2nd Symposium  
“Air Quality and Health”  
Book of Abstracts  

Wrocław 12 – 14.06.2017  

Editors:  
Anetta Drzeniecka-Osiadacz, Krystyna Pawlas, Izabela Sówka,  
Magdalena Korzystka-Muskała, Małgorzata Mirowska, Piotr Muskała,  
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Cover image:
Black plume from small heating boiler station in one of the villages near Wrocław,
Winter 2016/2017 (photo T. Sawiński)

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Is pollen air pollution?
Preface

The state of the environment, especially the quality of air, may directly affect human health, functioning and well-being. According to World Health Organization reports about 20% of deaths in Europe are caused by environmental factors in which high concentrations of air pollutants, especially particulate matter and benzo(a)pyrene are indicated as one of the main threats.

Despite the improvement of air quality, which have been observed in recent years, in Poland the level of particulate matter pollution is still one of the highest in Europe. It concerns especially metropolitan areas with high population and urban-industrial agglomerations, notably in Lesser Poland, Lower Silesia and Upper Silesia regions. The main sources of PM emissions come from individual heating systems as well as from transport sector which together form the bulk of so called low level emission. The problem highly concerns also smaller towns and villages, particularly in mountain areas, where solid fuels such as coal and wood are the source of heating energy for most households.

Our attempt to response the abovementioned crucial problems is the scientific conference “Air Quality and Health”. The second edition of this event is held this year. It brings together scientists, policy makers, and non-governmental organizations from across Poland, in order to discuss the problems related to air pollution, its sources and sinks as well as its impact on human health and the environment. In addition, during the conference, applications of management strategies and assessment tools for policy and decision makers is highlighted. This volume presents a collection of abstracts of oral presentations and posters presented at the Conference.

Anetta Drzeniecka-Osiadacz
Chair of Organizing Committee
of the Conference
Part I
Oral presentations
Project LIFE-APIS/PL: 4 years of experience

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KEY WORDS: air pollution, Lower Silesia, WRF-Chem, geoportal

Air quality is one of the most important environmental factors affecting health of the people in the region and has direct and indirect economic impacts. In Poland, concentrations of air pollutants in many regions significantly exceed the permissible levels. Improving air quality is a long-term process, and the introduction of drastic sanctions contributing to the reduction of emissions can generate tremendous resistance of the society. It is therefore necessary to create systems for forecasting and warning residents of air pollution.

Such assumptions have become the main reason for the development of the LIFE-APIS/PL Project, focused on creation of a comprehensive system providing information on hazards connected with air pollution and biometeorological conditions for Lower Silesia. This is first such system in Poland. It is based on the advanced air pollution dispersion model WRF-Chem integrated with the meteorological model. The modeling results are verified basing on the data from WIOS measurement sites and obtained with use of the prototype mobile measurement station.

The result of the project is the geoportal NaszePowietrze available for the public at https://powietrze.uni.wroc.pl/. The source data for the geoportal are the results obtained from the modeling. The service is complemented by a mobile application NaszePowietrze (available on the Google Play Store) and light information boards located in several places across Lower Silesia (Fig. 1). All the above mentioned means of information transfer the predicted distribution of pollutant concentrations and biometeorological conditions. Spatial data are presented with a resolution of 4 km. Forecasts are generated with a 1-hour time resolution for the next 72h.

Fig. 1. The ways to access to information about air pollution forecast for Lower Silesia

The results of the project assure a quick and reliable way to provide the public and decision-makers with the necessary information and warnings about air pollution and biometeorological conditions.

Acknowledgments
Project The system for forecasting concentrations of air pollutants and biometeorological conditions as part of the quality of life assessment - LIFE-APIS / PL is financed by the European Union under the LIFE + Financial Instrument and co-financed by the National Fund for Environmental Protection and Water Management
Air quality forecasting results – LIFE-APIS/PL

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KEY WORDS: air quality forecasting, WRF-Chem, particulate matter

INTRODUCTION

Air quality has a strong impact on human health, life quality and vegetation. High concentrations of atmospheric aerosols (PM₁₀ and PM₂.₅ – aerodynamic size of 10 and 2.₅ μm, respectively) are observed each year in Poland and limit values are significantly exceeded especially during the winter time. In this paper we show the air quality forecasting system, that was developed within the LIFE-APIS/PL system and produce air quality daily forecasts since 2016. The most recent version of the system has been running since the beginning of year 2017, and we focus here on January and February 2017. The comparison with measurements for PM₁₀ and PM₂.₅ is presented.

DATA AND METHODS

The forecasting system that has been developed within the LIFE-APIS/PL project uses the online integrated WRF-Chem model. The model is configured using two one-way nested domains, covering Europe with 12km x 12km grid and Central Europe with 4km x 4km. For January and February 2017 the system produced forecasts daily, starting at 00 UTC and with 72h lead time. For this period, the system was running using two different emission inventories. First, TNO MACC III anthropogenic emission was applied for both model domains. Second, for the Lower Silesia province, we have applied high resolution emission inventory provided by Ekometria. Both forecasts are evaluated using hourly and daily PM₁₀ and PM₂.₅ measurements for Poland (first run only) and Lower Silesia (both model runs).

RESULTS

The forecasts that used TNO emission alone show good agreement with hourly measurements of PM₁₀ and PM₂.₅. Index of agreement (IOA) is 0.43 and 0.49 for PM₁₀ and PM₂.₅, respectively, calculated for all available measuring sites. However, there is large underestimation if TNO emission is applied: -52 μg m⁻³ and -38 μg m⁻³ for PM₁₀ and PM₂.₅, respectively. For Lower Silesia, IOA for the model run with TNO emission is 0.43 for PM₁₀ and 0.49 for PM₂.₅. If local high resolution emission inventory is applied, the IOA increases to 0.50 and 0.59 for PM₁₀ and PM₂.₅, respectively. The bias for TNO run and Lower Silesia is -62 for PM₁₀ and -41 for PM₂.₅. The bias is decreased if high-resolution emission inventory is applied to -30 and -16, for PM₁₀ and PM₂.₅ respectively.

SUMMARY AND CONCLUSIONS

In this work we show the performance of the LIFE-APIS/PL forecasting system for PM₁₀ and PM₂.₅ for the very recent winter season. The forecasts reproduce spatial and temporal pattern of PM₁₀ and PM₂.₅ well. However, there is large uncertainty related with emission, which is reflected in significant underestimation of PM₁₀ and PM₂.₅ concentrations.
Jakość powietrza na Dolnym Śląsku – główne problemy

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KEY WORDS: jakość powietrza, klasyfikacja stref, obszary przekroczeń

W wystąpieniu przedstawiono syntetyczną ocenę jakości powietrza w Polsce w ostatnich latach, ze szczególnym uwzględnieniem obszaru województwa dolnośląskiego. Przedstawiono jak Polska prezentuje się na tle Europy – szczególnie niekorzystnie wypadamy pod względem poziomu zanieczyszczenia powietrza pyłami zawieszonymi i benzo(a)pirenem. Problem z dotrzymaniem norm dla tych zanieczyszczeń, pomimo wielu inwestycji ograniczających ich emisję, pozostaje od lat nierozwiązany.

Jakość powietrza w Polsce jest badana w ramach systemu Państwowego Monitoringu Środowiska (PMŚ). W bieżącym roku na terenie naszego kraju funkcjonuje ok. 280 stacji pomiarowych, w tym ok. 160 stacji prowadzi pomiary automatyczne, pozwalające na obserwację stężeń mierzonych zanieczyszczeń w trybie on-line. Informacje o jakości powietrza w Polsce są powszechnie dostępne na portalach Głównego Inspektoratu Ochrony Środowiska i poszczególnych wojewódzkich inspektoratów ochrony środowiska oraz w aplikacji mobilnej na smartfony: „Jakość powietrza w Polsce”.

W województwie dolnośląskim w ramach systemu PMŚ pracuje obecnie 27 stacji pomiarowych. Dolnośląska sieć monitoringu jakości powietrza jest jedną z najbardziej rozbudowanych w kraju. Podobną liczbą stacji dysponują jedynie 3 województwa: śląskie, małopolskie i łódzkie. Informacje uzyskane w ramach pomiarów są dodatkowo uzupełniane wynikami matematycznego modelowania jakości powietrza, wykonywanego corocznie na podstawie szczegółowych danych nt. emisji zanieczyszczeń do powietrza, danych topograficznych i danych meteorologicznych. Wyniki obliczeń są podstawą do określenia poziomów stężeń oraz wskazania obszarów przekroczeń poziomów normatych substancji w powietrzu na terenie całego województwa dolnośląskiego.

Wyniki rocznej oceny jakości powietrza i klasyfikacji stref województwa dolnośląskiego za 2016 rok, obok problemów z dotrzymaniem norm jakości powietrza dla pyłu PM₁₀ i benzo(a)pirenu, wykazały także przekroczenia norm obowiązujących dla dwutlenku azotu i pyłu zawieszonego PM₂,5 we Wrocławiu, arsenu w Legnicy i Głogowie oraz ozonu w strefie dolnośląskiej. W prezentacji przedstawiono zasięg obszarów przekroczeń dla wybranych substancji i prawdopodobną przyczynę tych przekroczeń wraz z wskazaniem udziału głównych grup źródeł emisji odpowiedzialnych za wysokie stężenia poszczególnych zanieczyszczeń w powietrzu.

Korzystny wpływ na rzecz poprawy jakości powietrza w województwie dolnośląskim, a szczególnie w miastach, powinny przynieść działania realizowane w ramach programów ochrony powietrza (POP) oraz działania inwestycyjne i organizacyjno-prawne podejmowane w gminach w ramach programów ograniczenia niskiej emisji (PONE), planów gospodarki niskoemisyjnej (PGN). Należy podkreślić jednak, że jest to proces długotrwały i spodziewane efekty ekologiczne będą widoczne dopiero w kolejnych latach.

Fig. 1. Trendy zmian stężeń pyłu zawieszonego PM₁₀ w województwie dolnośląskim
PIŚMIENICTWO

WIOŚ we Wrocławiu, 2017, Ocena poziomów substancji w powietrzu oraz wyniki klasyfikacji stref województwa dolnośląskiego za 2016 rok (zgodnie z art. 89 ustawy Prawo ochrony środowiska), Wrocław.
Contribution of high PM$_{10}$ episodes to the overall exposure

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KEY WORDS: PM$_{10}$, air quality modelling, gem-aq

MOTIVATION

Poor air quality is a health issue in Poland, especially during winter. In central and northern part of the country, the primary source is low-level emissions. In larger cities and agglomerations traffic emissions are also the major contributor. Quantification of the contribution of transboundary pollution sources is still an open issue.

SCOPE OF WORK

Analyses of 55 episodes for the period 2013-2016 with high PM$_{10}$ concentrations were carried out under a contract from the Chief Inspectorate of Environmental Protection in Poland. A tropospheric chemistry model GEM-AQ was run at 10 km resolution. GEM-AQ (Kaminski et al. 2008) is a comprehensive chemical weather model in which air quality processes (chemistry and aerosols), tropospheric chemistry are implemented on-line in the operational weather prediction model, the Global Environmental Multiscale-GEM (Côté et al. 1998) developed at Environment and Climate Change Canada. Model simulations were carried out to calculate PM$_{10}$ concentrations and the extent of individual episodes. A sensitivity study was undertaken to establish relative contributions from different emission sources and source locations. Model evaluation was done using station data from Poland and neighbouring countries: Germany, Czech Republic and Slovakia to calculate contributions from surface, line and point sources. Study of synoptic conditions and weather impact was undertaken. High resolution 3-D meteorological fields from the GEM-AQ model simulations were used to drive the HYSPLIT model (https://ready.arl.noaa.gov/HYSPLIT_traj.php). For each episode, back trajectories were calculated on 4 levels (100m, 500m, 1000 m). The trajectories were computed for the reference day for up to 3 station locations where the highest concentrations were recorded (Fig. 1).

Fig. 1. Backward trajectories for three reference days during episodes (done with HYSPLIT model, with GEMAQ high resolution meteorological fields)

We will present trajectories for different types of episodes, maps with contributions for specific emission sources and transboundary pollution. Also, mean distribution of PM$_{10}$ concentrations during episodes and their health impact in overall PM$_{10}$ exposure will be calculated and shown.

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The role of precursor emissions on ground level ozone concentrations

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KEY WORDS: ozone, air quality modelling, ozone precursor, Poland, air pollution, photochemical indicators

Ozone pollution is a significant summertime problem in Poland. Its high concentrations are driven by precursor emissions and meteorology, but most favourable conditions are not yet fully understood. In this study, the Weather Research and Forecasting model with chemistry was used to run three simulations for three summer months (June, July and August) of 2015 in Poland. One of them was run with default TNO-MACCII emission inventory, the other two with NOx and VOC emissions reduced by 30%, respectively. Obtained ozone concentrations were evaluated with data from 78 air quality measurement stations managed by Chief Inspectorate of Environmental Protection in Poland and ozone sensitivity to precursor emissions was estimated by ozone concentration differences between simulations and with the use of indicator ratios. They were calculated based on modeled mixing ratios of ozone, total reactive nitrogen and its components, nitric acid and hydrogen peroxide. The results show that the model overestimates ozone concentrations, with Normalized Mean Bias reaching 0.29 and the largest errors in the morning and evening. Better model performance for ozone is achieved in rural than urban environment. Modeled ozone shows mixed sensitivity to precursor concentrations, similarly to other European regions, but indicator ratios have different values than are found in literature, particularly H2O2/HNO3 is larger than in southern Europe (above 1 mol/mol for most sites). O3/NOy ratios are larger than NOx-sensitivity threshold (6-8 mol/mol) for majority of measurement sites, but similar for both scenarios, which indicates mixed sensitivity. However, indicator ratios often differ between locations and transition values need to be established individually for a given region.
Short-term air quality forecast system
in podkarpackie voivodeship

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KEY WORDS: air quality forecast, podkarpackie, modeling, WRF, CAMx, CALPUFF

Article 24 of Directive 2008/50/EC on ambient air quality and cleaner air for Europe says that “Where, in a given zone or agglomeration, there is a risk that the levels of pollutants will exceed one or more of the alert thresholds, Member States shall draw up action plans indicating the measures to be taken in the short term in order to reduce the risk or duration of such an exceedance”. This can be done properly only by using short term air quality forecast.

Since February 2014 Marshal’s Office of Podkarpackie Voivodeship decided to implement short-term air quality forecast system for whole voivodeship.

Currently functioning air quality forecast is based on a system developed by Ekometria and it uses 3 different models in 4 different scales. It initializes automatically, after global meteorological forecast data (GFS) appears on public servers. After downloading data on local computer, meteorological model WRF starts simulations of meteorological forecast, which provides meteorological data for dispersion models.

Next step is dispersion modelling. First, photochemical model CAMx is used for ozone forecast in regional scale (Europe and Poland). CAMx calculations (5 km resolution) also provides boundary conditions for all pollutants calculated by another dispersion model - CALMET/CALPUFF, which is used in local scales – 2 km resolution for voivodeship or 0,25 km resolution for selected cities.

The main distinctive factor of this system is short term emission forecast developed by Ekometria. It is based on emission inventory gathered for Air Quality Plans in podkarpackie voivodeship (bottom up inventory) and concerns all local emission types – industrial, transport and individual heating. This emission inventory is coupled mostly with meteorological data to maintain proper temporal variability.

Results of air quality forecast system calculations cover 3 day period. They are shown as maps of air quality index in daily resolution and as selected pollution maps in 1 hour and daily resolution. All maps are shown in two scales: whole voivodeship and selected cities - Dębica, Jarosław, Jasło, Krosno, Mielec, Nisko, Przemyśl, Rzeszów, Sanok, oraz Tarnobrzeg.

Since 2014 continuous system development and quality improvement is provided. Thanks to this it’s verifiability increases.
The impact of road transport on air quality in selected Polish cities

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KEY WORDS: air quality, air pollution, transport, mobility management

Road transport is widely recognised to be a significant and increasing source of air pollution. In the next few decades, this sector will remain an important contributor to air pollution in European cities (Colvile et al. 2001). According to National Centre for Emissions Management (KOBiZE) carbon dioxide and carbon monoxide (CO\textsubscript{2} and CO), nitrogen oxides (NO\textsubscript{x}), non-methane volatile organic compounds (NMVO) and dust (including TSP) have the highest share of emissions from transport in Poland (Sówka 2017, KOBiZE). The transport sector cause road dust resuspension which is a significant source of particulate matter emission. Tire wear, abrasion of road surface and brake pads also contribute to increasing dust concentration in the ambient air (www.eea.europa.eu). The combustion of liquid fossil fuel in engines affects tropospheric ozone formation (Colvile et al. 2001, Krzyzanowski et al. 2005, www.eea.europa.eu). Emission from road transport affects the chemical composition of particulate matter. Higher concentrations of PAHs and OCs are found in dust from measurement points located near busy traffic arteries and intersections than from measurement points without traffic (apart from the heating seasons in Polish conditions). The content of sulphates, nitrates, ammonia, organic matter or chlorides in suspended particulates originating from traffic stations is significantly different from those from urban, suburban or non-urban stations where car traffic is clearly lower (Rogula-Kozłowska 2015).

