European Network on New Sensing Technologies for Air Pollution Control and Environmental Sustainability - *EuNetAir*

COST Action TD1105

INTERNATIONAL WG1-WG4 MEETING on

New Sensing Technologies and Modelling for Air-Pollution Monitoring

Institute for Environment and Development - IDAD

Aveiro, Portugal, 14 - 15 October 2014

Action Start date: 01/07/2012 - Action End date: 30/06/2016 - Year 3: 2014-15 (*Ongoing Action*)

INDOOR AND OUTDOOR LEVELS AND CONTENT OF SELECTED TOXIC SPECIES IN PM10 AND PM2.5 OF URBAN KINDERGARTEN LOCATED IN RESIDENTIAL-COMMERCIAL AREA

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COST is supported by the EU Framework Programme

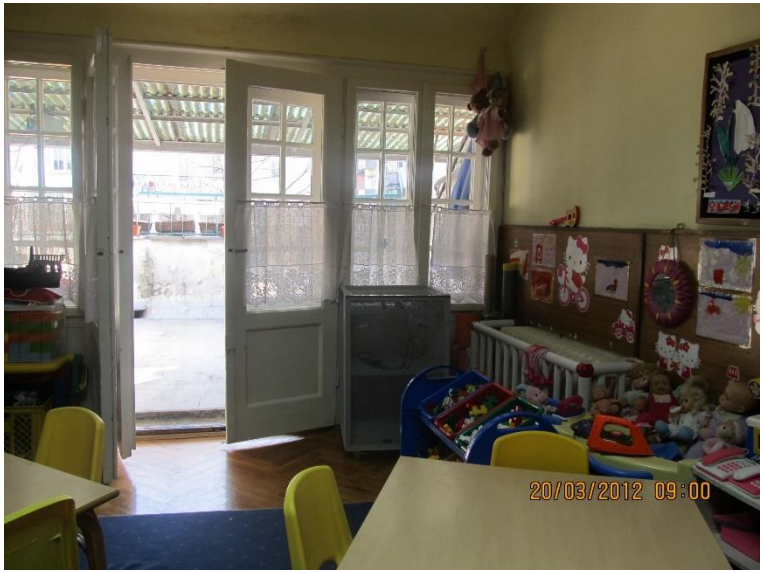
ESF provides the COST Office through a European Commission contract

Background and aims

First kindergartens and later schools are the microenvironments where adolescents spend significant period of time.

Indoor particulate matter (PM) represent mixture of both, infiltrated and indoor-generated PM.

Outdoor PM originate mainly from soil, traffic combustion and resuspension, industrial sources, temporally-variable emission sources such there are construction works, district heating plants, parking lots…

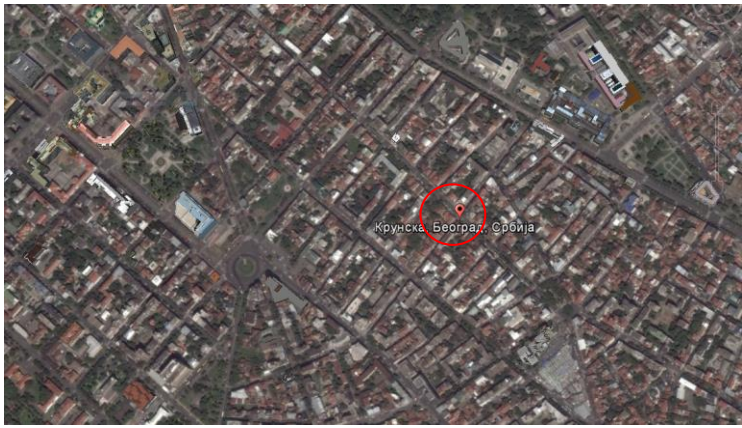


Background and aims

Although the kindergarten ambient is usually lacks typical home indoor PM sources such there are smoking and cooking, in many studies there are notified comparatively high concentrations of PM in classrooms.

Beside infiltrated outdoor PM through the building envelope, level and content of indoor PM are under influence of: air exchange rate; surface cleaning practice; number, age and physical activity of children in relation to room area and volume.

Background and aims



Levels of heavy metals and/or PAHs of indoor PM fractions in schools and kindergartens in European countries is concerned in limited number of studies.

To date, there are no simultaneous studies of the PAHs and elemental compositions of PM in indoor air in any kindergarten/school even other microenvironment in Serbia.

The aim of this study was to provide simultaneous information on the mass, organic and inorganic composition of indoor PM fractions of kindergarten located in a densely populated commercial-residential area with high traffic density in city centre of Belgrade.

Background and aims

Pollutants like PAHs and trace elements have the potential to cause adverse health effects as some of them are toxic, mutagenic or carcinogenic, etc…

For the purpose of better understanding ratio of risk from exposure in indoor and outdoor ambient specific for traffic urban environment in Serbia there were quantified:

- 16 EPA and EU priority PAHs (Nap, Any, Fle , Phe, Ant, Fla ,Pyr, Baa, Chr, Bbf, Bkf, BaP, Inp, Daa, Bpe)
- 16 metals and metalloids (Al, Ba, Fe, Ti, Zn, As, Cd, Co, Cr, Cu, Mn, Ni, Pb, Sb, Se, V)

Materials and methods

The kindergarten is located next to the busy street.

Sampling campaign was carried out in early spring covering heating and nonheathing season, for a time period of 40 consecutive weekdays.

PMs were collected on daily bases, 24h, while kindergarten was occupied form 6 a.m. to 6 p.m.

