of laboratory mammals.

- Biological effects, mainly inflammatory responses, varied according to the seasonality of coarse and fine PMs samples.

Acute inflammatory events were promoted by summer PM_{10}, in which endotoxins from gram-negative bacteria were abundant. This coarse fraction is also enriched by resuspended pro-inflammatory crustal elements, such as Si and Al. Lung cells, exposed to summer PM_{10}, actively synthesized pro-inflammatory cytokines, such as the interleukins IL6, IL8, and IL1-β, coupled with the expression of the defence protein heme-oxygenase-1 (HO-1). Alveolar macrophages, which clear particles by phagocytosis, are then able to activate the inflammatory response. These biological events correlate well with the induction of acute respiratory syndromes, like asthmatic diseases. The very low air circulation in the Po Valley, where Milan is located, induce very high PM concentrations in winter, when PM is dominated by combustion-derived fine particles, enriched in PAHs and heavy toxic metals such as V, Cr, Zn, Cd. These components are associated with increased genotoxic potential of the winter fine PMs. In human lung epithelial cells, winter fine PM modulated a large number of genes, mainly involved in the resistance to xenobiotics. Some of these genes are also pro-oncogenic. Cells were subjected to an increased production of reactive oxygen species (ROS) and actively produced detoxifying enzymes such as cytochromes CYP1A1 and CYP1B1. The most striking event at winter fine PM exposure was a G2/M cell cycle arrest, promoted by DNA damage and the activation of repair systems. Winter PM2.5 also evoked a detoxifying mechanism in instilled mouse lungs, mediated by the cytochrome enzyme, but not acute inflammatory events, suggesting possible genotoxic effects as a consequence of chronic exposure to high PM concentrations.

- When approaching UFPs, the lung defences were often bypassed and vascular system was under attack.

The lung defence, mediated by phagocytic cells and inflammatory cytokines, did not work efficiently when particle dimension was in the UFP range. The 0.4µm PM samples did not induce significant cytotoxic and inflammatory events, while they interestingly produced significant responses of the microvascular endothelial cells. This event was analysed by the use of an *in vitro* reconstructed air-blood barrier, which evidenced a cardio-circulatory risk associated with UFPs.

The respiratory toxicology profile of the atmospheric PM is still far to be completely clarified. Its complex composition, toxic impacts, biological mechanisms evoked, may orient the effects to a large number results. Only a more complete knowledge of particle sources and composition will help in the identification of the threshold values and the reliable molecular markers of exposure able to describe the risk on human health.

MUTAGENICITY AND CYTOTOXICITY OF AIRBORNE PARTICULATE MATTERS AS A PRESENT PROBLEM OF ENVIRONMENTAL HEALTH IN THE UPPER SILESIA

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Outdoor air is polluted by solid particles which concentration, chemical composition, type and amount depend on many factors of local and global form. Many pollutants reveal genetic toxicity, causing many different damages of cell genetic material in the form of gene and chromosome mutations.

Recently, there appears to be more and more allergy cases, and increasing incidence of cardiovascular disease, cancers and respiratory diseases. This is probably due to the influence of toxic agents on the body system. Respiratory dysfunction caused by air pollutants and long term exposure is associated with a risk of chronic diseases. Also short term exposure to air pollutants can cause asthma, cardiac disorders and allergic reactions.

Airborne particulate matter appears to be a mutagenic pollutant, due to its content of aromatic polycyclic hydrocarbons (PAHs). High human toxicity of PAHs and their derivatives appears to be a result of their mutagenic, carcinogenic and cytotoxic effects. In vitro studies using cell cultures, bacteria or other experimental organisms play an important role in determining properties of airborne particles and toxic agents. Observed changes in genetic material of cells, which were exposed to those agents, create the base for forecasting of mutagenic or cytotoxic agent activity on human cells.

In the area of Upper Silesia, samples were collected with the use of aspirator of air flow of about $1m^3$-min on fiber glass filters. High performance liquid chromatography (HPLC) was employed to determine and analyze PAHs amounts. Mutagenic effects of airborne particles extracts were assessed applying Ames test with the use of bacteria *Salmonella typhimurium* strain TA 98 and YG 1041. Cytotoxicity was determined with MTT test with the employment of macrophages RAW 264.7.

13 PAHs were determined, including benzo[a]pyrene (B[a]P) which concentrations between $14,4ng/m^3$ and $78,3\ ng/m^3$, exceeded acceptable level of $1\ ng/m^3$. For further analysis of associations between mutagenicity and PAH content, B[a]P was chosen as it is used in Ames test as diagnostic (reference) mutagen.

In our material, there was a prevalence of mutagens acting indirectly (i.e. requiring metabolic activation). Mutagenic activity for TA98 strain ranged from AM =3,96 to AM=8,93, while for YG 1041 strain were from AM=1,25 to AM=3,0. In MTT cytotoxicity assay we observed inversely proportional relationship between the dose of particulate matter, expressed as a number of m^3 of the air, and macrophages survival. Survival of macrophages RAW 264.7 ranged depending on the dose applied from 1,9% for $1m^3$ to 100% for $0,187\ m^3$.

Air pollution studies suggest that high concentrations of chemical agents in the outdoor air may cause increased morbidity and mortality. A correlation between PAHs toxicity and potential carcinogenic effect on living organisms is well documented. Our analysis has confirmed that air quality may have influence on lung cancer morbidity in Silesian Voivodeship. The analysis showed a statistically significant relationship between increased morbidity of lung cancer and PM_{10} fraction concentration in the outdoor air in a male cohort.

Mutagenic and cytotoxic assays application along with chemical analyses of air pollution may help to determine the level of environmental exposure and will enable true assessment of population exposure to mutagenic, toxic and cytotoxic factors and will also allow for better evaluation of health risk.