THE AIM OF THE STUDY

Trends of concentrations changes of CO, NO\textsubscript{2}, NO\textsubscript{x}, O\textsubscript{3}, PM\textsubscript{10} and PM\textsubscript{2.5} in 2010-2015 in selected polish cities (Poznan, Wroclaw, Cracow, and Warsaw) will be present in the paper. Variability in the spring-summer season will be considered. This will confirm the impact of transport on the quality of air in the urban atmosphere. Analysis of existing and planned solutions in planning and mobility management to improve air quality and reduce pollution from transport will be presented for the selected cities.

MATERIAL AND METHODS

Data from the databases of the Chief Inspectorate of Environmental Protection was used for analysis. Poznan, Wroclaw, Warsaw, and Cracow are the chosen cities. Sampling points chosen to analysis are located at two types of sites: urban background and traffic related locations. One-hour and daily measurement were used for the analyses. The data series were aggregated into daily, monthly and annual averages.

RESULTS

The analysis of the data shows that Polish cities have the problem of air pollution by particulate matter (PM) and also nitrogen dioxide (NO\textsubscript{2}) in the vicinity of major streets. For the CO, NO\textsubscript{2} at background locations and O\textsubscript{3} acceptable concentrations established for human health were not exceeded in the recent years. Concentrations of pollutants were higher on the traffic stations. At the same time, the highest concentration of pollutants was found in Cracow. In conclusion, air quality in these cities is significantly influenced by both transport, geographical location and so called low-stack-emission.
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Ambient particulates mass concentration and PM$_{2.5}$ to PM$_{10}$ ratio in the Polish countryside

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KEY WORDS: winter, dust, weather conditions, PCA

During the cold months of the year, anthropogenic activity leads to a considerable deterioration of air quality (Schwarz et al. 2013; Rogula-Kozłowska et al. 2016). This situation is particularly relevant for geographical area of the former Eastern Bloc, where household heating is based on useful energy supply from outdated systems. This problem is however, not limited only to urban areas (Krynica, Drzeniecka-Osiadacz 2013). In the areas of compact rural settlement, the ratio of solid fuels combustion in the total production of thermal energy is in the range from 70 to 95% (Olszowski 2014). Unfortunately, papers discussing the results of research on air quality in rural areas are scarce. The objective of this study was to analyze the variability of the ambient particulates mass concentration in an area occupied by rural development. The analysis applied daily and hourly PM$_{2.5}$ and PM$_{10}$ levels. Data were derived on the basis of measurement results (from 6th January till 10th February 2017) with the application of stationary gravimetric samplers and optical dust meters. The obtained data were compared with the results from the urban area of Opole city. Principal Component Analysis (PCA) was used for data analysis. Research hypotheses were checked using U Mann-Whitney. Selected results in the graphical form are shown below. It was indicated that during the smog episodes, the ratio of the inhalable dust fraction in the rural aerosol is greater than for the case of the urban aerosol. It was established that the principal meteorological factors affecting the local air quality. Air temperature, atmospheric pressure, movement of air masses and occurrence of precipitation are the most important. It was demonstrated that during the specific weather conditions, the values of the hourly and daily mass concentration of PM$_{2.5}$ and PM$_{10}$ are very improper. During winter, the decrease of the PM's concentration to a safe level is principally relative to the occurrence of wind and precipitation.

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Air quality in complex terrain on the example of Karpacz area (Karkonosze Mts., SW Poland)

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KEY WORDS: air quality, particulate matter concentrations, mountainous area, SW Poland

The main aim of this study was to investigate the spatial distribution of particulate matter concentration in a touristic town of Karpacz (population cca. 5000, may increase to 18,000 in touristic season), which represents typical features of Polish touristic town in mountain area. In such towns air pollution is a serious problem especially during the cold season, due to the extensive use of solid fuels (coal and wood in particular) in households heating.

For the purpose of the study two measurement campaigns were carried out in February and March 2017, during which a series of patrol measurements of the concentration of particulate matter (PM) were made with use of a mobile measurement station in Karpacz and Jelenia Góra Basin (Fig. 1). As a background to the research during both campaigns, measurements of meteorological parameters in the vertical profile of Karpacz and Jelenia Góra Basin, as well as stationary dust concentration measurements in a base station, located in the lower part of Karpacz, were carried out. The measurement campaigns were conducted in different synoptic conditions.

During the first campaign, southern Poland was under the influence of a pressure low. In the area of Karpacz and its surroundings, there was precipitation of rain and snow and strong gusts of wind. The conditions during the second campaign were far more conducive to the accumulation of air pollution, with significantly lower wind speed, no precipitation and stable atmospheric stability during the nights.

The results of both measurement campaigns show a strong correlation of high concentration spots with local emission sources (chimneys of individual buildings), which is clearly indicated even in windy or rainy/snowy conditions. Additionally, during the second measurement campaign the authors observed clear vertical differentiation of PM
concentration in the vertical profile of the study area, with highest concentrations in the lower part of Karpacz and relatively good conditions in its upper parts.

It should be noted, that the air quality conditions were even worse on the foreland of the city, outside the populated area of Karpacz. This indicates the scale and key role of gravitational flow-down of air in ventilating the valley and shaping air quality in Karpacz area, as well as in similar localities in Southern Poland. During the measurements the authors have found a dispersion of dust air pollution towards the bottom of Jelenia Góra Basin, as well as additional supply of air pollution from other valleys descending towards the bottom of the Jelenia Góra Basin (Fig. 2).

**Acknowledgments**
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Skutki zdrowotne ekspozycji na zanieczyszczenia powietrza u kobiet w ciąży i dzieci

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KEY WORDS: zanieczyszczenia powietrza, poród przedwczesny, hipotrofia, cukrzyca typu I, rozwój psychomotoryczny dzieci


Biorąc pod uwagę powyższe Rada Naukowa przy Ministrze Zdrowia rekomenduje:

1. Uznanie zanieczyszczeń powietrza za ważny czynnik ryzyka chorób układu krążenia, układu oddechowego, zaburzeń przebiegu i wyniku ciąży oraz negatywnie wpływający na zdrowie i rozwój dzieci.

2. Upowszechnienie wiedzy z zakresu jakości powietrza i jego wpływu na zdrowie (w ramach Narodowego Programu Zdrowia).

3. Wypracowanie i promowanie dobrych praktyk w celu poprawy jakości powietrza i tym samym ograniczania ekspozycji na jego zanieczyszczenia.

4. Wdrożenie kompleksowych badań naukowych popularyzacyjnych dot. skutków zdrowotnych zanieczyszczenia powietrza atmosferycznego w Polsce (NPZ, NCN, NCBiR).

5. Dostarczanie argumentów prozdrowotnych Rządowi i samorządom dla dobrej legislacji w celu redukcji epizodów smogowych i ekspozycji długookresowych.

PIŚMIENNICTWO:


Exposure to polycyclic aromatic hydrocarbons emitted from selected types of grills as a risk of lung cancer

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KEY WORDS: Barbecue, grill, lump charcoal, charcoal briquettes, propane, inhalation exposure, particulate matter, polycyclic aromatic hydrocarbons

INTRODUCTION

Exposure to polycyclic aromatic hydrocarbons (PAHs) consumed with grilled meat might be hazardous for human health. There is however lack of data, in scientific literature, concerning inhalation exposure to those compounds present in barbecue smoke. Such exposure might be relatively high, when taking into account substantial amount of PM emitted during grilling and the fact that 66% of Poles (according to the Millward Brown report from 2012) grills regularly every sunny weekend in spring and summer.

The main goal of the analysis was to assess the possible cancer risk from exposure to PM-bound PAHs generated during barbecuing and to compare risk, which could be experienced during the grilling process by the grill operator, depending on the type of fuel used for its powering.

METHODS AND MATERIALS

The investigation was completed with the use of three different types of fuel: liquid propane (LP) gas, lump charcoal (LC) and charcoal briquettes (CB). The measurement was carried out using 6 Gilian aspirators, 3 of which were equipped with an adsorbent for the extraction of polycyclic aromatic hydrocarbons (PAHs) in the gas phase, while the other three in a previously weighed quartz filter that was designed to separate from exhaust gases the respirable particulates (PM2.5) containing PAHs. Two measurement cycles were performed: the first one using empty grills, i.e. without food and the second with food (identical set of food on each type of grill). In the normal course of grilling PM2.5,100 and PM2.5 were collected. Than 16 polycyclic aromatic hydrocarbon (PAH) congeners were extracted from PM samples and measured quantitatively using GC chromatograph. Data concerning PAHs contents in PM was further used to calculate its size dependent deposition in different compartments of human respiratory tract using multiple path particle dosimetry (MPPD) model. Finally a probabilistic risk model was developed to assess the incremental lifetime cancer risk (ILCR) faced by people exposed by breathing to carcinogenic PAHs.

RESULTS AND SUMMARY

The incineration of gaseous fuel (not containing polycyclic aromatic hydrocarbons) and the temperature of the gasification process in the gas grill (about 200°C) were unfavourable for PAHs formation both in the solid phase and in the gas phase. Hence, none of the 16 analyzed PAHs was present in the exhausting gases from this type of barbecue. Below the detection limit were also PAHs in the sample collected from charcoal-fired grill (but only in the measurement made during combustion of the fuel itself). 12 out of 16 PAHs (both in solid and gaseous phases), including highly carcinogenic dibenzo(a,h)anthracene, were found to be present in the exhaust gases from charcoal
combustion during food preparation. In the exhaust gases from charcoal briquettes incineration, the presence of PAHs was observed both during food preparation and in the samples taken from only fuel incineration. The profiles of PAHs were different in both cases, and in the case of fuel sampling, did not include PAHs with the highest carcinogenic potential. Samples taken during food preparation (in solid and gaseous phases) contained 13 of 16 PAHs, including highly carcinogenic indene(1,2,3-cd)pyrene, dibenzo(a,h)anthracene and benzo(g,h,i)perylene.

The geometric mean of incremental lifetime cancer risk (ILCR) ranged from $5.57 \times 10^{-5}$ (exposure to PAHs bound with PM$_{2.5}$ while burning liquid propane without food grilling) to $5.77 \times 10^{-1}$ (when preparing food using charcoal briquettes). This risk, assuming the inhalation of gases and PM from the grilling process for 5 hours a day and 20 days a year, exceeds $10^{-3}$ (which is the US Environmental Protection Agency acceptable level), suggesting high probability of cancer occurrences due to PAHs exposure.

To summarize – this study shows that charcoal briquettes are most dangerous concerning inhalation exposure to PAHs from BBQ emissions. To protect against such risks it is recommended that the maximum exposure time for adult consumers should be less than 1 hour.

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Association between short-term exposure to traffic-related air pollutants and incidence of cerebral infarction: time series analysis

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KEY WORDS: outdoor air pollution, road traffic, cerebrovascular infarction, time series analysis

In Poland cerebral infarction (CI) is the third leading cause of death and the first cause of disability in people over 40 (Grabowska-Fudala et al. 2010). It is estimated that about 75,000 people are affected each year, of which one fourth die and one third are disabled. Until now, epidemiologic studies assessing the causes of stroke have highlighted that the most important etiologic factors are diet, physical activity, alcohol abuse and cigarette smoking (Zuber, Mas 1994). However, the environmental aspect of this syndrome is often neglected. The results of the research described in the world literature show a significant relationship between acute exposure to traffic-related pollution and the above-mentioned emergency life-threatening conditions (Kowalska, Kocot 2016; Weuve et al. 2016; Wang et al. 2014; Villeneuve et al. 2012).

The research methodology is based on a time series analysis (with Poisson distribution model) of seasonal trends and variations in (CI) and correlation of daily CI incidents data with data of traffic-related atmospheric pollution, i.e. nitrogen dioxide (NOₓ) and sulfur dioxide (SO₂), ozone (O₃) and particulate matter (PM₁₀) occurring in the Gdansk agglomeration in 2009-2014. Environmental data relating to meteorological conditions and environmental concentrations of selected pollutants was obtained from the ARMAAG Foundation, which monitors air quality in the Tricity agglomeration. Medical data on stroke hospitalization has been provided by the National Health Fund under the Act on Access to Public Information (Art. 10 sec. 1).

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Cardiovascular consequences of the environmental expose to particulate matter

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KEY WORDS: particulate matter, cardiovascular system

Unfortunately Poland is among European Union most polluted country. Some scientific investigations reported the existence of relations between environmental exposure to air pollution and the incidence and aggravation of some adverse health effects.

The factor of a great role in harmful activity are dust molecules that is particulate matter. Atmospheric dust particles with aerodynamic diameter below 2.5 μm are known as PM2.5, and dust with diameter <10 μm as PM10. In general understanding of adverse health effects of environmental exposure to pollution that is particulate matter there is mainly problem of respiratory diseases taking into account.

The aim of the study was to present the up-to-date knowledge on relationship between environmental exposure to particulate matter and morphology and function of cardiovascular system basing on the current medical research papers.

Respectively, we have discussed the role of environmental exposure to particulate matter as a pathogenic agent for atherosclerosis in peripheral arteries, stroke, coronary artery disease, heart failure, arrhythmias and thromboembolic complications.

Major patomechanisms explaining relations between exposure to particulate matter and specific cardiovascular diseases were presented. Moreover, factors influencing the described relationships were shown. Presented medical data on the relations between environmental exposure to particulate matter and increased risk of developing cardiovascular diseases show the necessity of including air pollution as an important risk factor of developing diseases of the heart and blood vessels.

According to the up-to-date medical knowledge, limitation of emission of some pollutants into the atmosphere may yield beneficial health and economical effects by potentially decreasing incidence of cardiovascular diseases.
Krakow citizens’ exposure to particulate matter concentration (PM$_{2.5}$): indoor and outdoor

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KEY WORDS: particulate matter, PM$_{2.5}$, air pollution, SidePak AM510

INTRODUCTION

Air pollution by PM$_{2.5}$ is one of the main threats to health and life of the residents of Krakow. This is due to the very small diameter of the molecule of PM$_{2.5}$, which easily gets through the respiratory system, sticks to the alveoli surface and finally reaches the circulatory system.

AIM OF THE STUDY

The assessment of exposure to PM$_{2.5}$ of the citizens of Krakow, including the factors which have an influence on the pollution with PM$_{2.5}$ fraction indoors and outdoors

MATERIALS AND METHOD

Measurements of the concentration of PM$_{2.5}$ were determined in a Krakow neighbourhood using a SidePak AM510. 358 such measurements each lasting 24 hours were performed. One device was placed indoors and yielded 179 measurements, while the other were placed outside and yielded 179 measurements. These measurements were taken in 2013-15, throughout Krakow, and the selection of citizens was random, from a list of volunteers who had previously allowed for such measurements to be taken in their homes. Additionally, data of modifying factors of measurements outdoor/indoor during the time that the above mentioned measurements were taken.

RESULTS

It has been proved that the amount of PM$_{2.5}$ statistically differs a lot from the measure group conducted outdoors and the measure group conducted indoors (p < 0.01) – the measures of PM$_{2.5}$ outside the buildings are higher than inside. It has also been noticed that there are seasonal changes in the amount of PM$_{2.5}$. Moreover, the additional modifying factors have an impact on measures of PM$_{2.5}$ inside and outside.

CONCLUSIONS

The air pollution by PM$_{2.5}$ is a very serious problem for public health in Krakow. The situation requires multidirectional activities aiming at the limitation of PM$_{2.5}$ emission, which results in lesser exposure of the society to the fraction of PM$_{2.5}$.

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Classical and photochemical smog – the implication of the differences between these phenomena for public health practice

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KEY WORDS: photochemical smog, classical smog, public health practice

The air pollution is an environmental health problem which recently has received in Poland a lot of public and mass-media attention. One of the most known phenomenon related to this problem is smog.

“Smog” is a term which was derived in the beginning of the previous century, linking two English words “smoke” and “fog”. It was initially used in order to describe a bad situation within some industrial cities, related to the heavy emission of air pollutants caused by the coal combustion processes. Nowadays, these kind of situations is referred to as “classical” (also: “winter” or “London-type”) smog in order to distinguish them from another type of air pollution problems called photochemical (also: “summer” or “Los Angeles-type”) smog.

According to many scientific researches these two phenomena pose a big threat to human health and adversely affect the quality of life. However the anthropogenic nature of their causes is similar, classical and photochemical smog differ in some points like main sources and conditions of their origin or chemical character.

During the presentation the similarities and differences between classical and photochemical smog will be described and the importance of the differences for the public health practice will be discussed. Especially, the less visible nature of the photochemical smog can be a challenge for environmental health professionals, posing a need for providing the information and communicating the risk to the public. Some qualitative analysis of the mass-media content suggests, that there is some gap regarding this area of interventions.
The air pollution of Polish health resorts in terms of spa treatment

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KEY WORDS: health resorts, low emission, medical treatment

Most of Polish health resorts are situated in the mountains, in the bottoms of the valleys – natural place to accumulate air pollution. Many of them are also the famous touristic destinations, with intensive local and transit traffic. The main source of air pollution in the health resorts, as in most small Polish cities is low emission from the houses: particulate matter and benzo(a)pyrene but also emission from traffic.

In the health resorts the air supposed to be more clean than in other places to allow different kind of climathotherapy (heliotherapy, aerotheraphy, terrain therapy) – this is one of the reasons for going to the treatment there.

Over the last years among 45 health resorts only in 6 there is the permanent air pollution monitoring within the protection areas (Busko-Zdrój, Ciechocinek, Inowroclaw, Sopot, Szczawno-Zdrój, Ustroń), in 4 the monitoring was outside the protection area (Cieplice-Zdrój, Czerniawa, Goldap, Swoszowice). Also in few health resorts there was temporary, 1-year monitoring: in 2014 in Rabka-Zdrój, in 2016 in Polanica-Zdrój, 2017 in Kudowa-Zdrój.

In 2014 yearly mean of PM₁₀ was between 18.7 µg/m³ to 46.3 µg/m³ (116% of the permissible EU norm and 232% of WHO suggested norm). The highest PM₁₀ concentrations reached: 228 µg/m³ in Szczawno-Zdrój and Cracow (Swoszowice), 215 µg/m³ in Jelenia Góra and 204 µg/m³ in Ustroń. Number of days with PM₁₀ concentration above the daily norm (50 µg/m³) was for example: 100 in Cracow (Swoszowice), 66 days in Szczawno-Zdrój or 45 in Ciechocinek (Fig. 1).

In 2014 PM₂.₅ was only measured in Cracow (Swoszowice) where mean yearly concentration reached 33.0 µg/m³ (132% of EU norm and 330% of WHO norm) and in Busko-Zdrój – 23.5 µg/m³ (94% of the EU norm).

Benzo(a)pyrene was measured in the vicinity of 7 health resorts and in all of them the yearly mean concentration exceeded the norms: the highest was in Rabka-Zdrój where it reached 8.1 ng/m³ (810% of the norm), the lowest in Inowroclaw (1.8 ng/m³ – 180% of the norm).

Fig. 1. Number of days with 24 hours PM₁₀ concentration above 50 µg/m³ in the health resorts in 2014 (based on the data from Regional Inspectorates for Environmental Protection)
Assessment of NO$_2$ immission and biothermal conditions in Legnica (2005-2014)

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KEY WORDS: Subjective Temperature Index (STI), Physiological Subjective Temperature (PST), Physiological Strain (PhS), Urban bioclimate

Legnica belongs to the central bioclimatic region (Błążejczyk, Matzarakis 2007). This region is characterized by an average temperature at 12:00 (UTC) in summer (June to July) 21.3°C and in winter (January to March) 1.9°C.

The aim of the study was to evaluate the distribution of hourly NO$_2$ concentration and biothermal conditions in Legnica, and define the relationships between NO$_2$ concentration and biothermal factors, based on selected indicators. In the study were used hourly meteorological data and hourly NO$_2$ concentration level data from the period between 2005 and 2014, received from the State Environmental Monitoring Station in Legnica, with international code PL0190A. The assessment of thermal sensations and thermal stresses was characterized on the basis of biothermal indicators: Subjective Temperature Index (STI), Physiological Subjective Temperature (PST), Physiological Strain (PhS), calculated using the Bioklima 2.6 program (https://www.igipz.pan.pl/Bioklima-zgik.html). The frequency of NO$_2$ hour concentrations was evaluated for all seasons of the year in the multi-year period study. An analysis of the correlation between NO$_2$ concentration and biothermal indexes and metrological parameters was conducted with the use of Statistica 12.5 software. The distribution of daily NO$_2$ concentration and STI, PST and PhS ratios were also compared. The highest concentrations of NO$_2$ were recorded in winter (December-February) and the lowest in summer (June-August). In winter, the largest, over 5% frequency, hourly concentrations >80 μgm$^{-3}$ was noticed from 17:00 to 19:00 UTC (Fig. 1).

![Fig. 1. Frequency of hourly concentrations of NO$_2$ (μgm$^{-3}$) in winter, 2005-2014.](https://www.igipz.pan.pl/Bioklima-zgik.html)

In winter the strongest correlations occurred between NO$_2$ concentrations and STI during the night (21:00-3:00 UTC), the correlation coefficient was, $r = -0.45 -0.46$ and $p <0.01$. In winter, the relationship between NO$_2$ concentration and PhS index, at $p = 0.05$, was not observed between 8:00-12:00 (UTC). The daily distribution of mean PhS values in winter shown a different dynamics than the STI values.

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Legal regulations on odour in Poland and in selected countries around the world

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KEY WORDS: odour nuisance, legislation

The emerging problem of odour nuisance requires taking legal steps aimed for introducing regulations focused on improving the odour air quality in selected areas. The work done in Poland ended with the preparation of the Project and Assumptions to the draft of “The Law on the Prevention of Odour Nuisance”. However, as a result of the social consultations held in Poland, the Ministry of Environment abandoned in 2015 the introduction of the so-called Anti-Odour law. At present, the action taken by the legislator in the area of odour problems in Poland resulted, among others “The Code of Countermeasures of Odour Nuisance” that was developed in September 2016.

In Poland and in the European Union countries, issues concerning on odour and odour nuisance are settled in a different way and there is still a lack of harmonized proposals e.g. in the case of odour complaints and in the context of odour reference values (expressed in ouE/m³).

The purpose of this work is to review the legislative proposals on odour in Europe and North America, together with an indication of their possible adaptation or application in the context of Polish legislation system.

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Estimation of intensity and hedonic quality of odour mixtures by electronic nose

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KEY WORDS: odour intensity, hedonic quality, electronic nose, model

Smell is a feature of volatile compounds complex mixtures present in the air in concentrations that can be detected by the sense of smell. These mixtures may consist of a single chemical compound or even several hundred components. All contribute to the unique characteristics and properties of the particular smell. There are several well-known characteristic parameters of odour: detection threshold, odour concentration, odour intensity and hedonic quality (Kośmider et al. 2002). To determine these parameters olfactometric methods are usually used. However, in recent years a growing interest in devices operating in the likeness of the human senses is noticeable. Particular attention should be paid to the machines that reflect the action of human smell - electronic noses. They are instruments, which comprises an array of electronic chemical sensors with partial specificity and an appropriate pattern-recognition system, capable of recognizing simple or complex odours (Gardner, Bartlett 1994).

Presented research shows an alternative way for evaluation estimation of intensity and hedonic quality of odour mixtures using electronic nose prototype. The study was conducted using model gas mixtures containing three aroma compounds: α-pinene, triethylamine and methyl methacrylate. Previous studies have shown that the odor intensity (I) dependence on the signals obtained from the e-nose MOS semiconductor sensors (S) can be represented by the equation (Gębicki et al. 2015):

\[ I = f \left( \log \left( \frac{1}{S} \right) \right) \]

To estimate the odour intensity (I) and hedonic quality (H) linear models was developed:

\[ I, H = a_0 + a_1 \cdot \left( \log \left( \frac{1}{S_1} \right) \right) + a_2 \cdot \left( \log \left( \frac{1}{S_2} \right) \right) + \cdots + a_n \cdot \left( \log \left( \frac{1}{S_n} \right) \right) \]

The research confirms the possibility of connecting the results obtained by an electronic nose with the results obtained by sensory analysis. Proposed linear models of multi-parameter linear regression have proven to be adequate and characterized by a high determination coefficient.

Acknowledgments

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Evaluation of the efficiency of biofilter deodorization by electronic nose and sensory analysis

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KEY WORDS: biofilter, deodorization, monitoring, electronic nose, sensory analysis

Many areas of human activity, especially waste disposal and waste water treatment processes are the source of odour nuisance. There are main four groups of techniques used to reduce odorants in the air: combustion, adsorption, absorption and biological methods. Biofiltration is one of the biological purification methods. It is based on the aerobic degradation of pollutants by microorganisms located in the filter bed (Sówka et al. 2013). The principle of biofiltration process is based on the contact of the odorants with the bed covered with biofilm. Odorants are absorbed and then decomposed by microorganisms (Adamiak et al. 2012). The most susceptible to biofiltration are low molecular weight and water-soluble compounds such as: hydrogen sulphide, ammonia, alcohols, aldehydes and ketones (Burgess et al. 2001).

Presented research shows an alternative way for evaluation of the efficiency of air biofiltration using electronic nose prototype, which is an instrument, which comprises an array of electronic chemical sensors with partial specificity and an appropriate pattern-recognition system, capable of recognizing simple or complex odours (Gębicki et al. 2015). Obtained results were compared with the results of sensory analysis.

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Sówka, Miller, Adamiak, Skrętowicz 2013, Use of some surfactants to increase the efficiency of biofiltration of industrial gases, Przemysł Chemiczny, Vol. 92, No. 7, pp. 1354-1357 (in Polish)
Microbiological assessment of indoor and outdoor air quality in a wastewater treatment plant

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KEY WORDS: microbial air quality, wastewater treatment plant, bioaerosols

Wastewater treatment plants (WWTPs) have been recognized as a source of odours and microbial pathogens to the outdoor air (Fracchia et al. 2006; Godayol et al. 2011). The results of many studies revealed that high amounts of microorganisms are not only present in the stream of wastewater or sludges but also in the bioaerosols that are generated during the different stages of the wastewater treatment. Hence, possible migration of biological contaminants into the interiors cannot be excluded. However, there is a knowledge gap in an assessment of the microbiological indoor air quality of facilities located at WWTPs. The aim of this study was to evaluate the level of outdoor microbial air contamination upon the indoor environment based on the determined outdoor to indoor (O/I) ratios. Sampling of airborne bacteria and fungi was conducted in three replications with sedimentation and impaction methods, during a one-year survey from August 2015 to July 2016 in ten technological and office buildings as well as their vicinity, at the Municipal Wastewater Treatment Plant of Lublin (Poland). Moreover, the cleanliness of hand contact surfaces in staff rooms was examined (Rodac plates). The studies were performed according to the Polish Standards PN-89/Z-04111/02 and PN-89/Z-04111/03. Additionally, bacteria and fungi identification was carried out.

The obtained results for microbial airborne concentration and identification of outdoor air samples were in agreement with the levels reported in the available studies from many Polish WWTPs (Filipkowska et al. 2000; Kruczalak, Olańczuk-Neyman 2004; Adamus-Białek et al. 2015). The highest concentration of total bacteria count (3617 CFU/m³) and fungi in bioaerosols (5386 CFU/m³) was detected in the air around sewage pumping station, close to aeration tanks. *P. fluorescens* was found in the air around grit chamber (78 CFU/m³). The majority of the examined indoor air samples were characterized with different levels of microbiological contamination – from non-polluted to medium polluted. The number of total bacteria counts range from 180 to 4073 CFU/m³. The highest estimated fungi indoor concentration was 4679 CFU/m³. The controlled surfaces were mostly contaminated with *Actinomycetes* and Coliform bacteria. No *Salmonella* sp. were detected.

Bacteria from the *Enterobacteriaceae* family were commonly isolated from the indoor and outdoor air samples.

The obtained data can be used to devise further guidelines facilitating control and management of WWTP to avoid or minimalize the staff exposure.

REFERENCES

Urban boundary layer characteristics and relationship with particulate matter concentration during air pollution episodes

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KEY WORDS: PM$_{2.5}$, SODAR, atmospheric boundary layer, air quality

Estimation of the planetary boundary layer height (ABL) is of major importance for air quality studies, as it strongly affects the transport and concentration of atmospheric pollutants. The structure of ABL changes in time and space, with diurnal and seasonal cycle, mainly forced by the energy budget at the surface, and is affected e.g. by the configuration of the terrain and land use. Particulate matter is one of the six main pollutants, and has the most important adverse effects on human health. Many reports and epidemiological studies indicate PM$_{x}$ can cause a wide range of diseases, e.g. chronic cardiovascular and respiratory disease. Although particulate matter (PM$_{10}$ and PM$_{2.5}$) concentrations have slightly decreased in recent years in many Polish cities, concentration levels are still higher than those in most European countries. In Wroclaw combustion of fuels used in domestic heating is found to be the largest source of PM$_{10}$ (57%), PM$_{2.5}$ (77%) and B(a)P (87%), so extremely severe PM episodes occur mainly in winter season.

The aim of this study is to investigate the interactions between weather factors and emission that lead to wintertime dust events during January and February 2017 in Wroclaw.

SODAR backscattering measurements were used to follow the boundary layer dynamics. The temporal distribution of aerosols (PM$_{10}$, PM$_{2.5}$) was characterised by in situ ground-based measurement (TEOM 1400a analyser). Additional data used in this study included precipitation rate, air temperature as well as wind speed and direction obtained by automatic weather station at Meteorological Observatory of University of Wroclaw. Moreover the HYSPLIT trajectory model has been used in order to assess the potential dust source region.

Fig. 1 The example of PM$_{2.5}$ concentration course vs sodar echograms (left) and trajectory frequencies (right) during episode of high PM concentrations 14-15.02.2017.

Two dust episodes of high PM concentrations were selected for the study. The severe air quality events are usually caused by several key factors. The most important are rate and temporal distribution of air pollution emission, topography and weather conditions. During the analyzed episodes, particulate matter was accumulated due to low
inversion layer with the depth up to 90 m a.g.l and low wind speeds preventing dispersal. Such conditions were favoured by high weather pressure system. Episodes were characterised by very high PM$_{2.5}$/PM$_{10}$ ratio (close to 1), indicating the processes of combustion coal and wood as a main source of dust. However, even during winter temperature inversion episodes the local emission had an important contribution to ambient air pollution, a some part of dust resulted from transport from high polluted region. During the episodes the average daily concentration of PM$_{2.5}$ exceeded 150 µg m$^{-3}$ with strong variation of day-to-night values (20 vs 300 µg m$^{-3}$) in some days (Fig. 1).

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Indoor and outdoor air quality in Silesian kindergartens, Poland

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KEY WORDS: air pollutants, I/O ratio, diagnostic ratios, MEQ, TEQ

More than 80% of people living in urban areas are exposed to air quality levels that exceed World Health Organization (WHO) limits. While all regions of the world are affected, populations in low-income cities are the most impacted (WHO 2016). As many as 33 Polish cities are among the 50 most polluted cities in the European Union (EU), with Silesian cities topping the list, according to the annual average levels of fine particulate matter (PM$_{2.5}$, ambient particles with aerodynamic diameter of 2.5 µm or less) latest presented in urban air quality database issued by the WHO in 2016.

The aim of this study is characterize the indoor and outdoor air quality in Silesian kindergartens base on the concentrations of gaseous compounds (SO$_2$, NO$_2$), PM$_{2.5}$, PM$_{2.5}$-bound bezno(a)pyrene (B(a)P) and sum of 15 PM$_{2.5}$-bound polycyclic aromatic hydrocarbons (PAHs), as well as mutagenic activity of PM$_{2.5}$ organic extracts in Salmonella assay (strains TA98, YG1024).

Indoor and outdoor 24-h samples were collected during heating period (March-April 2010) in two sites in southern Poland (Silesia) representing urban and rural areas. The I/O ratios (indoor/outdoor ambient concentration) of each investigated parameters were also calculated. Mutagenic (MEQ) and carcinogenic (TEQ) equivalents related to B(a)P and the percentage share expressed as mutagenic (MP) and carcinogenic (CP) potential of each individual compound to the total mutagenic/carcinogenic potential of the PAH mixture were also presented. The origin of PM$_{2.5}$-bound PAHs was identified based on the diagnostic ratios.

In urban site statistically lower concentrations of SO$_2$ and NO$_2$ were detected in indoor compared to outdoor, whereas in rural site such relationship was only observed for NO$_2$. No statistically significant differences in the concentrations of PM$_{2.5}$, PM$_{2.5}$-bound B(a)P and Σ15 PAHs in kindergartens (indoor) versus atmospheric air (outdoor) in two studied areas were identified. Mutagenic effect of indoor PM$_{2.5}$ samples was twice lower than outdoor samples. The I/O ratios indicated that all studied air pollutants in urban kindergarten originated from ambient air. In rural site concentrations of SO$_2$, PM$_{2.5}$ and B(a)P in kindergarten were influenced by internal sources (gas and coal stoves). In overall PAHs mutagenic and carcinogenic potential the percentage share of B(a)P was dominant and varied from 49.0-54.5 % to 62.5-70.0 %, respectively.

Results of this study indicate that PM$_{2.5}$ and PM$_{2.5}$-bound PAHs occurring both in the air outside and inside the kindergartens in the Silesian region are an important source of children's exposure to genotoxic agents. High levels of PM$_{2.5}$-bound PAHs are characteristic for heating period as a result of local emission - coal and biomass combustion in home furnaces and increased production in heating or/and power plants. The carried out study indicates the necessity of reducing PAH emission from solid fuel combustion, especially during winter/spring seasons. In the recent years health effects on children resulting from their activity pattern and air quality in the public places have been a serious problem.

REFERENCES

The role of pollutant deposition on spruce growth dynamics in the Jelenia Góra Basin as an example

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KEY WORDS: dendrochronology, forest degradation, Jelenia Góra basin, Sudety Mts.

INTRODUCTION

The presence of pollutants in the atmosphere and their deposition on the surface results in a number of consequences for particular components of the natural environment. Degradation of forest ecosystems is characterised by mosaic pattern of deforestation, manifesting itself in co-existence in close vicinity and similar site conditions of totally deforested areas with areas of moderate degree of deforestation, alongside forests in a relatively good condition. Slowing down or hampering the growth of trees is characterised in the reduction of annual increments (Emberson 2003, Schweingruber 1996). The scale of reduction provides information on the duration and the impact of pollutants (Malik 2012). Dendrochronological record of the tree trunks of subalpine Norway spruce (Picea abies) showed that the hardest period for the growth of trees in the Western Sudety Mts. was the first half of the 1980s of the 20\(^{th}\) century. Trees’ vitality (in relation to the reference year 1950), at the upper tree line in the Karkonosze Mts., reduced by as much as 70-80\%. Reduction in the emission in mid 90s translated into systematic improvement in the forest condition at all stations, which frequently reached the level recorded in the reference period.