THE GENES IN CELL DEFENSE SYSTEM AS THE FIRST LINE OF HUMAN DEFENSE TO AIR POLLUTION

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The chronic inflammation and oxidative stress in different tissues has been implicated in the pathogenesis of many non-infectious diseases, also called non-communicable disease the most important examples of are cancer, asthma, and heart diseases. Recently, particulate air pollution has been associated with cardiovascular morbidity and mortality, although the underlying mechanisms are not well understood. The air pollution, either chemical or particulate influences the living organism by inducing the oxidative stress, which triggers the inflammatory response with the tissue injury as an outcome. The inhalation of atmospheric pollutants, notably tobacco smoke and oxidant gases, including ozone, sulphur dioxide and nitrogen oxides represents the important source of reactive oxygen and nitrogen species. It is plausible that genetic variants involved in inflammation and protection against oxidative stress may influence the response to air pollutants and susceptibility to disease.

The glutathione-S-transferases (GSTs), have the general function of conjugating glutathione with electrophilic substances that are capable of generating free radicals, thus leading to detoxification of their effects. The virtual absence of enzyme activity is present in individuals with GSTT1 and GSTM1 deleted (null) genotypes. Our aim was to analyze the GSTT1 and GSTM1 deletion polymorphisms in association with both lung cancer and atherosclerosis.

The study included 330 healthy controls, 289 patients with lung cancer and 346 patients with carotid atherosclerosis. DNA was isolated from whole blood samples. A multiplex polymerase chain reaction (PCR) method was used to detect either the presence or absence of GSTM1 and GSTT1 genes in the genomic DNA samples simultaneously in the same tube; β-globin gene was co-amplified and used as an internal control. We found significant difference in GSTT1 deletion frequency in patients with atherosclerosis compared to both controls and patients with lung cancer. The GSTT1 null genotype was significantly less present in patients with atherosclerosis (5.49%) compared to both controls and patients with cancer. The frequencies of GSTM1 null genotype were not significantly different in the two groups compared to controls.

We found that GSTT1 might be an important factor in atherosclerosis. Larger studies in other populations should validate and replicate this result. Further studies should elucidate its effect on atherosclerosis in combination with air-pollution exposure data, especially $PM_{2.5}$.

SHORT-TERM EFFECTS OF BLACK SMOKE ON CARDIOVASCULAR HOSPITALISATION IN ELDERLY IN NIŠ, SERBIA

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Background. In past few years numerous epidemiological studies bring new evidence on the effects of particle air pollution on cardiovascular hospitalisations. The potential biological mechanisms of influence air pollution on cardiovascular system have two possible interlinks-inflammatory response and abnormal autonomic control. This is the first study providing quantitative estimates of the short-term effects of air pollution on cardiovascular hospitalisation in our country.

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

Method. Daily cardiovascular hospitalisations 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 ≥ 65-yrs-old. Air pollution data were provided by the Public Health Institute of Niš. Daily concentrations of BS was monitored in the local monitoring network. BS (μg/m^3) was measured by the refractometry method. The sampling was performed 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 hospitalisation 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.

Results. During the 5 years, there were 22749 all age cardiovascular hospitalisations in the city of Niš, and 10816 cardiovascular hospitalisations among person ≥ 65 yrs. The daily mean number of all age cardiovascular hospitalisations was12.46±6.26 (0 to 38) and 5.92±3.29 (0 to 20) among person ≥ 65 yrs. 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 person ≥ 65 yrs was 1,00135 (95% CI: 0,97835 to 1,02489), and estimated OR of bipolutant model was 1,00915 (95% CI: 0,99457 to 1,02394).

Conclusion. This hospitalisations time series study have shown, that all age cardiovascular hospitalisations and among person ≥ 65 yrs are not related to ambient air pollutants concentrations. There is a risk of cardiovascular hospitalisations 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.

INFLUENCE OF THE AIR POLLUTION TO ASTHMA EXACERBATIONS AND COPD WORSENING AND MORTALITY

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Objectives: the mode of influence of the air pollution to exacerbations of asthma and COPD is still not fully ellucidated.

Methods: retrospective study including patients with asthma exacerbations admitted (n=341) in the ICU and patients with COPD (n=346) worsening admitted into hospital on the day of worsening, in a two-years period (2009-2010). The admission and mortality rate (n=100) of COPD patients was analysed depending on concentration of SO_2, NO_2, CO, O_3, PM_{10}, benzene and soot, measured at 18 locations in the Belgrade region. The asthma admission rate into the ICU was analysed depending on same factors.

Results: difference in the SO_2 concentrations between days with and without COPD deaths was statisticlly significant. Similarly, difference in the soot concentration between days with and without COPD admissions was also statistically significant. Differences in CO concentrations nearly reached the level of statistical significance (P 0.058) in a way that higher concentrations were registered in days with vs. Days without admissions. Conclusion: air pollution seems to influence asthma and COPD worsening. The precise way of that influence needs further studies.

STROKE AND LONG-TERM EXPOSURE TO OUTDOOR AIR POLLUTION FROM NO2: A COHORT STUDY

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Background and Purpose: Years of exposure to tobacco smoke substantially increase the risk for stroke. Whether long-term exposure to outdoor air pollution can lead to stroke is not yet established. We examined the association between long-term exposure to traffic-related air pollution and incident and fatal stroke in a prospective cohort study.

Methods: We followed 57 053 participants of the Danish Diet, Cancer and Health cohort in the Hospital Discharge Register for the first-ever hospital admission for stroke (incident stroke) between baseline (1993-1997) and 2006 and defined fatal strokes as death within 30 days of admission. We associated the estimated mean levels of nitrogen dioxide (NO_2) at residential addresses since 1971 to incident and fatal stroke by Cox regression analyses, and examined the effects by stroke sub-types: ischemic, hemorrhagic, and non-specified stroke. Results: Over a mean follow-up of 9.8 years of 52 215 eligible subjects, there were 1 984 (3.8%) first-ever (incident) hospital admissions for stroke, of whom 142 (7.2%) died within 30 days. We detected borderline significant associations between mean NO_2 levels at residence since 1971 and incident stroke (hazard ratio 1.05; 95% confidence interval 0.99-1.11, per interquartile range increase) and stroke hospitalization followed by death within 30 days (1.22; 1.00-1.50). The associations were strongest for non-specified and ischemic strokes, while no association was detected with hemorrhagic stroke.

Conclusions: Long-term exposure to traffic-related air pollution may contribute to the development of ischemic but not hemorrhagic stroke, especially severe ischemic strokes leading to death within 30 days.