METHODOLOGY AND QUESTIONS

One of the most important research methods, which enable trees condition inventory and reconstruction of the growth dynamics in the past, is dendrochronology (Schweingruber 1996). This method allows the analysis of present and past tree health condition, which is important in the context of strongly changing atmospheric pollutant deposition. The study area encompasses the Jelenia Góra Basin as well as slopes of surrounding mountain ranges: the Karkonosze Mts., the Izera Mts. and the Kaczawskie Mts.

The main goal of this study is to reveal that existing spatial differences in spruce growth dynamics are controlled in considerable extent by atmospheric pollutant deposition. Results of experiments indicate that such dependence really exists and the largest spatial variations of forest degradation stem from pollutant dry deposition as well as direct deposition of fog/cloud droplets called also ‘horizontal precipitation’. The spatial variations of precipitation related deposition have surprisingly little influence on the observed spruce growth dynamics.

RESULTS

The health status of the drilled trees in the Jelenia Góra basin is closely correlated with dry deposition of pollutants and spatial variability of acid fog existence, showing only slight growth reductions (<10\%) at slope reference sites (500-600 m as.l.), where fog deposition is negligible and dry deposition not very intense. In such places, width of annual increments of spruce trees is related mainly to a given tree age rather than to past pollutant deposition level. At the bottom of the Jelenia Góra Basin (400 m a.s.l.) the reduction of annual growth in 1980s is as high as 30\%, if compared to the 1950s rate. It is due to exposure to highly polluted air from local industry and densely populated residential areas as well as clearly higher number of days with acid fog than at slope locations. Fog at such sites, typically of radiative origin, is formed at night within a thermal inversion layer, but dissipates during the day as a rule. Concluding, dendrochronological methods appear to be decisive for testing the hypothetical role of fog deposition for the health status of montane Norway spruce stands.

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Schweingruber 1996, Tree Rings and Environment. Dendroecology, Paul Haupt. AG, Bern, pp. 609
Quantitative assessment of PM$_{2.5}$ sources and their seasonal variation in Krakow

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KEY WORDS: Particulate Matter; Energy Dispersive X-ray Analysis; Ion Chromatography, Positive Matrix Factorization

In industry areas of Poland such as Silesia or urban sites like Krakow and some other cities the levels of pollutants frequently breach air quality standards. Particulate matter (PM) is the most important constituent of atmospheric pollution. Beginning on 1st February 2014 until 31st January 2015, the samples of fine particulate matter PM$_{2.5}$ (aerodynamic diameter of particles less than or equal to 2.5 µm) were collected at a site in the South Eastern Krakow urban background area. During this period 194 samples were taken. The samples showed daily variation of PM$_{2.5}$ concentration. From these data, monthly variations were estimated and presented in this paper. Monthly integrated data are more representative for the Krakow urban background and show seasonal variation of PM$_{2.5}$ pollution. The lowest monthly concentration value was found for August 2014 – about 10 µg m$^{-3}$, the highest for February 2014 – 70 µg m$^{-3}$, whereas the average annual value was about 31 µg m$^{-3}$. Utilizing X-ray fluorescence method, concentrations of fifteen elements for each sample were determined and eight inorganic ions were analysed by ion chromatography. Additionally, the samples were analysed for Black Carbon (BC).

Receptor model PMF (Positive Matrix Factorization) was used for source identification and apportionment. The modelling identified six sources and their quantitative contributions to PM$_{2.5}$ total mass. The following sources were identified: combustion, secondary nitrate and sulphate, biomass burning, industry or/and soil and traffic. Finally, monthly variations of each source are presented.
Evaluation of ecosystem–atmosphere interactions in terms of CO₂, N₂O and CH₄ emissions in urban grasslands

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KEY WORDS: urban ecosystem; GHG flux, chamber technique, isotope composition

A number of studies has shown that grasslands can be as a source or sink of greenhouse gases (GHGs) (Xu and Baldocchi, 2004; Holst et al. 2008). However, there are important differences between experimental data set for carbon budgets over natural, agricultural and various urban locations (e.g. grasslands, sequestration lands, industrial areas). In comparison to the natural, urban ecosystems have more complex GHG sources configuration because they depend on multiple human-induced factors. Nevertheless, gas fluxes from anthropogenic ecosystems are also the major component of GHG emissions contributing to the global C-distribution (Lal and Augustin 2011).

The current work represents the short-term measurements of GHG (CO₂, CH₄, N₂O) exchanges between ecosystem and the atmosphere. The ecosystem (including cover vegetation + soil) and soil (rhizosphere respiration including root respiration (after plant shoot removal), microbial and organic matter decomposition) fluxes from grassland and respective δ¹³C of respired CO₂ at natural abundance were simultaneously measured. The static chamber system (combination of transparent and opaque mode) on 8 different dates in grassland within two weeks during April 2017 at the urban area (city botanical garden in the north-eastern part of the city of Gottingen, Germany) was applied. The soil chemical composition and moisture content as well as ambient air temperature and air humidity, wind speed and direction were assessed during the experiment. The gas samples were analyzed in the laboratory by the gas chromatography and the CDRS Picarro laser spectroscopy.

Our study results demonstrate that non-significant difference of hourly average CO₂, CH₄ and N₂O fluxes was observed between 8 treatments. The values of CO₂ fluxes obtained with both transparent and opaque chambers differ significantly due to the combined effects of the incoming photosynthetically active radiation (PAR) and temperature on gas emissions. The average cumulated value of measured CO₂ flux with opaque chambers was 586.05 ± 92.9 (mg m⁻² h⁻¹) vs. 89.57 ± 31.34 (mg m⁻² h⁻¹) with transparent chambers for the experimental plot. Current magnitude provides the pattern of the ecosystem sink activity during ambient light conditions. Finally, our study explores the coupling between photosynthesis and respiration processes and indicates the potential to C storage in soils and vegetation in urban grasslands.

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Weryfikacja urządzeń grzewczych w zakresie emisji zanieczyszczeń do powietrza - autorskie certyfikaty i znaki budynków „PreQurs”

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KEY WORDS: emisja zanieczyszczeń do powietrza, ocean budynków, certyfikaty PreQurs, znaki budynków

WPROWADZENIE

W celu ułatwienia komunikacji między ludźmi w Instytucie Certyfikacji Emisji Budynków (ICEB) opracowano prostą metodę oceny budynku oraz źródła ciepła pracującego na jego potrzeby. Jest to prosty i łatwy do interpretacji system opracowanych klas oraz oznakowania budynków. System ten umożliwia łatwą ocenę i wzajemne porównywanie budynków w zakresie emisji zanieczyszczeń do powietrza. Dokumentami potwierdzającymi jakość budynku są certyfikaty oraz znaki jakości PreQurs.

PODSTAWY Certyfikacji

Prostota tych certyfikatów polega na tym, że budynek oceniany pod względem niskiej i ogólnej emisji umownie „przykrywa się kloszem” i określa się masę zanieczyszczeń, która zostanie wytworona w ciągu roku przy produkcji ciepła na potrzeby ogrzewania oraz przygotowania ciepłej wody użytkowej. Wynik otrzymany w rocznym bilansie budynku porównuje się do masy zanieczyszczeń jaka została wytworzona przez budynek referencyjny (znajdujący się również pod kloszem) wyposażony w kotłownię węglową lub olejową (Fig. 1).

Fig. 1. Budynki oceniane pod względem niskiej emisji w odniesieniu do budynku referencyjnego wyposażonego w kotłownię węglową

Na tej podstawie oceniany jest budynek i jego źródło energii elektrycznej lub energii elektrycznej i ciepła, tj. ile procent (stopień redukcji S) lub ile razy (krotność redukcji K) mniej lub więcej wyemitował on zanieczyszczeń do powietrza w ciągu roku w porównaniu do budynku referencyjnego. Jeden z certyfikatów dotyczy niskiej emisji, w którym oceniana jest całkowita emisja pyłów zawieszonych (TSP) oraz benzo(a)pirenu (B(a)P). Oceniana jest także emisja dwutlenku węgla (CO₂), który nie jest niebezpieczny, ale stanowi gaz cieplarniany. Drugi z certyfikatów, dotyczący ogólnej emisji, zawiera ocenę całkowitej emisji pyłu zawieszonego (TSP) i benzo(a)pirenu (B(a)P) Dodatkowo oceniana jest także emisja dwutlenku węgla (CO₂), dwutlenku siarki (SO₂), tlenków azotu (NOₓ) oraz tlenku węgla (CO). Certyfikaty PreQurs występują zatem parami. Na tej podstawie przyznaje się klasy i znaki jakości budynków ze względu na emisję zanieczyszczeń do powietrza.
Rozpatrzmy budynek wielorodzinny zasilany z kotłowni węglowej, który w ramach termomodernizacji zostanie przyłączony do ciepła systemowego.

**OCENA BUDYNKU W ZAKRESIE NISKIEJ EMISJI ZANIECZYSZCZEŃ DO POWIETRZA**

W przypadki oceny niskiej emisji zanieczyszczeń do powietrza (patrz przykład budynku zasilanego z sieci ciepłowniczej fig. 1.) wyznaczenie krotności \( K_{nj} \) zanieczyszczeń dowolnej substancji szkodliwej „\( j \)” emitowanej do powietrza obliczane jest według poniższej zależności:

\[
K_{nj} = x \cdot \left( \frac{m_{2j}}{m_{3j}} \right)^x
\]

gdzie:

- \( m_{2j} \) – masa zanieczyszczenia „\( j \)” wyemitowana przez referencyjny budynek z kotłowni węglowej (w analizowanym budynku emisja pyłu zawieszonego TSP wynosi \( m_{2TSP} = 58,87 \text{ kg/rok} \)),
- \( m_{3j} \) – masa zanieczyszczenia „\( j \)” wyemitowana przez ciepłownię na potrzeby ocenianego budynku z uwzględnieniem sprawności przesyłania ciepła (w analizowanym budynku po przyłączeniu do ciepła systemowego jego emisja pośrednia pyłu zawieszonego wynosi \( m_{3TSP} = 5,08 \text{ kg/rok} \)),
- \( x \) – współczynnik regulujący; \( x = 1 \) gdy \( m_{2j} > m_{3j} \) oraz \( x = -1 \) gdy \( m_{2j} < m_{3j} \) (przy tym budynku \( x = 1 \)).

Zależność ta obowiązuje, gdy wysokość komina ciepłowni od poziomu gruntu \( h \) jest niższa od tzw. wysokości granicznej \( h_{gr} \). W przypadku gdy wysokość komina \( h \) jest równa lub wyższa od wysokości granicznej \( h_{gr} \) przyjmuje się krotność redukcji \( K_{nj} > 1000 \) i na tej podstawie przyznaje się klasę redukcji „NO SMOG”. Wysokość graniczną w tym przypadku przyjęto na poziomie \( h_{gr} = 35 \text{ m} \).

W przypadku danych jak wyższych krotność redukcji niskiej emisji pyłu TSP wyniesie:

\[
K_{nj} = 1 \cdot \left( \frac{58,87}{5,08} \right)^{1} = 11,59
\]

W sytuacji gdyby wysokość komina wynosiła \( h < 35 \text{ m} \) przyznano by klasę redukcji niskiej emisji typu B – na podstawie klasyfikacji wyszególnionej w tabeli nr 1, co jest równoznaczne z przyznanym znaku „LOW SMOG” na szarym polu (tabela 1). W przypadku gdy wysokość komina \( h \) jest równa lub wyższa od wysokości granicznej \( h_{gr} \) przyjmuje się klasę redukcji „NO” tj. “NO EMISSION” (Fig. 2) i w zależności od udziału bezemisyjnej energii OZE przyznano by zgodnie z klasyfikacją wyszególnioną w tabeli nr 1 odpowiednią klasę redukcji „A” lub wyższej.

**OCENA BUDYNKU W ZAKRESIE OGÓLNIEJ EMISJI ZANIECZYSZCZEŃ DO POWIETRZA**

W przypadki oceny redukcji ogólnej emisji zanieczyszczeń do powietrza (patrz przykład budynku zasilanego z sieci ciepłowniczej fig. 1.) wyznaczenie krotności \( K_{oj} \) zanieczyszczeń dowolnej substancji szkodliwej „\( j \)” do powietrza obliczane jest według poniższej zależności:

\[
K_{oj} = x \cdot \left( \frac{m_{2j} + m_{5j}}{m_{3j} + m_{4j}} \right)^x
\]

gdzie dodatkowo:

- \( m_{5j} \) – masa zanieczyszczenia „\( j \)” wyemitowana przez krajowy system energetyczny na wytworzenie energii elektrycznej niezbędnej do pracy kotłowni węglowej w budynku referencyjnym \( m_{5TSP} = 0,073 \text{ kg/rok} \)),
- \( m_{4j} \) – masa zanieczyszczenia „\( j \)” wyemitowana przez krajowy system energetyczny na wytworzenie energii elektrycznej niezbędnej do pracy ciepłowni na potrzeby ocenianego budynku z uwzględnieniem transportu ciepła \( m_{4TSP} = 0,047 \text{ kg/rok} \)).

Po podstawieniu danych krótłość ogólnej redukcji pyłu TSP do powietrza w przypadku analizowanego budynku wyniesie:

\[
K_{oj} = 1 \cdot \left( \frac{58,87 + 0,073}{5,08 + 0,047} \right)^1 = 11,50
\]
Na tej podstawie przyznaje się w przypadku pyłu zawieszonego TSP (zgodnie z tabelą nr 1) klasę redukcji ogólnej emisji typu B. Na certyfikacie poświadczającym jakość budynku ze względu na ogólną emisję umieszcza się również uzyskany znak budynku ze względu na redukcję niskiej emisji zanieczyszczeń do powietrza.

Tabela 1. Wyszczególnienie krotności i stopni redukcji oraz klas znaków niskiej emisji ocenianego budynku oraz nazewnictwa w porównaniu z budynkiem referencyjnym wyposażonym w kotłownię olejową

<table>
<thead>
<tr>
<th>Klasy redukcji emisji budynku</th>
<th>Znaki redukcji niskiej emisji budynku</th>
<th>Stopień redukcji $S_j$ [%]</th>
<th>Zakres krotności redukcji $K_j$</th>
<th>Nazwa redukcji</th>
</tr>
</thead>
<tbody>
<tr>
<td>A***</td>
<td>NO SMOG</td>
<td>99 plus 81 &lt; $S_j$</td>
<td>100 plus 81 &lt; $K_j$</td>
<td>Zupełna A3 plus</td>
</tr>
<tr>
<td>A**</td>
<td>NO SMOG</td>
<td>99 plus 50 &lt; $S_j$ ≤ 99 plus 81</td>
<td>100 plus 50 &lt; $K_j$ ≤ 100 plus 81</td>
<td>Zupełna A2 plus</td>
</tr>
<tr>
<td>A*</td>
<td>NO SMOG</td>
<td>99 plus 19 &lt; $S_j$ ≤ 99 plus 50</td>
<td>100 plus 19 &lt; $K_j$ ≤ 100 plus 50</td>
<td>Zupełna A1 plus</td>
</tr>
<tr>
<td>A</td>
<td>NO SMOG</td>
<td>99 &lt; $S_j$ ≤ 99 plus 19</td>
<td>100 &lt; $K_j$ ≤ 100 plus 19</td>
<td>Zupełna</td>
</tr>
<tr>
<td>B</td>
<td>LOW SMOG</td>
<td>96 &lt; $S_j$ ≤ 99</td>
<td>25 &lt; $K_j$ ≤ 100</td>
<td>Celkowita</td>
</tr>
<tr>
<td>C</td>
<td>LOW SMOG</td>
<td>90 &lt; $S_j$ ≤ 96</td>
<td>10 &lt; $K_j$ ≤ 25</td>
<td>Bardzo wysoka</td>
</tr>
<tr>
<td>D</td>
<td>LOW SMOG</td>
<td>81 &lt; $S_j$ ≤ 90</td>
<td>5,26 &lt; $K_j$ ≤ 10</td>
<td>Wysoka</td>
</tr>
<tr>
<td>E</td>
<td>MED SMOG</td>
<td>65 &lt; $S_j$ ≤ 81</td>
<td>2,86 &lt; $K_j$ ≤ 5,26</td>
<td>Średnia</td>
</tr>
<tr>
<td>F</td>
<td>MED SMOG</td>
<td>40 &lt; $S_j$ ≤ 65</td>
<td>1,67 &lt; $K_j$ ≤ 2,86</td>
<td>Niska</td>
</tr>
<tr>
<td>G</td>
<td>HIGH SMOG</td>
<td>0 &lt; $S_j$ ≤ 40</td>
<td>1,00 &lt; $K_j$ ≤ 1,67</td>
<td>Bardzo niska</td>
</tr>
<tr>
<td>H</td>
<td>ECO</td>
<td>$S_j$ = 0</td>
<td>$K_j$ = 1,00</td>
<td>Bud. referencyjny</td>
</tr>
</tbody>
</table>

W oparciu o analogiczne obliczenia jak wyżej wyznaczono krotności redukcji pozostałych zanieczyszczeń oraz wydano certyfikaty PreQurs w zakresie niskiej i ogólnej emisji budynku do powietrza jak niżej (Fig. 2). Na certyfikacie ogólnej emisji uwidoczniony jest także znak „NO SMOG” uzyskany przez budynek w zakresie oceny niskiej emisji.
Instytucją uprawnioną do certyfikacji budynków jest nowo powstały Instytut Emisji Zanieczyszczeń Budynków – „ICEB” z siedzibą w Krakowie. Przyjęta klasyfikacja stopnia redukcji i krotności redukcji zanieczyszczeń do powietrza jest pomysłem autorskim i z tego powodu jest zastrzeżona. Świadectwa sporządzane na podstawie przyjętej klasyfikacji (lub podobnej) mogą być wydawane wyłącznie w porozumieniu z Instytutem Certyfikacji Emisji Budynków (ICEB) w Krakowie.

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ViaZone – Mobilny System Zarządzania Ruchem

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KEY WORDS: harmonizacja ruchu drogowego, ITS – inteligentne systemy transportowe.

Przebudowa i modernizacja dróg jest we wszystkich krajach skomplikowanym procesem. W miejscach, w których istnieją czasowe ograniczenia ze względu na rekonstrukcje dróg lub ich modernizacje, ważne są aspekty dotyczące bezpieczeństwa i płynności ruchu. Jednym z narzędzi, eliminujących ograniczenia w ruchu i ich negatywne oddziaływania, w tym na środowisko (hałas, zanieczyszczenie powietrza, zużycie paliw), jest wykorzystanie mobilnych systemów telematycznych. W celu wyeliminowania wspomnianych zagrożeń zaprojektowany został mobilny system sterowania ruchem dla stref roboczych ViaZone, który harmonizuje na ich obszarze przepływ ruchu.

System rozpoznaje warunki sprzyjające powstawaniu zatorów i zmienia automatycznie np. znaki ograniczania prędkości dla nadjeżdżających do miejsca zwężenia aut, aby nie dopuścić do zatrzymania ruchu.

Kompletny system to zestaw narzędzi sprzętowych i programowych, które pozwalają wpływać na zachowania kierowców za pomocą drogowych znaków zmiennej treści VMS. Opracowane algorytmy, wyświetlaną w czasie rzeczywistym piktogramy i komunikaty na drogowych znakach VMS, na podstawie przetworzonych danych wejśćowych z różnych detektorów, które są zainstalowane w kilku predefiniowanych strefach na danym obszarze drogi. Oprogramowanie do analizy danych i zdalnego sterowania systemem, pozwala na jego działanie w trybie automatycznym.

Kluczową sprawą w systemie jest osiągnięcie najwyższej możliwej dokładności określenia struktury ruch drogowego przy wykorzystaniu bezinwazyjnych technologii pomiarowych. Warstwa oprogramowania jest reprezentowana przede wszystkim przez unikalnie opracowany system, który jest połączeniem bazy danych i GUI. W trybie automatycznym, serwer współpracuje z algorytmami predefiniowanych odpowiedzi na zmiany zachowań ruchu, zmieniając treści na panelach LED tablic VMS.
Mobile measurements of particulate matter spatial distribution in Małopolska and Silesia regions

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KEY WORDS: particulate matter, mobile measurements, air quality, PM\textsubscript{10}

In Southern Poland, where the air pollution is a common problem, there is a dire need to evaluate the sources of air polluting dust particles in wide range of spatial and temporal regimes. In order to optimise the governmental spending aimed at remediying the problem, the capabilities of the national air quality monitoring network may be expanded by independent research. This study presents an example of such research, performed with a custom-made particulate matter monitoring device based on a commercially available analyser, which allows to perform mobile dust pollution measurements with precise positioning.

During the period of 2015-2017, a series of night-time mobile transects were performed in Silesia and Małopolska, in which several cities are registering the highest daily levels of PM\textsubscript{10} concentrations in European Union (EEA 2016). Here we to present the results obtained during these campaigns, together with the analysis of meteorological conditions prevailing during the days of measurements. The analyses performed based on the obtained data have allowed to identify previously unknown emission hot-spots in the study area together with an estimation of spatial distribution of particulate matter during the high-pollution events. An example is presented in Fig. 1., where extremely high PM\textsubscript{10} concentrations were observed on March 16\textsuperscript{th} in Skala and Liszki towns. These high values were probably caused by strong emissions from local coal and wood stoves, used for residential heating.

First steps towards an independent estimation of the PM\textsubscript{10} emissions in the study area have been taken, by means of comparison between the observed PM\textsubscript{10} levels and predictions from a modelling system based on a modified FAPPS framework (see FAPPS 2017, and references therein), run in the diagnostic mode and driven by meteorological data from combined IMiGW, AGH, UJ and TRAX observation networks.

Acknowledgments
We hereby acknowledge provision of the data from National Air Quality Monitoring Network by Voivodeship Inspectorates for Environmental Protection. We thank Krakow Smog Alert for financial support and providing measurement equipment. Partial support of statutory funds of AGH University of Science and Technology (project no. 11.11.220.01) is kindly acknowledged.
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Pragmatics of mobile particulate matter measurements in urban and mountain areas – experiences from LIFE-APIS/PL project

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KEY WORDS: particulate matter, mobile measurements, PM spatial distribution

Particulate matter concentration is strongly varied in space, depending on many factors such as landform and relief, emission, land use and current weather conditions. Efficient modeling of PM spatial distribution in high resolution requires detailed studies on meteorological conditions of PM dispersion in complex areas, such as mountain valleys or city centers. This paper presents the results of a research on the methodology of mobile measurements of air pollutant concentrations and further processing of such obtained data. The developed methodology allows the identification of factors determining the distribution of pollutants in mountain areas and cities.

The measurements were based on a mobile measurement station equipped with a mobile particulate matter meters type DustTrak DRX, measuring the concentration of different fractions of PM with high time resolution (1s). In addition, reference measurements of PM concentrations and meteorological parameters (air temperature, air humidity, wind speed, wind direction, atmospheric pressure P and solar radiation) were held, either at the Meteorological Observatory of University of Wrocław or in a site representative for the study area. All measurements were completed by the information of the vertical structure of atmosphere in a profile up to 350 m, obtained from SODAR sounding.

Mobile station measurements were made while driving at a fixed speed (10-30 km/h), depending on type of the area: faster in undeveloped, flat areas, slower in mountain valleys and city centers. The length of the measurement transects varied from 20-150 km. GPS recording (precise locator Garmin GPSMap 64 saves station position every 1 s). As far as possible, the measurements were made early in the morning or in the afternoon and in the evening, in stable weather conditions. The dust meter intake is located outside the vehicle, at the height of approx. 2 a.g.l. The clocks of DustTrak and GPS were precisely aligned to get 100% location compatibility with measurement results. During the measuring
drive all characteristic moments (e.g. extremely high or extremely low concentrations of PM, effects of passing vehicles or construction work etc.) are recorded in the measurement chart. The planned route included the maximum possible area – i.e., all the streets of the settlement, village, etc. – so as to indicate a complete, objective picture of spatial distribution of concentrations - not only the problematic areas but also the directions of spread of pollutants.

So far, the measurements were made among others in the following locations of Lower Silesia: Wrocław and surroundings (i.e. Długołęka, Żórawina), Trzebnica, Dzierżoniów, Nowa Ruda, Bystrzyca Kl., Karpacz, Jelenia Gora, Kowary, Leśna, Oleśnica, Strzelin and Jawor. The results of the measurements bring thousands of numbers informing about spatial distribution of PM concentrations along the measurement route. With the measurement frequency of 1 second and assumed speed of 10 km/h we obtain results with a 2.7 m spatial resolution. For such precise data to be legible and easy to interpret, it should be aggregated and visualized. Thus maps were drawn (Fig. 1) with points representing the average or maximum concentration of PM in a particular neighborhood. This gives an information on background concentration and maximum exposure on dust pollution in the given area, set according to the land use and land relief of the transect. Usually the resolution of the points was set between 50 and 500 m.

Acknowledgments
The research was a part of the project “Air Pollution and biometeorological forecast and Information System” (LIFE-APIS/PL) co-financed by European Union, under the Financial Instrument LIFE+ and The National Fund for Environmental Protection and Water of Management.
Using low-cost PM monitors to detect local changes of air quality

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KEY WORDS: low-cost PM monitors, air quality, sensor networks

Air pollutions have a negative impact on human health. Some substances are particularly harmful and poisonous to humans. Examples of such substances are nitrogen dioxide, sulfur dioxide and particulate matter. Particulate matter can cause many respiratory diseases, including lung cancer even. Studies demonstrate compound exposure to dust from the increase in mortality of individuals suffering from pneumonia and cardiovascular problems.

To care for air in Poland and in the world, its quality is monitored. Thus, it is possible to develop of appropriate plans of improvement air quality in certain areas. Unfortunately, the number of stationary equipment in large cities is usually insufficient. For example, in Warsaw under the State Environmental Monitoring, information on the concentrations of pollutants in the air provide only 8 automatic stations and 3 manual stations, of which only 5 stations belong to the Mazovia Voivodeship Inspectorate for Environmental Protection.

It is presented the concept of using low-cost PM measuring devices to increase the spatiotemporal resolution of air quality measurements supplementing the network of reference devices. On the example of Nowy Sącz, it is shown the use of such devices for the detection of urban areas with locally increased values of pollutants originating from low level emission.

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Comparison of measurement properties of different optical dust sensors

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KEY WORDS: particulate matter, workplaces, monitoring

The term particulate matter (PM) covers a wide range of complex mixtures of organic and inorganic substances suspended in the air (Krzyzanowski 1999). Nowadays PM is considered as one of the most important indoor air pollutants. Particulates present in indoor air are associated with adverse health effects such as sensory irritation, allergy, wide range of respiratory and cardiovascular effects (Bernstein et al. 2008; Mølhave 2003).

The exposure to PM could be a potential health threat especially for workers at industrial workplaces (Elihn et al. 2011). In such environments exposure to PM is often high and particles size distribution could be varied over a wide range. Furthermore PM concentrations can vary widely in time (Glytsos et al. 2014). Particle measurements are therefore required for health risk assessment, decision-making and for appropriate ventilation system design and operation. Real time data acquisition systems are essential for such tasks.

Currently, several types of equipment, employing different technologies and in various price ranges, could be used for PM monitoring (Amaral et al. 2015). Small and cost effective solutions are especially needed in case of multipoint monitoring systems. There are necessary for reliable air quality evaluation in large indoor space like production halls.

The article presents comparison of signals obtained from different light-scattering instruments. TSI’s photometer, Alphasense’s optical particle counters and low-cost dust sensors were used for PM measurements in wood processing workplace. The paper discuss differences in data collected from those devices.

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Krzyzanowski, 1999, Particulate matter (PM₁₀ and PM₂,₅), In: Monitoring ambient air quality for health impact assessment, WHO regional publications, European series, No. 85, pp. 99-107
With the development of new technologies there are observed increasing environmental pollutions. One of many environment elements is atmosphere. The average person gets each day from 12 to 15 m$^3$ of ambient air. The health and life if the whole society depends in the purity of this component. Fine particulate matter pollutions can penetrate deep into alveoli causing diseases. The main sources of particulate matter are low-emissions, industrial emissions and urban traffic. Among diseases induced by exposure to air pollutants are for example allergies, respiratory system problems including asthma, problems with immunodeficiency and cancer (Burns 2014). These diseases are found not only in risk groups of society (elderly and children) but also in potentially healthy part of the population (Lim 2014). This is why concentrations of ambient air pollutions in many countries are constantly monitored and restricted by law.

In Polish legislation a document that sets acceptable particulate matter concentrations is Directive 2008/500/EC of the European Parliament and of the Council of 21 May 2008 on ambient air quality and cleaner air for Europe. This Directive defines acceptable levels for PM10 on 50 µg$\cdot$m$^{-3}$ daily and 40 µg$\cdot$m$^{-3}$ yearly and for PM2.5 on 25 µg$\cdot$m$^{-3}$ yearly.

Currently standard air quality testing methods as seen above include only measurements of dust concentration. Pollution assessment is also examined by determining the concentration of polycyclic aromatic hydrocarbons listed in the U.S. EPA list and comparing their values to legal limit values. This approach to research particulate air pollution is not appropriate because it allows only evaluate momentary assessment of the state atmospheric environment. Leading chemical analyzes do not allow to predictions of the effects of the effects adsorbed particles that are adsorbed on the particular fractions of contaminated particles in living organisms permanently exposed to them. So far, no type of research has been used as a standard for understanding the effects of pollutants adsorbed particles on lives organisms (Piekarska 2010).

Pollutants adsorbed on the surface of particulate matter have cytotoxicity and genotoxicity effects. One of the method to check mutagenicity properties of environmental samples is Salmonella test, known also as Ames test. This test examines if the sample causing reversion of mutation in Salmonella typhimurium test strain (Belcik 2014). The same principle is used in Ames II test. The difference to the classical test are types of test strain used and form of research, which is based on a microplates. Other test to asses genotoxicity is SOS-chromotest. SOS-chromotest uses the process of DNA repair of Escherichia coli K12 PQ37. Measurement consists in checking the expression of genes in the SOS system and β-galactose activity (Piekarska 2008). One of the most interesting methods to asses genotoxicity properties is comet assay. This tests uses electrophoresis to extract DNA from damaged cell. More extracted DNA means higher genotoxicity of sample (Collins 2015).

There are also many methods to check the cytotoxicity of particulate matter of ambient air pollutions. Most of them are based on the method direct contact of sample with monolayer cell culture. Cytotoxicity tests can examine destruction of cell but some of them measure other effects of toxicity (Piekarska, Zaciera 2011). Toxicity test can evaluate the integrity of cell membrane (LDH test), assess mitochondrial activity (XTT, MTT tests), evaluate lysosomal activity (NR test) or check total protein content (SRB test).

The Faculty of Environmental Engineering of Wroclaw University of Science and Technology conducts research aimed at comparing methods of biomonitoring genotoxic and cytotoxic effects of particulate matter on the human body. For this purpose there are performed Salmonella assay and Ames II test to assess mutagenicity properties, SOS-chromotest and comet assay to asses genotoxicity and battery of cytotoxicity tests PAN-I to assess toxicity effect of particulate matter on living organisms.
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Emission and an energetic mix in polish realities in relation to the Paris Agreement

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KEY WORDS: energetics, coal, emission

The Paris Agreement ratified by Poland came into force in 2016. The Agreement has a well-defined goal – reduction of the increase of the temperature on earth by development of a low-emission economy. This is a big challenge for polish energetics predominantly based on combustion of hard and brown coal, which is a main source of pollutants emitted to the atmosphere.

This article focuses on the possibility of choosing of an energy mix of coal, oil, gas, nuclear energetics and renewable energy sources (OZE) changing gradually in time, would allow Poland to meet the requirements of the Paris Agreement on climate change. Reducing greenhouse gas emissions (e.g. CO₂ - carbon dioxide) is usually associated with the reduction of other air pollutants. On the other hand, making efforts to implement a low-carbon economy development and the introduction of an energy supply mix can lead to improve the quality of life and reduce health risks.
Social and environmental awareness of exposure to air pollution

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KEY WORDS: awareness, air pollution, survey

INTRODUCTION

Poland is one of the countries with the highest concentrations of ambient air pollutants. This problem especially refers to particulate matter (PM₁₀ and PM₂.₅) and benzo [a] pyrene. The most important sources of pollutant emissions contributing to low air quality are the municipal and transport sectors. The annual report by the European Commission on the Cost-benefit Analysis of the Final Policy Scenarios for the EU Clean Air Package (Holland 2014) indicates that over 45,000 people die prematurely in Poland due to poor air quality (this is over 12% of annual sum of deaths in Poland, without taking into account external causes). Last year’s report by the European Environment Agency “Air Quality in Europe - 2016 report” (European Environment Agency 2016) indicates that this number is even higher and according to data for 2013 it reached 48,000 due to exposure to PM₂.₅. Total economic loss due to health effects caused by poor air quality is estimated at around 39-119 billion Euros per year.

METHODS AND MATERIALS

One of the important factors influencing the current situation is the lack of widespread social awareness of the causes and the effects of high levels of air pollution. Hence, this study was undertaken to make an initial assessment of the social perception of the problem. The study was carried out in Legionowo (city population: 55 000 residents) near Warsaw, characterized by the highest or one of the highest (depending on the year and type of pollution) concentrations of air pollutants in the Mazowieckie voivodeship. There are representations of two major sources of pollutants for Poland. One is a major road (DK 61) connecting Warsaw to the north-eastern part of the country. Secondly, an important part of the buildings (especially single-family houses) in Legionowo is not connected to the central heating network and uses individual solid-fuel fireplaces. The study was conducted in the form of an electronic questionnaire on a group of 287 people living in the analyzed town and its nearest surroundings. Attention was paid to the reasons that, in public opinion, affect the current bad air quality in Poland and the Legionowo. Also, there were questions about the air quality itself and the sources which contribute the most to pollutant emissions. Survey respondents were also asked about an important issue which are health effects caused by exposure to air pollution.