Implications: Our study offers new evidence that long-term exposure to traffic-related air pollution in adult life may be a risk factor for ischemic stroke, but not hemorrhagic stroke. Fatal ischemic strokes, likely denoting admissions for more severe strokes, were most strongly associated with NO_2. Our study adds to the existing evidence that reductions in NO_2 levels might mitigate the stroke burden.

FORMATION OF SECONDARY ORGANIC AEROSOLS (SOAS) FROM AIR FRESHENERS INDOORS – A CASE STUDY

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Introduction. Air fresheners (AF) are terpene-containing consumer products commonly used indoors to create a pleasant smell. Although it is recognized the formation of aerosols and a number of oxidation products as result of the terpene-ozone reaction indoors, little information exists on the emission strengths of terpenoid compounds from a realistic use of air fresheners in confined spaces and on their reaction with ozone under actual daily conditions indoors. In order to gather such information, experiments with some commercial available air fresheners in presence of typical indoor ozone levels were undertaken in a large environmental chamber.

Materials and Methods. Two types of air fresheners were used (AF1 and AF2). AF1 was equipped with a diffusive body while AF2 was equipped with an electrical unit. Separate experiments were carried out in a 30 m^3 walk-in type environmental chamber (Indoortron) at 23 ºC, 50% relative humidity and 0.5 air exchange rates. The AF was placed inside the chamber and its emissions monitored over time. Ozone, in the 10-70 ppbv range, was continuously supplied to the chamber and the SOAs formation was monitored by a condensation and an optical particle counters (CPC and OP). In some experiments the particle size distribution was measured by a differential mobility particle sizer (DMPS). The formation of terpene-ozone reactions products was investigated by analyzing the air inside the chamber for determination of VOCs and of low molecular weight aldehydes according to ISO 16000-6 and ISO 16000-3 standard methods.

Preliminary information on emissions from the AF was gathered by liquid injection and head space GCMS analysis

Results. Both AFs emitted terpenoids and a variety of compounds. The emission amount and pattern of each AF was different. Experiments with AF1 revealed an increase on the number of submicron particles with the ozone level supplied, reaching peak values up to 2100 particles/cm^3 at 60 ppbv of ozone. At the same level of ozone when using AF2 peak values of 7720 particles/cm^3 were measured. A prominent decline on the particle number was registered when the ozone supply into the chamber terminated. The concomitant use of two particle counters, CPC and OPC, allows arguing that the size of the particles registered during the experiments are mainly in the 0.01-0.3 µm range.

The individual concentration of a number of ozone initiated reaction products increased with the amount of ozone supplied to the chamber (e.g. formaldehyde levels reached values up to 4 µg/m^3 (in the experiments with AF1 and 60 ppbv of ozone) and 15 µg/m^3 (with AF2 and 65 ppbv of ozone). Accordingly a reduction of some of the initial terpene concentration took place.

Conclusions and Recommendations

The experiments simulating a realistic scenario for the use of AF in the presence of ozone at levels relevant for indoor environments evidenced the formation of submicron particles in the (0.01-0.3µm) along with some reaction by-products (e.g. carbonyls). The levels measured depend on the composition of the AF and the ozone concentration inside the chamber. Consumer behavior (e.g. selection of products, mode and frequency of use...) influences the type and level of chemicals and on their reaction products that can be found in confined spaces. The contribution of such consumer products to indoor air quality should be systematically studied applying common use scenarios.

SEASONAL VARIATION AND SOURCE IDENTIFICATION OF PAHs IN INHALABLE PARTICULATE MATTER FRACTION (PM_{10} AND PM_1) OF URBAN AREA OF BELGRADE (SERBIA)

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Long-term exposure to high concentrations of polycyclic aromatic hydrocarbons (PAHs) is associated with adverse health problems. PAHs comprise the largest class of chemical compounds associated with carcinogenic and mutagenic effects. Atmospheric PAHs, either in particulate matter or gaseous phase, originate from incomplete combustion of organic matter. Beside natural sources, the major PAH sources outdoors are:

- stationary sources (industrial sources, residential heating, power plants, incineration),
- mobile emissions (motor vehicle exhaust, diesel and petrol engines)
- agricultural activities (open burning of brushwood, straw, stubble, etc.)

In this study, we collected two fractions of particulate matter, $PM_{10,}$ and PM_1, and in both fractions, identified 16 priority PAHs listed both by the EU regulations and US EPA.. Aerosol samples were collected at a sampling site located at a roof 30 m above ground, at New Belgrade, a mixed residential, industrial and traffic area, Four campaigns were performed, two in non-heating and two in heating season.

$PM_{10,}$and PM_1 values in Belgrade showed typical seasonal profile. They were higher during the heating season than in the non-heating season, with a number of PM_{10} samples exceeding the limit value of 50 $\mu g/m^{-3}$: 34 values above target value with a maximum value 210.2 $\mu g/m^{-3}$. In non-heating season, only two PM_{10} values were above 50 $\mu g/m^{-3}$, with maximum 54.89 $\mu g/m^{-3}$. PAH values had the same trend as the PM values. The average concentrations for sum of PAHs in PM_{10} and PM_1 fractions were more than 10 times higher in winter (29.03 ng/m^3 and 17.27 ng/m^3) than in summer campaign (2.36 ng/m^3 and 1.23 ng/m^3). Benzo(a)pyrene was highest in PM_{10} in the heating season (11.5 ng/m^3). During the non-heating season campaigns, all values for Benzo(a)pyrene were below the target value.

The contribution of sources of PAHs to the PAH mass in PM_{10} were identified by Positive Matrix Factorization analysis (PMF). 16 species of PAHs and 53 and 61 samples in heating and non-heating season were used as input data. Each PMF factor profile was compared with several profiles reported in literature. The identified sources (factors) were: (1) stationary sources of combustion, oil, coal, power generated, residential heating (2) diesel and gasoline vehicle exhaust, (3) biomass burning.