RESULTS AND SUMMARY

Conducted study on air quality awareness shows that, despite the high concentrations of air pollutants, which are recorded annually in Legionowo (one of the highest concentrations of PM₁₀ and PM₂.₅ and benzo [a] pyrene in Mazowieckie voivodeship), the awareness about the causes and effects of air pollution, and even on the actual scale of the problem of low air quality in Legionowo, is poor. Most residents consider air quality as good (41%) and even very good (6%). At the same time, more than 40% of respondents would consider changing their place of residence due to poor air quality (with a lower degree of education) and 33% would agree to pay additional fees (local tax) allocated to improving air quality. 26% of the respondents were concerned about air quality, and 47% were a little bit afraid. Only one fifth do not have any concerns about this issue. In summary, it is important to point out that, in general, the public awareness of air quality problems and their health effects is so small that it is necessary provide general education of the society.

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Smartphone application based study regarding inflammatory effects of air pollution.

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KEY WORDS: feedback, mobile application, communication, air pollution

INTRODUCTION
Information flow in medical research is usually unidirectional. Patients and members of the study groups do not usually benefit from participation in a study right away, as gathered data is usually published after a delay, as well as hard to access and understand for a layman. The rise of mobile technology allowed us to design an application-based study, which in addition to its main data gathering feature constantly informs the user about the current and future levels of air pollution, his reported health state, and alarming symptoms.

METHODS
AirPoll is a mobile application that serves as a gateway to a nation-wide air pollution study based in United States. We designed it using Apple’s Research Kit - an open source software framework for medical researchers. After all the permissions are granted and consent form is signed digitally, the application uses phone’s Global Positioning System to determine user’s location and then connects to the server of US Environmental Protection Agency to determine the level of various air pollutants. Those include: particulate matter with a mean aerodynamic diameter of 2.5 μm and 10μm, ozone, sulphur oxides and volatile organic compounds. Data provided by EPA with varying spatial resolution of 100-25 square kilometres per pixel, is updated daily and displayed for user after being averaged by application algorithm. The built in questionnaire module allows us to gather data related to user’s health, including past medical history, modified EORTC Quality of Life Module for Head and Neck Cancer and OSDI Dry Eye questionnaire. To raise user’s engagement in the study and provide an information feedback, every user has access to his or her data presented in an easy to understand manner. Both current pollutants in the user’s location and his approximate health state is displayed in a simple graph form.

CONCLUSION
This innovative approach to sharing information in medical research not only raises user’s involvement in the study, but also fulfils an educational purpose.
Geoportal “Nasze Powietrze”

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KEY WORDS: air pollution, Lower Silesia, WRF-Chem, geoportal

In October 2013 University of Wrocław’s Departament of Climatology and Atmosphere Protection with cooperation
with Voivodeship Inspectorate of Environmental Protection in Wrocław (WIOS) launched the LIFE-APIS/PL Project,
focused on creating a widely available and easy-to-use forecasting and information system on air quality and
biometeorological conditions for Lower Silesia. As a main component of the System, geoportal have been planned,
presenting in most accessible way information about spatial and temporal variability of the predicted parameters.
The other planned components were a mobile application as well as information light boards, both presenting
forecasts of selected parameters for the place of users location/board installation.

The system was operational in December 2016, when it was also published as “Nasze Powietrze” (“Our Air”;
http://powietrze.uni.wroc.pl). The System has been developed according to the Project team concept, by Wrocław Centre
for Networking and Supercomputing (WCSS), which also provides the computing and service infrastructure
necessary for the current work of the system. The entire system is based on the prognostic model WRF-Chem
(meteorological and air pollution forecast) and the pollutant emission base prepared by WIOS. Modeling results
are postprocessed and placed in a geospatial database, which provide information and data for each component of the
System. The forecasts are generated every 24 hours, and their time range covers 72h, with a 1h time resolution. They
are prepared for the whole Lower Silesia area, with spatial resolution of 4x4 km.

The Geoportal, which is the main, most elaborate component of the System, provides following set of forecasts:

- selected air pollutants forecasts (PM$_{10}$, PM$_{2.5}$, NOx, O$_3$, SO$_2$, NH$_3$, CO) and computed on their basis Polish Air
  Quality Index values;
- forecasts of meteorological background parameters (air temperature and relative humidity, wind direction and
  velocity, air pressure, sum of precipitation, solar irradiation)
- biometeorological forecasts, including wind chill temperature WCT, heat stress index HSI and universal thermal
  climate index UTCI.

Information about the spatial variability of abovementioned parameters is presented in the form of maps covering the area of
Lower Silesia (maps are available for each forecast hour). In addition, the graphs presenting variability of selected parameters
are also available for each location which may be selected within the region. Prognostic information is completed by a knowledge
base that provides useful supplementary information about all the parameters presented.

Based on the conducted tests and the experience of the 5-month period of public exploitation of the system – the Geoportal in
particular – we may point that its strengths include relatively good and constantly improving forecasts, the wide range of
presented information, high temporal and spatial resolution and relatively long range of forecasts (72h, 48h were planned). As an
area requiring further work, improvement of the spatial resolution of the Geoportal should be pointed. Experience shows
that the adopted resolution of 4x4 km is acceptable in the lowland areas of the region, but in areas with complex
terrain, the adopted spatial resolution should be higher.

Finally, it should be noted that the early recognition of air quality as a social problem has allowed the LIFE-APIS/PL team to respond almost immediately to the increase in social demand for detailed and actual air quality information which have been observed over the last two years. The need for such information and usefulness of the solutions implemented within the Project is reflected, among others, by visitor statistics of the Geoportal “Nasze Powietrze”, where one may observe clear dependency between the number of users during and occurrence of periods of deteriorated aero-sanitary conditions (Fig. 1).

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Part II
Poster presentations
Variability of particulate matter concentration (PM$_{10}$, PM$_{2.5}$) in mountainous region: a case study from Tatra Mountains

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KEY WORDS: PM$_{2.5}$, PM$_{10}$, particulate matter, air quality, background station, Kasprowy Wierch

In 2015 the PM measurements was launched at Kasprowy Wierch in Tatra Mountains by Environmental Physics Group at the AGH University of Science and Technology. Results were compared to similar measurements provided by the Voivodeship Inspectorate for Environmental Protection Agency in Zakopane City, located in the valley at the base of Tatra Mountains.

Kasprowy Wierch is a high-altitude meteorological station in north-western High Tatra mountain ridge (1989 m a.s.l.), named after the peak on which the laboratory building is located. As the station is situated in the convergence area of three large valleys. The nearest town is Zakopane located 6km to the north and about one kilometer below Kasprowy Wierch. This is the most famous mountain holiday resort in Poland. Therefore the number of people residing in the Podhale region increases even several times during the summer and winter holidays. In Zakopane and surrounding villages dominates low housing construction, and homes in the vast majority are still heated by coal or wood stoves. Therefore, relatively large anthropogenic emissions of particulate matter occurs in this region, especially during the winter months.

DustTrak™ II Aerosol Monitor 8530 was used to measure size fraction of particulate matter using light-scattering laser photometry technique. Monitor was installed at Kasprowy Wierch station in June 2015 and operated until May 2016 (Fig. 1.). It is first available record of particulate matter concentration measurements in the air of Polish Carpathians Mountains.

![Fig. 1. Simultaneous measurement of PM at Kasprowy Wierch (in red and orange) and in Zakopane city (in black). Individual points indicate hourly means. Grey area indicates the prevalence period of continuous snow cover at Kasprowy Wierch.](image)

During the measurement period the highest PM concentration at Kasprowy Wierch was c.a. 30 µg/m$^3$, while in Zakopane City it exceeded 400 µg/m$^3$ (Fig. 1.). Relatively frequent temperature inversions and poor ventilation,
observed inside this valley, can induce accumulation of particulate matter originating from the so-called low emission in the lower part of troposphere.

Acknowledgments
We hereby acknowledge provision of the data from National Air Quality Monitoring Network by Voivodeship Inspectorates for Environmental Protection. We thank Krakow Smog Alert for financial support and providing measurement equipment. Partial support of statutory funds of AGH University of Science and Technology (project no. 11.11.220.01) is kindly acknowledged.
Spatial and seasonal variability in the mobility of the selected elements bounded to the submicron PM$_1$ particles

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KEY WORDS: submicron particles, PM$_1$, elements, metals, mobility, water-solubility, single-stage extraction

The study describes the occurrence of 18 elements in water-soluble (mobile) fraction of submicron atmospheric particles (PM$_1$). The scope of this work include: sample collection performed simultaneously at two urban sites in Poland (Zabrze and Warsaw cities) during the four-month measurement campaign (summer 2014 and winter 2014/2015); the designation of the elemental composition of the PM$_1$ samples after their acid digestion, the determination of the PM$_1$ elemental composition (the other half of each 24-h PM$_1$ filter) and the calculation of the share of water-soluble form of each element in its total mass, all summarized by the proper statistical analysis.

The average concentrations of PM$_1$-bound elements were much differentiated concerning both spatial and seasonal dependencies. A statistically significant differences were found in case of V, Zn, As, Cd, Pb, Cr, Mo, Al and Ti in Zabrze and in the case of V, Mn, Co, Ni, Zn, As, Rb, Sr, Cd, Pb, Ga, Mo and Ti in Warsaw (U Mann Whitney test, p<0.05) when comparing their 24-h concentrations in summer and winter.

The average concentrations of the PM$_1$-bound elements, concerning both their total and water-soluble forms differed significantly between the sampling sites. The mobility of the elements expressed as a percentage of water-soluble species in their total mass ranged from several percent (e.g. V, Ga, Mo) to even 90% (e.g. Zn, Pb and Cd). Generally for most elements the estimated water-solubility was higher in winter than in the summer.

A huge variations in the mobility of PM$_1$-bound elements between seasons and locations corresponds well with the differences in their origin. Winter period was characterized by a higher mobility of elements, due to their co-occurrence with easily soluble salts (chlorides, sulfates, nitrates) – formatted as an acid aerosols from gaseous precursors emitted from the energy sector, household stoves, etc.
The comprehensive estimation of carbonaceous pollution sources in PM$_{10}$ of Lower Silesia

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KEY WORDS: PM$_{10}$, carbonaceous pollution origin, OC/EC ratio,

The PM$_{10}$ samples were gathered in 2011 in Lower Silesia in eight points (five urban background, one industrial and two regional background) by employees of Voivodeship Inspectorate for Environmental Protection (Wroclaw VIEP). The main objective of our study was to identify potential sources of PM$_{10}$, as well as to estimate the human pressure impact on the amount of carbon in the PM$_{10}$ pollution. The sampling point characteristics allowed to define PM$_{10}$ mass concentration reaching values up to even three times higher (157, 152 or 115 µg·m$^{-3}$ at the urban background points) than CAFÉ Directive limit value (50 µg·m$^{-3}$). In order to give an answer what was the carbon origin in PM$_{10}$, the organic and elemental carbon (OC and EC) concentration as well as their ratios were analyzed.

The average annual values of measuring components were noted as follow:

(i) for urban background points: OC concentration 11.93 µg·m$^{-3}$ and EC concentration 1.95 µg·m$^{-3}$

(ii) for industrial point: OC concentration 6.91 µg·m$^{-3}$ and EC concentration 0.96 µg·m$^{-3}$

(iii) for regional background points: OC concentration 6.42 µg·m$^{-3}$ and EC concentration 0.84 µg·m$^{-3}$.

The comprehensive analyses let us to identify, that the carbon pollutants in PM$_{10}$ originated from various sources (solid and liquid fossil fuels combustion, biomass burning and less bio aerosols or biogenic fragments). Moreover, the spatio-temporal distribution of primary and secondary OC in PM$_{10}$ indicates on the individual pollutants character in all sampling points of Lower Silesia. Hence, it is important to avoid a generalized approach to preventing air pollution.

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Relations between atmospheric dust composition and meteorological conditions: a case study from Sosnowiec (Poland)

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KEY WORDS: atmospheric dust, phase composition, meteorological conditions, sources of pollution

INTRODUCTION

Sosnowiec is a city in the Upper Silesia Industrial Region (USIR), S Poland – one of the largest industrial and urban centers in Europe, in which 341 industrial emitters produce 38.5 Mg of dust annually (CCSO 2014). In USIR, 95 % of PM₁₀ is derived from anthropogenic sources, including residential land use, domestic low emission, municipal and service sectors (47%), power stations, steelworks, coke plants etc. (40%), and traffic (8%). Only 5 % of PM₁₀ originates from natural sources (RIEP 2014). Meteorological conditions and atmospheric circulations play an important role in dispersion of air pollutants (Niedzwiedz 2005). The aim of this study was to determine concentrations and phase composition of PM₁₀ in Sosnowiec, in relation to meteorological conditions and air mass circulation. Particular attention was paid to the smog episodes caused by temperature inversion, which is the major factor in increasing concentration of particulate matter to abnormal levels.

METHODS

Airborne particulate matter (PM₁₀) was collected in Sosnowiec, at 3 m and 100 m above ground level (a.g.l.) The collected PM₁₀ was investigated by analytical scanning and transmission electron microscopes (SEM, TEM) and X-ray powder diffraction. The identification of phases in PM₁₀, their morphology, chemical compositions, structure and particle size enabled the precise pinpointing of the emission sources.

RESULTS and CONCLUSIONS

Abundant ultraparticles occur in the PM₁₀ fraction. Those ultraparticles are carriers of heavy metals including Pb, Zn, Cd, Fe and others. The most common component of PM₁₀ in the winter season is soot, while the summer is dominated by aluminosilicates and pollen.

The other ingredients often found in atmospheric dust are quartz, iron oxides, amorphous and crystalline aluminosilicates. Minor components of PM₁₀ are iron and alloys, chlorides (sylvine, halite, lead chloride), spinels, Pb-, Zn-sulphides, dolomite, phosphates (monazite, apatite). All of the observed mineral phases in PM₁₀ are typical of fossil fuels combustion and of car exhausts.

As expected, the highest concentrations of PM₁₀ were observed during the prevalence of anticyclonic conditions, at low speed winds, and the lack of precipitation. The extremaly high concentrations of PM₁₀ were associated with the thermal inversion. The presence of some mineral phases in PM₁₀ (e.g. Zn, Pb, Cd-sulfides, Sn alloys) combined with back-tracing of air flow allowed precise location of particular sources of dust emissions. A large number of nanoparticles often form aggregates containing toxic elements affixed to the soot surface. Toxic metals together with respirable soot particles can be inhaled by humans and may have adverse effect on their health.

Extremely high concentrations of dust particles derived from local sources occur during smog episodes. Soot and led chlorides originating from traffic and particulate matter from the coal combustion in households (soot, iron oxides, glassy aluminosilicates, barite, gypsum, chlorides of sodium and potassium) were the most abundant solid pollutants at both 3 and 100 m above ground level.

Differences in the composition of PM₁₀ collected at 3 and 100 m a.g.l. were observed during change in the air mass circulation. Minerological composition of PM₁₀ suggested major contribution from local pollutions at 3 m and the occurrence of particles from long-range transport at 100 m a.g.l.
Acknowledgments
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Air quality according to CAQI index in selected cities in Poland

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KEY WORDS: air pollution, weather, winter

Indices presenting air pollution status and its influence on human health in an accessible and comparable way have recently gained worldwide interest. For example, an interactive platform http://www.airqualitynow.eu provides real-time data on air quality in selected European cities, according to the CAQI index (Common Air Quality Index). The CAQI index was developed within the framework of CITEAIR project and comprises 5 classes of air quality which relate to air quality standards recognized in the European Union.

The aim of the study was the assessment of air quality, according to the complex CAQI index, in 6 cities in Poland (Gdańsk, Szczecin, Poznań, Warszawa, Łódź, Katowice) and identification (with the use of cluster analysis) of weather conditions determining aerosanitary conditions. The study uses hourly data from automatic measurements of PM$_{10}$, NO$_2$ and O$_3$ concentrations (WIOŚ stations) and meteorological elements (I class IMGW PiB stations) i.e., temperature and relative humidity of air, wind speed and atmospheric pressure. The study covers only the period of the calendar winter (Dec.-Feb.) in the period 2004/2005 – 2013/2014.

According to CAQI index, air quality in the ten winter seasons under analysis was, in the vast majority of cases, classified as very poor and poor. PM$_{10}$ concentrations were found to have the greatest effect on air quality, ranging from 62% in Gdańsk to 91% in Katowice. Significantly more frequently, concentrations of tropospheric ozone had greater influence on aerosanitary conditions than concentration of nitrogen dioxide. Katowice was found to have the most polluted air. In approximately 30% of days, air quality was found to be within the two worst classes of the pollution level: high and very high.

Average highest CAQI values, ranging from 90 to 200, were recorded in all cities in the conditions of lower temperature and, generally, elevated atmospheric pressure and lower wind speed, i.e. atmospheric conditions associated with anticyclonic weather.
Evaluating the quality of the forecasts of atmospheric SO$_2$ concentration in an urban agglomeration

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KEY WORDS: air pollution, SO$_2$ concentration, forecast, quality of forecasts

Monitoring air quality is of considerable significance for cities located in the southern part of Poland, particularly for Krakow, which, in regard to its air condition, is classified as one of the most polluted agglomerations in Poland and EU. It is necessary to select effective methods permitting a thorough assessment of a large amount of the monitoring data and the forecast of changes. The objective of this paper is to present the assessment results of the author’s forecast of SO$_2$ concentration in Krakow. The development of the forecasting models involved the use of the data covering the last ten years provided by the Provincial Environmental Protection Inspectorate and the monitoring station in the AGH University of Science and Technology in Krakow. The forecast was performed using the three following models: (1) the regressive model obtained by the “multivariate adaptive regression splines” (MARS) method in the Statistica programme, (2) the classical regression model of many variables, (3) the trend time series modeling with seasonal and cyclic variations taking into account the effect of random factors. The paper discusses the results of the statistical verification of the applied models. It also includes critical comments on the models’ usability, which in the case of the time series models depend on the degree of reality of the introduced extrapolation assumptions for each model component.
Effects of boundary layer dynamic on urban aerosols concentration during fair-weather condition in Wrocław (SW Poland)

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KEY WORDS: PM₂.₅, SODAR, atmospheric boundary layer, air quality

Particulate matter is one of atmospheric pollutants of a great concern to human health and climate. During last decades the epidemiological studies have confirmed a link between short and long-term exposure on PM₂.₅ and respiratory and cardiovascular diseases. Most of anthropogenic aerosols emitted in the atmosphere are released in the atmospheric boundary layer (ABL) and then become diluted by the convection and turbulence. Thus ABL structure plays a crucial role in understanding the fate of dust and its impact on air quality.

The main aim of this study was to investigate the effects of atmospheric boundary structure on the levels and variability of the particulate matter (PM₂.₅). The study concerns the episodes with short-term high concentration of PM₂.₅ during radiative weather related with relatively constant synoptic-scale high pressure systems. The dynamics of atmospheric boundary layer (ABL) were estimated with use of Doppler SODAR (SOund Detection And Ranging). The PM₂.₅ concentration and sodar data were gathered at the Meteorological Observatory of University of Wrocław in the years 2010-2014. PM₂.₅ mass concentration was measured by means of an automatic dust concentration monitor TEOM 1400a. Basic meteorological data were used as a background. All data were collected with time resolution of 1 minute.

Dilution and concentration of particulate matter depend strongly on the local ABL structure and its dynamics. During fair weather conditions the ABL structure is characterized by well marked periodicity. During day urban ABL is usually unstable and therefore deep and turbulent, which results in effective vertical dispersion and strong minute-to-minute variations of PM₂.₅ concentrations. Vertical air velocity in a convective BL exceeds 1 m s⁻¹. After evening transition period (before the sunset) the process of creating a stable boundary layer starts with radiative inversion ranges from about 50 to 200 m a.g.l (above ground level). Turbulence at this layer is weak and air subsidence dominates with vertical velocity not exceeding 0.75 m s⁻¹. In such conditions the concentration of pollutants increases and reaches the state of dynamic equilibrium. The maximum mass concentration is about 100 µg m⁻³. A change in
weather conditions associated with an increase in ventilation index leads to a decrease of PM$_{2.5}$ concentration also during stable situation. A second, weaker, maximum, is marked in some cases during the morning transition period (Fig. 1).

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Below-cloud scavenging of atmospheric aerosols with aerodynamic diameter less than 2.5 µm

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KEY WORDS: below-cloud scavenging, precipitation, particulate matter, PM$_{2.5}$, meteorological conditions

The main objective of the presented work was to determine the variability of particulate matter with aerodynamic diameter less than 2.5 µm, with assessment of the seasonality of washout effects and efficiency for removal of pollutants from the atmosphere by wet deposition.

Data used in this study were obtained in Wroclaw – a city in SW Poland with population of about 600 000 and strong degree of air pollution, especially particulate matter. The whole series cover a 5-year measurement period (May 2010 - June 2016) and was collected in Meteorological Observatory of University of Wroclaw, located in a residential area at the edge of the city center. The data contain information about the variability of PM$_{2.5}$ concentration and precipitation as well as background meteorological conditions. The time resolution of the measurements was 1 min. PM$_{2.5}$ measurements were conducted with use of automatic dust concentration monitor TEOM 1400a. Precipitation was measured by optical disdrometer PARSIVEL, enabling i.e. measurements of precipitation intensity in high temporal resolution and identification of precipitation types according to SYNOP categories (rain, snow, drizzle, rain or drizzle with snow, hail). The analysis was based on scavenging coefficient $\lambda$, calculated for precipitation episodes according to formula (Hameed, Sperber 1986):

$$\lambda(d_p) = 1 - \frac{1}{t_1 - t_0} \ln \left( \frac{c_1}{c_0} \right)$$

where $d_p$ – aerodynamic diameter of particle, $c_0$ - initial concentration in time $t_0$ and $c_1$ – final concentration in time $t_1$. The time step between $t_0$ and $t_1$ used in calculations was 600 sec. Due to character of available data it was assumed that the calculations of $\lambda$ coefficient would be made for the whole PM$_{2.5}$ fraction.

The obtained results show a clear variability of the scavenging process depending on precipitation characteristics – its intensity, size of precipitation particles and type of precipitation. At the same time it can be seen that other meteorological parameters, such as wind speed during the precipitation episode also strongly influence the process.

Table 1. Median of scavenging coefficients in relation to precipitation intensity for rain, snow and all precipitation types

<table>
<thead>
<tr>
<th>precipitation intensity [mm/h]</th>
<th>all precipitation types</th>
<th>rain</th>
<th>snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0,0;0.1&gt;</td>
<td>1.40E-05</td>
<td>1.84E-05</td>
<td>5.15E-06</td>
</tr>
<tr>
<td>(0.1;0.5&gt;</td>
<td>1.29E-05</td>
<td>1.33E-05</td>
<td>7.90E-06</td>
</tr>
<tr>
<td>(0.5;1.0&gt;</td>
<td>4.70E-06</td>
<td>0</td>
<td>1.13E-05</td>
</tr>
<tr>
<td>(1.0;2.0&gt;</td>
<td>2.14E-05</td>
<td>1.52E-05</td>
<td>3.26E-05</td>
</tr>
<tr>
<td>(2.0;3.0&gt;</td>
<td>2.93E-05</td>
<td>2.73E-05</td>
<td>3.85E-05</td>
</tr>
<tr>
<td>(3.0;4.0&gt;</td>
<td>3.20E-05</td>
<td>2.78E-05</td>
<td>-</td>
</tr>
<tr>
<td>(4.0;5.0&gt;</td>
<td>2.23E-05</td>
<td>2.08E-05</td>
<td>-</td>
</tr>
<tr>
<td>(5.0;7.0&gt;</td>
<td>1.42E-05</td>
<td>1.46E-05</td>
<td>-</td>
</tr>
<tr>
<td>(7.0;10.0&gt;</td>
<td>1.62E-04</td>
<td>1.82E-04</td>
<td>-</td>
</tr>
<tr>
<td>&gt;10.0</td>
<td>1.47E-04</td>
<td>1.22E-04</td>
<td>-</td>
</tr>
<tr>
<td>all intensities</td>
<td>1.54E-05</td>
<td>1.65E-05</td>
<td>9.41E-06</td>
</tr>
</tbody>
</table>
Table 2. Median of scavenging coefficients in relation to wind velocity for rain, snow and all precipitation types

<table>
<thead>
<tr>
<th>velocity classes [m/s]</th>
<th>all precipitation types</th>
<th>rain</th>
<th>snow</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 0.5</td>
<td>1.24E-06</td>
<td>-1.29E-05</td>
<td>-7.03E-06</td>
</tr>
<tr>
<td>&lt;0.5;1.0)</td>
<td>-1.51E-06</td>
<td>-1.28E-05</td>
<td>5.89E-07</td>
</tr>
<tr>
<td>&lt;1.0;2.0)</td>
<td>1.59E-05</td>
<td>2.30E-05</td>
<td>7.46E-06</td>
</tr>
<tr>
<td>&lt;2.0;3.0)</td>
<td>2.43E-05</td>
<td>3.79E-05</td>
<td>7.63E-06</td>
</tr>
<tr>
<td>&lt;3.0;4.0)</td>
<td>3.41E-05</td>
<td>2.54E-05</td>
<td>2.96E-05</td>
</tr>
<tr>
<td>&lt;4.0;5.0)</td>
<td>6.09E-05</td>
<td>3.81E-05</td>
<td>6.07E-05</td>
</tr>
<tr>
<td>≥ 5.0</td>
<td>6.97E-05</td>
<td>4.56E-05</td>
<td>5.10E-05</td>
</tr>
<tr>
<td>all velocities</td>
<td>1.54E-05</td>
<td>1.65E-05</td>
<td>9.41E-06</td>
</tr>
</tbody>
</table>

According to the authors, such variation is caused by genetic characteristics of precipitation observed in Wrocław, which is primarily related to the frontal weather with advection of fresh air masses, caused by movement of low pressure systems mainly from the sectors: NW – W – SW. This situation is clearly visible, especially when such weather occurs after prolonged episodes of very cold rainless and windless weather, typical for winter anticyclonic conditions.

Situations with limited air mass exchange, when removing of pollutants depends mainly on pure scavenging are quite rare, and they are associated most often with slight precipitation of low scavenging effectiveness. It should be noted, that in these conditions we may even observe increase of PM concentration despite precipitation. Such situations may occur in cold season, when rainy/snowy weather is associated with temperature drop. In these cases effect of scavenging may be reduced by increase of PM emission caused by intensive heating.

The results indicate that in Central European conditions the potential effectiveness of particulate matter scavenging should be assessed not only with respect to physical parameters of the precipitation, but also in the context of the whole “weather complex”, including genetic determinants of precipitation, intensity of the advection, type of inflowing air mass etc.

Acknowledgments:
The research was a part of the project “Air Pollution and biometeorological forecast and Information System” (LIFE-APIS/PL) co-financed by European Union, under the Financial Instrument LIFE+ and The National Fund for Environmental Protection and Water of Management.

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Atmospheric circulation conditionings of PM$_{10}$ concentration over Lower Silesia

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KEY WORDS: atmospheric circulation, PM$_{10}$ concentration, Lower Silesia

Atmospheric circulation conditionings of PM$_{10}$ concentration over Lower Silesia in the years 2014-2016 were analyzed. Daily PM$_{10}$ concentrations from 23 station, measured by Voivodship Inspectorate of Environmental Protection, were taken into consideration in selected air circulation types. Automatic classification of atmospheric circulation types for Lower Silesia was used (Ojrzyńska 2015), based on meteorological data from NCEP/NCAR reanalysis (Kalnay et al. 1996). Variability of PM$_{10}$ concentration was analyzed in 40 selected circulation types and its groups aggregated by the same direction of advection, type of lower and upper vorticity and humidity of air masses. The one-way analysis of variance ANOVA and post-hoc Tukey’s HSD test were done for all PM$_{10}$ concentration and also only for the measurement from heating season.

The significant variability of PM$_{10}$ concentration between selected circulation types and groups of types were showed. It was proved that humidity of air masses has significant influence on PM$_{10}$ concentration -higher concentration was observed for circulation types with dry air masses in opposite to corresponding wet types. In spite of fact that the highest PM$_{10}$ concentrations (with maximum exceeding 250 µg m$^{-3}$) were noted in circulation type with lower and upper anticyclone (NWAAD, SWAAD, NEAAD), high PM$_{10}$ concentration were observed also in circulation types with lower anticyclone, upper cyclone (NWACD, SWACD, NEACD). The significant role of lower anticyclone in very high PM$_{10}$ concentrations was connected with occurrence and depth of lower inversion layer which inhibits PM$_{10}$ dispersion. In types NWACD, SWACD and especially NEACD characterized by the lowest temperature in winter additional influence on PM$_{10}$ concentration had increased emission from residential heating. In heating seasons there were noted higher PM$_{10}$ concentration in circulation types with advection from west sectors (SE and NE), however this situation always concerns types with lower anticyclone.

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Assessment of inhalational exposure of residents of Wroclaw, Cracow and Warsaw to benzo(a)pyrene

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KEY WORDS: benzo(a)pyrene, health risk assessment, air pollution

INTRODUCTION

Burning of fossil fuels and biomass, transport and industry are the main sources of PAH (Polycyclic Aromatic Hydrocarbons) in the atmosphere. Benzo(a)pyrene (B(a)P) is also a compound identified in cigarette smoke (Trojanowska, Świetlik 2013). The International Agency for Research on Cancer (IARC) has qualified benzo(a)pyrene for compounds with proven carcinogenic effects on humans (IARC 2012). The target value for benzo(a)pyrene, taking into account health protection purposes, is defined in the Regulation of the Minister of the Environment on the levels of certain substances in the air and it is annual average concentration 1 ng/m³ (OJ 2012 item. 1031).

THE AIM OF THE STUDY

The aim of the study was to carry out a cancer risk assessment for residents of Wrocław, Cracow and Warsaw related to inhalation exposure to benzo(a)pyrene in ambient air.

MATERIAL AND METHODS

The methodology employed by the American Environmental Protection Agency (US EPA) was used in the study (US EPA 1986; US EPA 1989). The lifetime exposure of adults and children was assumed. The results of measurements carried out at the air monitoring stations under the State Environmental Monitoring by the Voivodship Inspectorates for Environmental Protection (VIEP) in Wrocław, Cracow and Warsaw in the years 2014-2016 were used.

RESULTS

The average concentration of B(a)P in the years 2014-2016 was 4.14, 6.31 and 2.19 ng/m³ for Wrocław, Cracow and Warsaw respectively. The calculations show that the highest risk of cancer was obtained for the inhabitants of Cracow: 1.54·10⁻⁵ children, 7.52·10⁻⁶ women, 6.30·10⁻⁶ men. The estimated cancer risk was higher for Cracow residents than for Wrocław (1.01·10⁻⁵ children, 4.94·10⁻⁶ women, 4.14·10⁻⁶ men) and Warsaw, where these indicators were the lowest (children: 5.34·10⁻⁶, women: 2.61·10⁻⁶, men: 2.19·10⁻⁶). Children are the group most exposed to the risk of cancer associated with B(a)P in the air among the examined subpopulations.

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Regulation of the Minister of Environment of 24 August 2012 on the levels of certain substances in the air, (OJ 2012 item. 1031).

Adverse health effects of air pollution in Lower Silesian and Łódź voivodeships

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KEY WORDS: ambient air pollution, air pollution health effects

Research has been carried out to estimate the ambient air pollution impact to health of the inhabitants of Lower Silesia and Łódź voivodeships. Due to availability of PM₁₀ and PM₂.₅ dust concentration data authors have chosen the period of 2008-2015. The following health effects of exposure to ambient air pollution have been calculated: the number of premature deaths, the number of cases of bronchitis in children and chronic bronchitis in adults and number of days in work absence.

The basis for estimation was the annual level of dust concentrations obtained in the measurements carried out by the Voivodeship Inspectorate for Environmental Protection in Lower Silesia and Łódź voivodeships. In case of lack of PM₂.₅ measurements, ratios of PM₁₀ to PM₂.₅ were estimated, based on monthly average of particular communes.

Population data, for exposure assessment, came from the Central Statistical Office (CSO) and were prepared for each municipality for specific age groups. The indicators of the population health status in case of the number of deaths were obtained from the CSO and the number of sickness absence from the Social Insurance Institution (SII). Estimation of Number of bronchitis among children and the number of chronic bronchitis among adults were based on World Health Organization recommendations (World Health Organization 2013).

Not for all selected communes in analyzed period good quality of air pollution data was available. Taking into account completeness of data further estimation for year 2015 was made. Results of rough estimation was: number of annual premature deaths -Lower Silesia: 3 thousand, and in Łódź voivodeships was around 4 thousand.

REFERENCES

Mutagenicity of road pollutants adsorbed on spider webs in Wrocław (Poland)

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KEY WORDS: spider webs, air pollution, mutagenicity

Atmospheric pollution is responsible for great damage to human health and all living organisms. Cars are the largest source of environmental contamination. Spider webs proved to be useful indicators of road traffic emissions, they are even more reliable than mosses and lichens whose activity is often limited by the lack of water and sun which restricts their use. Advantages of the use of spider webs for the assessment of air quality are as follows: simple and cheap sample collection, non-invasiveness of studies, easiness of long-term measurements. Mutagenicity of spider webs exposed to pollutants has never been studied. In presented studies samples (spider webs) were collected from 6 indoor sites in Wrocław (Poland). Only the webs of Pholcidae were used. They were extracted with dichloromethane in a Soxhlet apparatus. PAHs content in extracts was determined by the high performance liquid chromatography technique using fluorescence detection. For mutagenicity studies the standard Salmonella assay was used. Two Salmonella typhimurium strains, TA98 and YG1041, were used in the assays. The assays were conducted with and without a metabolic activation. All studied samples appeared to have mutagenic effect, but they differed against each other with regard to a total content of PAHs, depending on the studied site. The highest content of total PAH in webs was found in the sites situated near busy roads and at homes with traditional heating system (wood burning stoves). The highest mutagenic effect was also recorded for web samples collected from the same sites. Webs of Pholcidae proved to be very useful, easy and reliable monitoring tool. Studies will be continued with outdoor and indoor samples.
The role of biological methods in the municipal management odor nuisance reduction strategy

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KEY WORDS: odor nuisance, biofiltres, bioscrubbers, municipal management

An important potential source of odor emissions is municipal management objects. These include sewage systems, waste water treatment plants, waste landfills and waste processing plants. Both, waste management facilities and waste treatment facilities are designed to reduce the negative impact of human activities on the environment. The common feature of these objects is the similarity of the chemical composition of emitted gases and their hedonic quality, eventually, the nature of odor emissions dependent on the type of object and technological solutions. Sources differ in the amount of emissions and intensity of odors that can affect the amount of odor nuisance. Problems in reducing odor impact of municipal management objects can be mainly due to the multiplicity and variety of sources of odor emissions located in their area, as well as from the fact that they are often area sources and they might be difficult to encapsulate (Sówka et al. 2016).