Factor 1: This source accounts for 62.1% (~18 ng/m^3) in winter and 29.8 % (~ 0.7 ng/m^3) in summer of the PAHs in the PM_{10} samples that represent stationary sources such as coal and oil combustion, residential and domestic heating etc. Residential heating with coal and oil have large contribution to PAH pollution in winter. Main congeners are FLA, BAA, ANT.

Factor 2: The percentage contribution of this source to the PAHs is 30.4 % (~ 8.8 ng/m^3)in winter and 37.2 % (~ 0.9 ng/m^3) in summer. It contains PAHs that are tracers for diesel and gasoline vehicle exhaust emission. BbF and BkF are the highest loaded PAHs on this factor but NAP, FLU, PYR, BBF and DBA are also present. Tracers that represent diesel exhaust emission are NAP, FLU, PHE, ANT, FLT, PYR and CHR. PHE, FLU, ANT and CHR while BbF and BgP represent petrol exhaust emission.

Factor 3: Only 7.5% (~2.9 ng/m^3) in winter and 33.2 % (~0.9 ng/m^3) in summer of the PAHs is coming from this source that is dominated by FLA, NAP represents biomass including wood burning**.**

ANALYSIS OF EMISSIONS AND ATMOSPHERIC DISPERSION OF PM FROM 280M HIGH STACK OF TPP NIKOLA TESLA B

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With the increasing demands for electric power, air pollutant emission from thermal power plants became an important source of atmosphere pollution. As starting point of any policy to decrease the environmental burden by air pollution, estimation of pollutant emission from thermal power plants is essential.

Coal combustion facilities represent a major source of fine particulate matter (PM) in the atmosphere, even though air pollution control devices remove more than 99% of the PM from flue gases. Importantly, the particle-capture efficiency of these devices is size-dependent. For example, the efficiency of electrostatic precipitators (ESPs) is smaller for fine particles (<2.5 μm in diameter; PM2.5) than for larger onesandgenerally has a minimum in the 0.1-1 μm size range. Particles in this size range are therefore emitted preferentially.

In this study we evaluate the impact of Thermal power plant “Nikola Tesla B”. This power plant is located on the right bank of the river Sava, approximately 50 km southwest of Belgrade, near the town of Obrenovac. It is lignite-fired power plant consisting of 2 x 620 MW units. Blended, pulverized, surface-mined lignite is burned in both of the units. After air pollution control devices, flue gases go to atmosphere through 280m high stack.

The AERMOD modeling system was applied to estimate the particulate matter impacts of power plant. AERMOD is a steady-state dispersion model designed for short-range (up to 50 kilometers) dispersion of air pollutant emissions from stationary industrial sources. In the stable boundary layer (SBL), it assumes the concentration distribution to be Gaussian in both the vertical and horizontal. In the convective boundary layer (CBL), the horizontal distribution is also assumed to be Gaussian, but the vertical distribution is described with a bi-Gaussian probability density function. AERMOD also tracks any plume mass that penetrates into the elevated stable layer, and then allows it to re-enter the boundary layer when and if appropriate.

ACCURACY IN PRESENTING OF DUST CONCENTRATION FIELDS AROUND ASHES DISPOSAL SITES DUE TO LIMITING NUMBER OF MONITORING POINTS

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In this study, we explain loss of accuracy in representing a field of air pollution concentration due to reduction of number of monitoring points or changes in their location around ashes disposal sites of thermal power plants, located in Obrenovac near Belgrade.

In order to calculate lifting of dust from ash depots, dry surfaces of disposal sites were represented as a sum of numerous smaller surfaces which are treated in the model as the point dust sources

Using a mathematical model to simulate the raising of dust and a Gaussian type diffusion model to simulate its dispersion, a high resolution ashes concentration field was generated. The grid consisted of 98800 points. We then reduced number of points by two orders of magnitude, forming the grid of 988 points. We then did the second reduction to 24 points, still forming a regular grid. Finally we had 42 (manual sampling data) and 3 (automatical sampling data) points whose positions are in a qualitative agreement with the actual distribution of sampling stations in the area.

Since the first priority is to understand the spatial distribution of air pollution concentration from different sources and meteorological and topographical condition, it is necessary to have as many as possible air pollution concentration data from controlled area. There are two ways to achieve that: measuring and numerical modeling.

SOURCE APPORTIONMENT ON $PM_{2.5}$ AEROSOLS MEASURED IN THE URBAN AREA OF BELGRADE

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Measures to reduce particulate matter (PM) levels in urban areas need to be based on knowledge of source contribution. To assess sources of PM, a source apportionment study was conducted at a representative urban location in Belgrade. 24h samples were collected in four campaigns during the heating and non-heating season, between February and December 2009. A total of 62 samples from heating and 53 from non-heating seasons were analyzed for PM_{10} ,$PM_{2.5}$and PM_1 mass, and for and 28 chemical constituents in the $PM_{2.5}$ fraction, including elements, cations and anions.

Mean daily concentration of PM_{10} in the heating season was 69.7 μg/m^3, with 34 days were above limit value (50 μg/m^3, EU 2008). Mean daily value of PM_1 was 19.35 μg/m^3 and $PM_{2.5}$ 36.76 μg/m^3 with 25 values above target value (25 μg/m^3, EU 2008). PM_1 accounted for 35 % of PM_{10}, and $PM_{2.5}$ for 70% of PM_{10}.

In the non-heating season, mean daily concentration of PM_{10} was 23.26 μg/m^3, $PM_{2.5}$ 12.76 μg/m^3 and PM_1 8.63 μg/m^3. PM_1 accounted for 37.11 % of PM_{10} and $PM_{2.5}$ for 54.89% of PM_{10}. Ratio of $PM_1/PM_{2.5}$ was 0.68 and $PM_{2.5}/PM_{10}$ 0.56. Only two PM_{10} daily averages were above limit value, while there were no days with $PM_{2.5}$ above the target value.

The total mass of the 28 chemical species analysed accounted for 64,1% of $PM_{2.5}$ during the non-heating season, almost twice the proportion for heating season (37.6%). Positive matrix factorization (PMF) identified five factors in both the heating and nonheating seasons.