The biological methods are increasingly used for the purification of waste gases in relation to other odor reduction methods both, for ecological reasons and for economic competitiveness. Biological purification of gases is carried out using biofilters, bioscrubbers, biotrickling filtres or membrane bioreactors (Mudliar et al. 2010). The differences between these methods are a consequence of used solutions and result in the division of operating costs (Estrada et al. 2013). The efficiency of the removal of hydrogen sulphide by biofiltration obtained by various authors is at least 99% with a wide range of inlet pollution concentration, while for ammonia it is slightly lower (from 96% to 98%). The effectiveness of the biofiltration of VOCs depends substantially on their nature and properties (water solubility, vapor pressure), and varies from 40 to 100% (Burgess et al. 2001; McNevin, Barford 2000). The obtained deodorization efficiency by biofiltration is above 90%, and can even reach values over 99% (van Groenestijn, Kraakman 2005).

In the paper examples of the application of biological methods in municipal management objects together with the assessment of their effectiveness in reducing the emission of odor and selected odorant pollutants will be presented and discussed.

Acknowledgments
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Indoor PM$_{10}$ particulate matter pollution assessment during the smog events

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KEY WORDS: indoor air, particulate matter, air quality, PM$_{10}$, model

Particulate matter is one of the most important indoor and outdoor air quality pollutants (WHO 2003). In Southern Poland, where the ambient air quality is a common and continuous problem, there is a dire need to describe the relation between ambient and indoor air quality. It is well known that ambient air pollutants are transported inside the buildings with the air flow forced by ventilation. The question that motivated the following research was how much of the particulate matter is filtered before it reaches building interior.

In most of the previously published papers, indoor and outdoor dust concentration was analysed either from samples collection on filters, or from long term mean measurements made with other methods (Eštoková 2010; Diapouli 2005). In this work, we present the analysis based on high frequency particulate matter (PM$_{10}$) measurements, performed between December 2016 and April 2017 by optical dust monitors (TSI, Environmental DustTrak). Simultaneous measurements performed both inside and outside of the surveyed buildings (11 sites of different ventilation and construction characteristics) have allowed the modelling of the indoor PM$_{10}$ concentration dynamics, which were mainly forced by changes of ambient dust concentrations.

Lumped parameter model was used as a base of calculations. RMSE cost function was calculated in order to compare in-situ observations against a range of predictions performed in appropriate ranges of model parameters (delay constant - $\tau$ and filtration coefficient - $r_f$). The optimisation has allowed to obtained a very good fit of the model to the observed concentrations ($R^2$ better than 0.95), and thus to quantify the impact of external pollutants on indoor air. It was found that between 30% and 70% of the external dust concentrations are propagated indoors, depending on the type of building, its construction, age and ventilation type.

Acknowledgments

We hereby acknowledge the support of governmental and private hosts that provided housing for the research equipment during the respective measurement periods. We thank Krakow Smog Alert for providing measurement equipment. Partial support of statutory funds of AGH University of Science and Technology (project no. 11.11.220.01) is kindly acknowledged.
REFERENCES


PM air pollution inside beauty salons

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KEY WORDS: respirable particles, indoor air, I/O ratio, particulate matter (PM)

The Upper Silesia Agglomeration is one of the most PM-polluted European areas, especially when considering fine particles. Within the Agglomeration, with a total population of more than 2 million residents, more than 60% of employed, work in so-called services sector. Among different service facilities - beauty salons are ones, which importance is growing to the much extent nowadays (fashion for a healthy lifestyle and well-groomed appearance), but on the other hand, where are undoubtedly a significant sources of PM indoor emission.

The aim of this study was to investigate the concentrations of PM inside four selected beauty salons (BS1-BS4) located in the Bytom city (one among 14-th Upper Silesian cities with an area of 69 km² and 170 thousand inhabitants) and to compare this concentrations with the outdoor levels. PM samples were collected from 7 July to 29 August 2015 in 8-hour cycles (10.00-18.00). At each measuring location, two identical samplers (GilAir PLUS) were set up to for the simultaneous collection of the indoor and outdoor concentrations of two PM fractions: PM₄ (respirable particles) and TSP (total suspended particles). The mass of a PM sample was determined by filter weighing on a microbalance (Radwag; resolution of 1 μg) before and after the exposure.

The average indoor concentrations of PM₄ and TSP were significantly higher compared to the outdoor (atmospheric) ones (Tab. 1). The largest differences in the average indoor (I) and outdoor (O) PM concentrations were found in BS4 salon, where the average 8h I/O concentration ratio was 9.6 and 9, respectively for PM₄ and TSP respectively. The smallest I/O ratio was found in case of BS1 salon, located near a busy road. The 8-h indoor and outdoor concentration differences, regarding both PM₄ and TSP were statistically significant (Mann-Whitney U Test, p <0.05 at \( p_{\text{assump}}=0.05 \)).

It was found that typical hair treatments (haircutting, dyeing, modeling, spa and other care treatments, etc.) as well as nail styling treatments (shortening, lengthening and decorating) which were constantly performed during PM collection, regardless of degree of background PM pollution (pollution of atmospheric air) was the main source of the PM emission inside BS1-BS4 salons. In the studied service facilities, due to the type of the performed activities, the main component of the PM air pollution are probably various organic pollutants.

Tab. 1. Average indoor and outdoor concentrations of PM₄ and TSP for selected beauty salons (BS1-BS4)

<table>
<thead>
<tr>
<th></th>
<th>PM₄</th>
<th>TSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indoor BS1</td>
<td>156.8</td>
<td>277.5</td>
</tr>
<tr>
<td>Outdoor BS1</td>
<td>105.0</td>
<td>147.1</td>
</tr>
<tr>
<td>Indoor/Outdoor BS1</td>
<td>2.2</td>
<td>2.5</td>
</tr>
<tr>
<td>Indoor BS2</td>
<td>118.1</td>
<td>185.5</td>
</tr>
<tr>
<td>Outdoor BS2</td>
<td>26.2</td>
<td>43.7</td>
</tr>
<tr>
<td>Indoor/Outdoor BS2</td>
<td>4.8</td>
<td>4.7</td>
</tr>
<tr>
<td>Indoor BS3</td>
<td>92.8</td>
<td>136.0</td>
</tr>
<tr>
<td>Outdoor BS3</td>
<td>24.8</td>
<td>43.7</td>
</tr>
<tr>
<td>Indoor/Outdoor BS3</td>
<td>5.1</td>
<td>4.7</td>
</tr>
<tr>
<td>Indoor BS4</td>
<td>170.2</td>
<td>272.5</td>
</tr>
<tr>
<td>Outdoor BS4</td>
<td>19.4</td>
<td>33.5</td>
</tr>
<tr>
<td>Indoor/Outdoor BS4</td>
<td>9.6</td>
<td>9.0</td>
</tr>
</tbody>
</table>

a) both indoor and outdoor; number of data for each fraction n = 10;
total number of samples in each service facility N = 40
The concept of home air quality management system for individual consumers

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KEY WORDS: air quality management, low cost sensor

The air quality in a given indoor space is an outcome of four factors: the outdoor air quality, the intensity of pollutants emission indoors, the ventilation rate, and the effectiveness of the air treatment. All factors should be considered in reliable indoor air quality management systems necessary for maintaining high indoor air quality and reducing the health risk for occupants.

This work shows a concept of a modular, low cost air quality monitoring system, for home and office use, and prototypes of its components. The system consist of four functional layers: data acquisition, data analysis, control and user interface.

The data acquisition layer is a set of miniature sensor modules providing real time information about air quality indicators like PM, CO₂, CO, O₃ and VOC concentration. The modules use different kinds of low cost sensors (light-scattering, NDIR, electrochemical, and semiconductor).

The data analysis layer is an algorithm of sensor data fusion based on set of rules in fuzzy logic. Locally collected data could be combined with data acquired from air quality monitoring stations. Proposed algorithm can manage many indicators, for example it can reduce the supplied air volume when the outdoor air quality is poor (which means to tolerate higher CO₂ concentration indoors) and intensify air treatment.

The control layer can include actuators like VAV regulators, windows/vents controllers, and air treatment devices like air purifiers with HEPA and carbon filters or UV lamp/ionization units.

The user friendly interface is very important when people have to manually manipulate the airflow, which is typical situation, gravity ventilation without any controller is still commonly used in a vast majority of homes. Two kinds of graphical interfaces are proposed: local (computer/phone) and remote (web server).

The price calculated for large scale manufacturing (about 100 EUR for single measuring device) shows that the system can be affordable for regular EU consumer.

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Knowledge and attitudes towards air pollution. How has it changed among residents of Lower Silesia region during the year?

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KEY WORDS: air pollution, knowledge, survey

Air pollution is one of the biggest problem of today's world. It has been shown, that it can cause respiratory, cardiovascular, and oncological diseases (Brook et al. 2010). There are evidences of health effects of physical activity with exposure to air pollution. For instance, it has been proven that runners after run near highways have reduced lung function (Rundell et al. 2008). Studies also suggest, that people who are more exposed to air pollution, perceive stronger this thread than people who live in relatively clean air area (Chakraborty et al. 2017). Therefore it is crucial to perpetually remind and verify the awareness of the harmful effects on health caused by polluted air. Consequently, well informed population can press on governments to improve environmental protection. The proper knowledge and attitudes should help in improvement of understanding, that protection of environment and health policy have to be more targeted and effective.

The main aim of our study was to assess the awareness and behaviors towards air pollution and health among residents of Lower Silesia Region.

Material and methods: An online survey was conducted in Lower Silesia region in February 2017 and in February 2016. Personal information and questions concerning the knowledge, practices towards ambient air pollution and health were contained in questionnaire. Descriptive statistics, chi-square tests and student tests were used.

Results: The questionnaire was completed by 648 inhabitants of Lower Silesia region. It was filled out by 316 people in February 2016 and 332 January 2017. In the survey from 2017 28.3% of our responders were men and 71.7% women. Average age was 25.2. 47.1% of them got higher education. The results of our survey from 2017 were not statistically different from the group who answered questionnaire in 2016. 33% of residents assessed air quality in their place of residence as sufficient, 30% as bad, 16.9% very bad, almost the same amount of responders evaluated air in their place of residence as good (15%). According to subjective evaluation, the air quality has worsened since last year.

Knowledge about the main sources of air pollution and seasons when air is mostly polluted has improved in comparison to results from 2016. The vast majority of respondents (84.6%) felt, that air is mostly polluted in winter months, and for the most of them (57.4%) inappropriate heating of households is the main source of air pollution. Nearly all of respondents agreed that smog has a negative impact on human health. 46% of respondents observed that the air has gotten worse since last year, for 38.3% it hasn't changed. Education and place of residence were revealed factors associated with the level of knowledge about air pollution (p<0.05).

Conclusions: Resident's knowledge about air pollution has improved compared to previous year. It is markedly stronger in health protection awareness and enthusiasm for air pollution control among inhabitants of the Lower Silesia region. The less-educated responders and residents living outside the Wroclaw are the targetable population for improving environment.

REFERENCES

Air pollution awareness amongst physically active people

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KEY WORDS: Smog, air pollution, physical activity

Objective: Air pollution is a part of atmospheric phenomenon called smog, word coming from the combination of words “smoke” and “fog”, which is harmful for one’s health. Dusts and chemical compounds forming smog may be allergenic; additionally they may cause asthma, chronic bronchitis and cough. The awareness of pathogenic influence of smog and possibility to obtain information about its level should be significant for activity planning and to prevent inhalation of highly polluted air.

Methods: For the needs of the study a questionnaire was prepared, which afterwards was published online amongst groups and forums uniting people active outdoor. For further evaluation 265 of the filled questionnaires were used.

Results: Among 265 of respondents 54% are living in the city of Wroclaw. While the pollution levels are exceeded even 42.6% of respondents do not change their training plan, despite 76.6% of them believing, that during outdoor training they are more vulnerable to negative impact of air pollution than people not playing sports outside. Even 36.2% of respondents do not check the air pollution levels, however, the majority of the others check them less than once a week or when the pollution topic is being raised by media. Only 55.5% know what do abbreviations PM2.5 and PM10 stand for. 66.4% of respondents believe that Poland is amongst countries with the highest levels of air pollution.

Conclusion: The results show, that despite the awareness of being exposed to inhalation of pollution, only about a half of respondents change their training plan to avoid exceeded air pollution standards. In our opinion, it is very unsatisfactory. One third of respondents never check the levels, which testifies that there is a significant need for education addressed to outdoor active people about the impact that air pollution may have.
The stimulus conditions of Kłodzko and Polanica Zdrój climate

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KEY WORDS: heat stress index of the human body UTCI, heat stress, cold stress, Kłodzko, Polanica Zdrój

Due to its geographic location and the terrain, Kłodzko Land has a variable and varied bio-climate. The rich mineral healing resources and favourable bioclimatic conditions have resulted in the establishment of many health resorts in the area (Kuchcik i in. 2014).

The stimulus conditions of Kłodzko and Polanica Zdrój climate was analyzed on the basis of the Universal Thermal Climate Index (UTCI; Błażejczyk 2013) in 1966-2015. They were calculated from data obtained from IMGW measurement resources (Kłodzko and Polanica Zdrój), based on temperature, humidity, wind speed and cloudiness. The annual and multi-annual waveforms of the UTCI and the frequency of the indicator values corresponding to the specific stimulus (heat and cold stress) were analyzed. The calculated UTCI values were compiled in 10 classes of indicator values with specific stimulus, proposed by Błażejczyk et. all (2013). For the analyzed years, the incidence of these classes was calculated. The influence of meteorological conditions on shaping extreme values of UTCI was evaluated for selected periods of heat and cold. Heat waves are designated as strings of a minimum of three days with a maximum temperature of more than 30°C on each day, while cold waves respectively as strings with a maximum temperature below -10°C.

REFERENCES
Application of the HYSPLIT model for the analysis of source areas of ragweed pollen for Wrocław.

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KEY WORDS: HYSPLIT, pollen, Ambrosia artemisiifolia  

In this study the relationship between the inflow of air masses and the ragweed pollen concentration in Wroclaw (SW Poland) has been analyzed for a ten year period of 2005-2014. The HYSPLIT trajectory model was used to verify if the inflow of ragweed pollen can be related to the main known ragweed centers in Europe, like Pannonian Plain, northern Italy and Ukraine. The results show that days with high pollen concentration are connected with air masses coming from south and south-west Europe, which confirms the existence of known ragweed. Additionally, the results show that the episodes of high pollen concentration (above 20 pm⁻³) represent a great part of total recorded ragweed pollen in Wroclaw.
Is pollen air pollution?

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KEY WORDS: Betulaceae, pollen, health, climate change

Air pollution and climate change can potentially increase the intensity and duration of respiratory allergic diseases, such as hay fever or asthma. Epidemiological studies have indicated that high levels of air pollution, especially ultrafine particles (e.g. BC) are positively correlated with frequency of respiratory allergy. Researchers have showed that incidence of allergies has increased steadily over the last several years, particularly among people living in urban areas and health effects arise from simultaneous exposure to pollen and air pollution (Ghosh et al. 2010; Peden and Reed 2010). In Poland the Betulaceae family pollen (Betula, Alnus, Corylus) along grass pollen is the main cause of the inhaled allergies.

Analysis of the dynamics of pollination of trees flowering in early spring provides on the start of the pollen season and, in consequence, on the allergic risk for sensitive individuals.

The aim of this study is to assess the influence of meteorological variables on the pollen season for three types of trees and shrubs belonging to the birch family (Betulaceae): hazel (Corylus sp.), alder (Alnus sp.), and birch (Betula sp.) in the context of changing climatological conditions.

This study shows the results of pollen monitoring for a period of eleven years (2003–2013) using a Burkard volumetric spore trap. The main characteristics of the hazel, alder, and birch pollination season were studied in Wroclaw (SW Poland) in the period between 2003 and 2013.

The correlation analysis indicates that the thermal factor had major impact on the course of the pollen seasons of the selected taxa. In particular, the pollen season start date depended on the sum of the temperatures above the thresholds of 5°C and 7°C, especially for December and January. The pollution intensity depended on the thermal conditions in November and December. It was also noticed that higher temperatures at the end of winter resulted in an earlier start of the Corylus and Alnus pollen season.

The phenological data collected are insufficient for trend assessment, however, when compared with meteorological data and its change over the multi-year period, they reveal distinct patterns of changes in the start dates for early spring species in relations to winter and spring temperature. Climatological analysis indicates that despite the general upward trend in temperature during the winter and spring seasons that has been recorded in this part of Europe, there are very large year-to-year differences in climatic factors, which also result in significant dynamism in the course of pollen seasons and increases the probability of the occurrence of extreme situations- such as an increase in the number of days with concentrations of pollen causing the occurrence of acute allergic symptoms, or the overlapping of plant pollen seasons.

Changes in the pollination period features due to climate change, both timing and intensity of pollen productivity would have important consequences on allergy sufferers.

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