In the heating season, the main contribution to the mass of $PM_{2.5}$ were (1) mixed coal-fired thermal power plant and fuel oil combustion in heating plants (29.9%); (2) traffic exhaust (27.7%); (3) secondary aerosol (23.1%); (4) resuspended dust from road (10%), and (5) mixed resuspended salt from road and coal combustion from domestic heating (9.2%).

In the non-heating season, the main contribution to $PM_{2.5}$ was from: (1) mixed traffic exhaust and secondary aerosol (54.8%); (2) coal-fired thermal power plant (17.7%); (3) resuspended dust from road (11.7%), (4) traffic exhaust (9.1%); (5) and element of crust (6.9%). The highest contributor to the measured mass was the mixed traffic and secondary aerosol factor.

The main contribution to $PM_{2.5}$ mass in both seasons was from the coal-fired thermal power plant, secondary aerosol formation, traffic exhaust and resuspended dust from road. As expected, during the heating season there is a significant contribution from fuel oil combustion in heating plants, resuspended salt from road as well as coal combustion from domestic heating. In the non-heating season, crustal elements also contribute to fine particulate mass.

PARTICULATE INDOOR AND OUTDOOR AIR POLLUTION OF THE KINDERGARTEN AT STREET LEVEL IN CITY CENTER OF BELGRADE (SERBIA)

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Background: First kindergartens and later schools are the microenvironments where adolescents spend significant period of time. Outdoor particulate matter (PM) originate mainly from soil, traffic, and industrial sources, while indoor PM represent mixture of infiltrated and indoor-generated particle. Although the kindergarten ambient is usually lacks typical home indoor PM sources, in many studies there are notified comparatively high concentrations of PM in classrooms. Beside infiltrated outdoor PM through the building envelope, indoor PM are under influence of: air exchange rate; frequency and thoroughly of cleaning surfaces; number, age and physical activity of children in relation to room area and volume, with permanent resuspension of PM from room surfaces.

Aim: The aim of this study was to provide simultaneous information on the mass, organic and inorganic composition of indoor and outdoor PM fractions of kindergarten located next to the busy street, in a densely populated commercial-residential area with high traffic flows in city centre of Belgrade. Pollutants like PAHs and trace elements have the potential to cause adverse health effects as some of them are toxic, mutagenic or carcinogenic, etc…For the purpose of better the understanding ratio of exposure in indoor and outdoor ambient specific for traffic urban environment in Serbia there were quantified 16 EPA and EU priority PAHs and 16 elements (Al, Ba, Fe, Ti, Zn, As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Sb, Se, V).

Methods and materials : PM_{10} and $PM_{2.5}$ were collected in the indoor air of room of the kindergarten and simultaneously in outdoor air in front of the windows on a balcony, Sampling was carried out in period March-May 2010, 8 weeks, from Monday to Friday. No specific industrial sources for emissions are known of in this area. Sampling was performed on daily bases with LVS (Sven/Leckel) using quartz filters. Microbalance, Precisa XR 125 SM was used for PM mass quantification. The elemental analysis was performed on ICPOES (Varian, Vista Pro) and ISPMS (Octopole Reaction System, Agilent 7500ce). PAHs were analyzed with GCMS (Agilent 6890N with MSD).

Result: The indoor and outdoor concentration were significant for both size fractions, average mean daily of collected indoor and outdoor mass of PM_{10} were 38,67 and 44,84 and $PM_{2.5}$ 32,30 and 40,04 $\mu g/m^3$ respectively. Calculated indoor-to-outdoor concentrations ratios (I/O) of PM_{10} and $PM_{2.5}$ mass was 0,93 and 0,89 respectively. Al, Zn and Fe represent about 90% measured elements in PM_{10} and $PM_{2.5}$. Observed average mean daily concentrations for Pb, As, Cd and Ni in PM_{10} were below EU annual limit values. It was notified I/O of trace metals in PM_{10}: for Al>1 (1,21); between 0,95-1,05 for Ba, Cd, Cr, Cu and Zn; for other 0,60<Fe<Sb< Mn<Pb<Ti<Se <V <As<Ni <Co <0,90. Average indoor and outdoor daily mean of PAHs in PM_{10} were 6,79 and 8,31 and in $PM_{2.5}$ 4,04 and 6,32 ng/m^3 respectively. Average I/O of PAHs in PM_{10} was 0,88, while in $PM_{2.5}$ was 0,66. For individual PAHs in PM_{10} average I/O were for: Nap, Ane, Any, Fle, Phe, Ant, Baa and Daa >1; BaP about the same average level in PM_{10} indoor and outdoor;. Nap and Ane average ratio I/O $PM_{2.5}$ was ~ 1, while Any, Fle, Inp and Bpe were higher indoor than outdoor. BaP were content almost all in fine PM fraction, concentration of ~ 0,5 ng/m^3.

Conclusions: Data from this study prove that PM_{10} as well as fine PM concentration exceed limit and target values set in WHO guideline and EU regulative. Average daily mean PM mass as well as PAHs are higher outdoor than indoor in PM_{10} and $PM_{2.5}$. It was detected that average ratio I/O mean daily PM is higher for some of PAHs and Al in indoor ambient. Findings above proved that beside sources from outdoor indoor generated or resuspended particles from indoor surfaces contribute to PAHs and Al exposure. Our preliminary results order to follow investigations of the chemical characterization and source apportionment in the kindergarten.

POSTER PRESENTATIONS

INVESTIGATION OF REGIONAL TRANSPORT AND HEALTH RISK EFFECTS OF METALS IN $PM_{2.5}$ AIR PARTICULATE MATTER IN BELGRADE

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Airborne particles with aerodynamic diameter less than 2.5 μm ($PM_{2.5}$) penetrate deep into the respiratory system and pose a health concern. These particles contain toxic metals, which can accumulate in the human body and exert additional health problems. Thus, there is a need for monitoring the $PM_{2.5}$ concentration and their metal content.

This paper aims to present the results of comprehensive research of regional transport and health risk effects of metals in $PM_{2.5}$ sampled in the Belgrade urban area. Daily average mass concentrations of $PM_{2.5}$ were taken in episode measurements from July 2003 to December 2006 in Belgrade. The measurements were performed using Mini-Vol air samplers (Airmetrics Co., Inc.; 5 l min^{-1} flow rate) provided with a $PM_{2.5}$ cutoff inlet. Particle mass was determined by gravimetric analysis, and the concentrations of ten elements (Al, Cd, Cr, Cu, Fe, Mn, Ni, Pb, V and Zn) in the $PM_{2.5}$ samples were determined by atomic absorption spectrometry (AAS). The results show that the Fe is the most abundant metal (1627 ng m^{-3}) followed by Al (901 ng m^{-3}), Zn (943,6 ng m^{-3}), Cu (44,7 ng m^{-3}), Mn (18,3 ng m^{-3}), Pb (43,7 ng m^{-3}), V (71,4 ng m^{-3}), Ni (29,2 ng m^{-3}), Cr (4,4 ng m^{-3}) and Cd (1,5 ng m^{-3}). The size distribution, morphology and chemical composition of suspended particles were analyzed using Scanning Electron Microscopy (SEM) coupled with Energy-Dispersive X-ray analysis (EDX) to aid source identification of collected particles.

Processes in the atmosphere represent a complex problem due to the simultaneous influence of several independent factors (meteorological conditions, pollutant emission level, topography) and thus the environmental data are random variables that follow natural lognormal distribution. Deviation from lognormal distribution of atmospheric aerosols is a positive indicator of possible transport processes. Therefore, in this study the quantiles for ten heavy metals in $PM_{2.5}$ samples were analyzed by the quantile-quantile P-P slope test. This is used for fitting the quantiles of the expected theoretical cumulative probability for normal, lognormal and Weibull distribution with the quantiles of the cumulative probabilities calculated for the experimental dataset. The results show that the Weibull distribution is the most appropriate for Pb, V, Ni and Cr suggesting their possible regional transport. In order to identify possible source locations for these metals in $PM_{2.5}$ measured at the receptor site, two hybrid receptor models Potential Source Contribution Function (PSCF) and Concentration Weighted Trajectory (CWT) were used. PSCF model provides a map of source potential of geographical areas while CWT distinguishes major sources from moderate ones by calculating concentration gradients. The results indicate possible significant transport from north-west and east region for Pb and north and south-west for V and Ni. Potential source emissions for Cr are mainly distributed in south region.

The health risk assessment caused by the heavy metal content of the $PM_{2.5}$ particles in Belgrade was conducted using the US EPA health risk assessment model. For that purpose, incremental lifetime cancer risk (ILCR) has been calculated for Cd, Cr, Ni, and Pb, the elements which are human carcinogens. The obtained values indicate low cancer risk. In order to estimate non-cancer effects of analyzed heavy metals, the corresponding hazard quotients were calculated. These quotients do not exceed the nominal value 1, suggesting that the analyzed metals are not likely to cause adverse health effects.

RECEPTOR MODELING STUDIES FOR THE CHARACTERIZATION OF PM_{10} POLLUTION SOURCES IN BELGRADE

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Atmospheric aerosols have a confirmed role in climate change and radiative budget, impact on human health, effects on ecosystems and local visibility. Previous epidemiological studies indicated statistical associations between mortality and ambient concentrations of particulate matter (PM), particularly fine particles that can more readily penetrate into the lungs and are therefore more likely to increase the incidence of respiratory and cardiovascular disease. One of the main difficulties in air pollution management is to determine the quantitative relationship between ambient air quality and pollutant sources. Source apportionment is the process of identification of aerosols emission sources and quantification of their contribution to the aerosol mass and composition. Identification of pollutant sources is the first step in the process of devising effective strategies to control pollutants. Various receptor models have been used to identify aerosol sources and estimate their contributions to PM_{10} (particles less than 10 μm in diameter) concentrations at receptor sites and downwind areas in Europe.

In this study, the Unmix model has been used to analyze the three years (2003-2006) PM_{10} data set for source apportionment purpose in Belgrade. Suspended PM_{10} particles were collected on preconditioned and pre-weighed Pure Teflon and Teflon-coated Quartz filters (Whatman, 47 mm diameter, 2 μm pore size) using MiniVol air sampler provided with PM_{10} cutoff inlets. The elemental composition (Al, V, Cr, Mn, Fe, Ni, Cu, Zn, Cd and Pb) of the PM_{10} samples was determined by the atomic absorption spectroscopy method (AAS). Unmix resolved four sources related to resuspended road dust, fossil fuel combustion, traffic exhaust and regional transport mainly from steel and petrochemical industry. In addition, the average source contributions as well as the seasonal variability of the identified sources were also examined. To estimate the local source impacts from various wind directions, the Conditional Probability Function (CPF) was performed for each source using the source contributions estimated from the Unmix coupled with the surface wind direction data.

Hybrid receptor models Potential Source Contribution Function (PSCF) and Concentration Weighted Trajectory (CWT) were used for identification of source regions. The PSCF values can be interpreted as a conditional probability describing the spatial distribution of probable geographical source locations inferred by using trajectories arriving at the sampling site. Since the PSCF method is known to have difficulties distinguishing strong sources from moderate sources, the CWT model that determines the relative significance of potential sources has been additionally performed. To estimate the likely source locations for regional transporting aerosols, the PSCF and CWT were calculated using the daily source contributions to PM_{10} concentration deduced from the Unmix and backward trajectories. Air masses back trajectories were computed by the HYSPLIT (HYbrid Single Particle Lagrangian Integrated Trajectory) model through interactive READY system. Daily 48-h back trajectories, started from Belgrade (44.804o, 20.478o) at 12:00 UTC each day, were evaluated for six different heights above the starting point at ground level (200, 350, 500, 750, 1000 and 1200 m). The impact of transported particulate matter on air quality and human health is considered to be significant at receptor areas. In addition, a study of airflow characteristics was performed using cluster analysis of 48-hour backward trajectories of air masses arriving above Belgrade. Airflow directions were grouped into six classes indicating typical origin of air masses. The results suggest that highest PM_{10} concentrations were related to the west-southwest and south pathways.

DETERMINATION OF HEALTH RISK ZONES OF AIR POLLUTION IN THE CITY OF NIŠ CAUSED BY PRESENCE OF SOOT BY USE OF RBF NEURAL NETWORK

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This paper determines and shows the specific zones of health risk in relation to concentration of soot particles present in ambient air of Niš for the period from 1995 to 2009. The originality of the method applied in this paper for assessing territorial health risk lies in predicting the concentration of soot particles in ambient air of Niš.

Prediction of soot particle concentration particles was made using a RBF (Radial Basis Function) neural network, and in relation to measured and statistically analyzed concentration of soot particles that are monitored through an established monitoring network. So far, the prediction of concentration of pollutants in ambient air was based on knowledge of emission of pollutants from certain polluters, as well as on knowledge of transmission of pollutants into the atmosphere. Given that the process of transmission of pollutants into the atmosphere is complex, prediction of concentrations in ambient air based on emission concentrations requires knowledge of meteorological data, terrain topography, physical-chemical transformation of pollutants, and their diffusion and deposition. For these reasons, the application of RBF neural network method is simpler and the results are satisfactory. When health risk zones are determined by use of the RBF neural network on the territory of Niš, the estimated maximum absolute error is 10^{-4} or less.

For the analyzed period from 1995 to 2009 in the city of Niš, the zones of health risk with above-permissible values of soot concentrations were present in 2001, 2002, 2003, and 2008. The value of total carcinogenic risk in those years in specified health risk zones ranged from $3.71 \cdot 10^{-6}$ to $3.30 \cdot 10^{-5}$. The values of total carcinogenic risk were determined as the product of population's exposure to concentrations of soot particles and the coefficient of carcinogenicity.

PRELIMINARY ANALYSES OF THE MAJOR SOURCES OF PAHS IN BELGRADE METROPOLITAN IN PERIOD 2010-2011

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Major sources of PAHs, especially in large urban areas, are gasoline and diesel vehicles. Other significant sources are coal and oil combustion as well as wood burning. The ratios of some particulate PAHs are suggested to be characteristic of certain sources. The aim of this paper was to identify PAHs sources on three measurement site in wider Belgrade area: (1) Lazarevac – 54pprox.. 10 km from coal mine "Kolubara" (rural-industrial site) and (2) Grabovac 54pprox.. 15 km from coal-fired thermal power plant "Obrenovac" located in suburban zone of town Obrenovac (suburban-industrial site).

PAHs were analysed in PM_{10} aerosol fraction during 2010 and 2011. All PM_{10} samples (n=150) were collected using European reference low-volume sampler (Sven/Leckel LVS3) provided with inlets to collect particulate matter onto 47 mm Whatman. Samples were collected on a daily basis (24 hours). Collected samples are prepared according to Compendium Method TO-13A using Gass Chromatography Agilent 6890N with Mass Selective Detector. It was used Semi Internal standard (deutered PAHs) for internal calibration. Prior to analysis, calibration curves for the 16 PAHs were obtained by spiking seven known quantities of substances, all with an R^2 of the calibration curve above 0.995.

Identified ratios of benzo[a]anthracene (BaA) to chrysene (Chry) (0.28-1.2) and indeno[1,2,3-cd]pyrene (IdP) to the sum of benzo[g,h,i]perylene (BghiP) and indeno[1,2,3-cd]pyrene (0.35-0.70) indicate that traffic had a substantial impact on PAH concentrations in both sampling period on all measurement sites.

The low BaP-to-BghiP ratios (0.3-0.78) suggest a considerable impact of gasoline-fuelled traffic on particulate composition in the summer campaign, whereas the higher values of the same ratios during the winter campaigns indicated an involvement of coal and/or oil combustion. This is confirmed for the measuring points located in a urban and suburban area, Slavija and Grabovac. At a rural-industrial site, as it is Lazarevac, the higher values of the same ratios indicated an involvement of coal combustion in the both seasons.

The low value for Fla-to-Fla plus Pyr (0.4-0.5) indicates influence of traffic at Slavija and Grabovac and at Grabovac only in summer. Higher value of same ratio (>0.5) at Grabovac in winter indicate wood burning as source emission of PAHs.

Based on the ratio between Ant and sum of Ant and Phe, there was a significant contribution of wood combustion during the whole monitoring period, except at sampling site Slavija during summer when the same ratio was higher (about 0.24) than in winter (about 0.1). This indicates traffic as the main source of PAHs at the Slavija site.

AMBIENT PARTICLE CONCENTRATIONS, A SCREENING STUDY

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In one of the most polluted cities in the World, Dhaka Bangladesh, a screening study was performed to investigate the typical levels of suspended particles in the air, by using simple handheld instruments. The main objective was to gain an overview of the background concentrations and the spatial distribution of air pollution in Dhaka during winter season.

The screening study was performed during the winter season, the most polluted period of the year. Thousands of brick kilns are being operated during this period. These factories emit large amounts of particles and SO_2 into the atmosphere. Other possible sources of particulate matter (PM) include re-suspension of road dust from traffic, open air burning of waste, and industrial sources such as cement manufacturing and metal smelting. Regional haze on the plains south of the Himalayas due to sources in India burning dirty coal is also a significant contribution to local PM values on the regional scale. In order to map this regional scale particulate haze over Bangladesh, satellite data were analyzed for Aerosol Optical Depth (AOD). As part of the screening study surface measurements, also SO_2, NO_2 and ozone was measured using simple passive samplers, placed at 1m-2m height above ground and run for 30 minutes. The sampler was left alone for the sampling period, with careful attention not to have others walk in the vicinity of the sampler. Data was downloaded from the sampler each evening into a MS Excel macro for easy display and analysis. Samples were collected from different types of microenvironments around the city, and at a fixed location on a near daily basis during the sampling period.

Of the 23 PM_{10} grab samples taken, the average 30-minute concentrations ranged from 258 $\mu g/m^3$ to 2039 $\mu g/m^3$, with an average of 613 $\mu g/m^3$ for all sites. The average $PM_{2.5}$ concentration from the 23 grab samples was 439 $\mu g/m^3$ for all sites. Measurements were also collected at one site over a 24 h period, indicating that the average winter concentrations of PM in Dhaka frequently exceeded national and international air quality limit values.

Simultaneous measurements of $PM_{2.5}$ and PM_{10} allow to study the ratio of the size fractions. The $PM_{2.5}/PM_{10}$ ratio ranges from 0.47 to 0.99, with all site average was 0.8. This indicates that during the winter season, PM levels in the atmospheric air are dominated by $PM_{2.5}$ fraction and smaller, and combustion sources are major contributors particles in Dhaka. It also indicated that the regional component of aerosols may play an important role.

It has been shown that in addition to local sources of air pollution, PM levels in Dhaka are also influenced by contribution from more distant pollution sources through long-range transport. It is therefore valuable to utilize satellite data for obtaining a synoptic view of regional spatial patterns of PM beyond the boundaries of Bangladesh. Satellite data for Aerosol Optical Depth (AOD) were analyzed to map regional air pollution over Bangladesh, to obtain a regional-scale spatial overview of PM levels, and to investigate to what extent the AOD data can duplicate time series measured on the ground. PM concentrations cannot yet be retrieved directly from satellite data, but AOD is an operational product and is closely linked to PM concentrations. This empirical relationship between AOD and PM has been applied in the past to map PM from satellite images. Available AOD data was collected every day during the study period from the Moderate Resolution Imaging Spectroradiometer (MODIS) sensor onboard of NASA's Terra and Aqua satellite platforms.

This simple screening study using hand held equipment and passive samplers has shown that Dhaka experiences severe air quality problems in the winter season, and the sheer volume of human exposure to these ambient pollutants is staggering. PM concentrations are exceeding national and international standards.

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SEASONAL OC/EC VARIATION IN BELGRADE METROPOLITEN IN 2010

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Urban air quality in many large cities is adversely affected by air pollutants such as particulate matter (PM) and hazardous air pollutants (HAPs). Various studies have provided evidence that PM10, especially PM2.5, which represents the size range of particles likely to pass through the nose and the mouth, is associated with a range of effects on humans, such as morbidity and mortality rates particularly due to cardiovascular and respiratory illness(3). For another example, airborne carbonaceous materials elemental carbon (EC) and organic carbon (OC) are the largest contributors to the particle burden (1). OC contains polycyclic aromatic hydrocarbons (PAHs) and other components with possible mutagenic and carcinogenic effects(4). Thus an investigation of their physical and chemical characteristics is very important to elucidate particles toxicity and evaluate urban air quality(5).

This paper presents OC/EC concentration level in air in Belgrade metropoliten area during summer (Aug-Sep) and winter (Nov-Dec) season in 2010. During summer the sampling was done at the two representative locations in Belgrade area: (1) Lazarevac – aprox. 10 km far from coal mine "Kolubara" (rural-industrial site) and (2) Grabovac aprox. 15 km far from coal-fired thermal power plant "Obrenvac" loctted in suburban zone of town Obrenovac (suburban-industrial site). During winter session data were collected at one more site in city center of Belgrade - (3) Slavija square - (urban-traffic site).

The samples were collected every day in selected months (24h) using a European reference low-volume sampler (Sven/Leckel LVS3) with inlets to collect particulate matter PM_{10} onto 47 mm Whatman QM-A quartz fiber filters. All samples were analyzed by Sunset laboratory inc. Instrument by thermal optical method and FID detector.

The obtained results show variations in concentration level in winter (heating) and summer (nonheating) periods. In summer season concentration of OC and EC in Lazarevac and Grabovac were similar with average value of OC 6.1±0.3 μg/m^3 respectively and with maximum 16.4±0.3 μg/m^3. In the same period the average value of EC was 1.3±0.1 μg/m^3 in Lazarevac and 1.2±0.1 μg/m^3 in Grabovac. The maximum recorded EC value was 3.5±0.2 μg/m^3 in Grabovac. In winter average OC value was 25.3±1.3 μg/m^3 in Lazarevac, 15.3 ±0.8 μg/m^3 in Grabovac and 19.7±0.9 μg/m^3 on Slavija. Maximum recorded OC value in this period was 77.6±3.8 μg/m^3 in Lazarevac. Average values of EC in the same period were 2.8±0.2 μg/m^3 in Lazarevac, 2.0±0.1 μg/m^3 in Grabovac and 5.2±0.3 μg/m^3 on Slavija. Maximum EC value was 10.1±0.5 μg/m^3 on Slavija.

Seasonal variations of OC/EC values could be considered by domestic heating in urban, rural and suburban area during winter season. To determine this variations new and more broad researches are needed.

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ENVIRONMENTAL TOBACCO SMOKE EXPOSURE AND RESPIRATORY HEALTH IN SCHOOL AGE CHILDREN

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In recent year exposure to environmental tobacco smoke (ETS), also known as passive smoke, secondhand smoke and involuntary smoke, has been an important public health hazard, especially in Serbia with about 3.000.000 smokers. Particles smaller than 2,5 μm are major component of cigarette smoke and can enter deep into the lung where cause serious health problems. Children are particularly vulnerable to ETS because they are still developing. The aim of the present study was to investigate an association of respiratory symptoms and illnesses in schoolchildren in relation to their ETS exposure.

This epidemiological study included 708 children (49.15 % males) aged 11-14 years, from three primary schools in the City of Niš (Serbia). The children were surveyed by a structured questionnaire, based on the instrument developed for similar investigations, 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. Our questionnaire also included items about other indoor environmental determinants (type of heating, keeping of pets, density of habitation, mold presentation in home). ETS exposure was defined as any current exposure to cigarettes in the home.In order to limit exposure misclassification, the analysis were restricted to children who were at the same adress from birth. According to the officinal data, the 10-year average concentrations of outdoor air pollutants monitored at the relevant background monitory stations were similar. A statistical package SPSS 10.0 was used for data analysis.

Tobacco smoke was the most prevalence source of indoor air pollution at children's home and of the final study sample, 430 children (60.73%) were ETS exposed and 278 (39.27%) were ETS non-exposed. We found a significant association between ETS exposure and increased prevalence of respiratory symptoms (dyspnea, wheezing) and bronchitis and asthma. It is necessary to inform parents of the risks of environmental tobacco smoke exposure during childhood and to encourage parents' efforts to quit smoking and/or limit their child's exposure to tobacco smoke.

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