Materials and methods

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PM10 and PM2.5 were collected with LVS (Sven/Leckel LVS3) using quartz filters in the indoor air of room of the kindergarten and simultaneously in outdoor air in front of the windows on a balcony.

Materials and methods

- Microbalance, Precisa XR 125 SM was used for PM mass quantification.
- The elemental analysis was performed on ICP-OES (Varian, Vista Pro) and ICP-MS (Octopole Reaction System, Agilent 7500ce)
- PAHs were analyzed with GCMS (Agilent 6890N with Mass Selective Detector).

RESULTS: PM10 and PM2.5 mass concentration

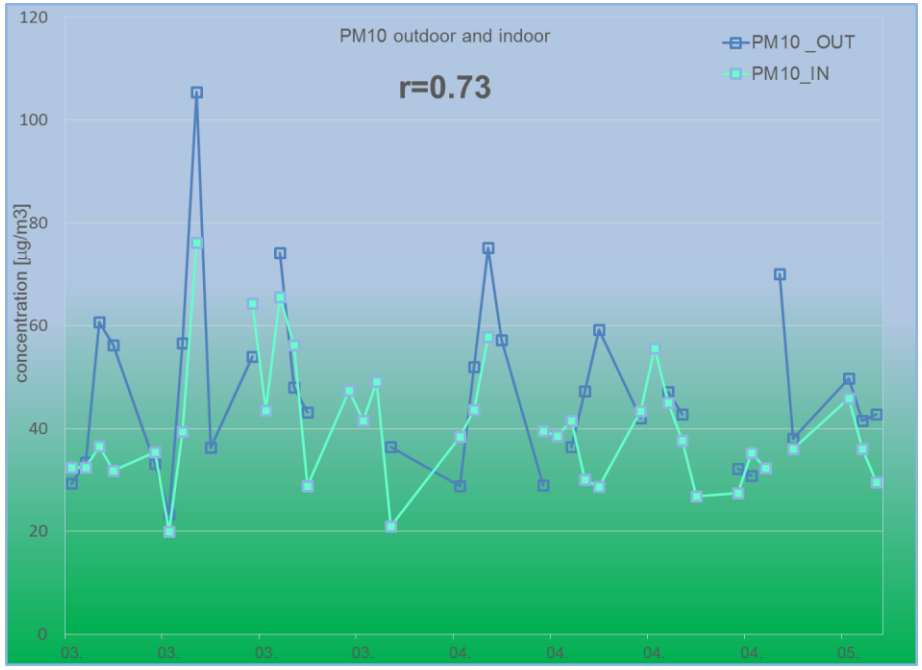
- The indoor concentrations were significant for both size fractions, mean daily concentration, time weighted average value for 24 h, were 40.61 and 32.35 $\mu g/m^3$ for PM10 and PM2.5, respectively.
- Mean daily value of PM10 and PM2.5 indoor concentrations were varied in range 19.93-76.20 and 19.02-63.23 mg/m^3, respectively.
- Outdoor mean daily concentrations for both frictions were higher than indoor, but…

RESULTS: PM10 and PM2.5 mass concentration

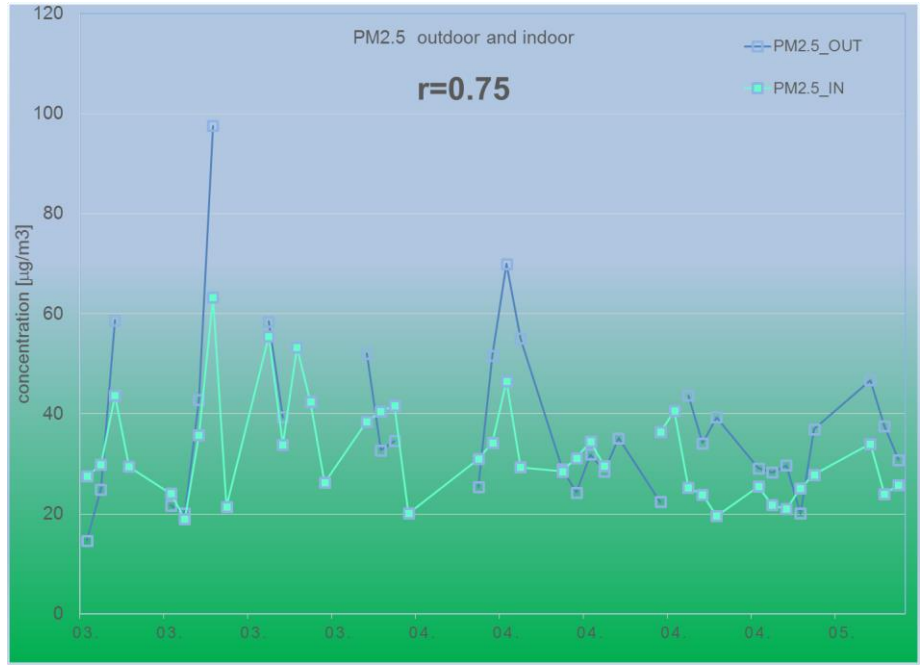
- This study sampling procedure included both time periods, when children were and weren't in classroom, while mean daily indoor PM concentrations might be underestimating the children exposure to particles.
- In all studies where PM measurements were carried out separately during children occupancy, concentrations were about twice as high as mean daily classroom concentrations.
- In anyway, in this study, daily PM concentration for both fractions were higher in indoor than in outdoor of the kindergarten environment, for sure during more than 20% days

RESULTS: PM10 and PM2.5 daily concentration

PM10

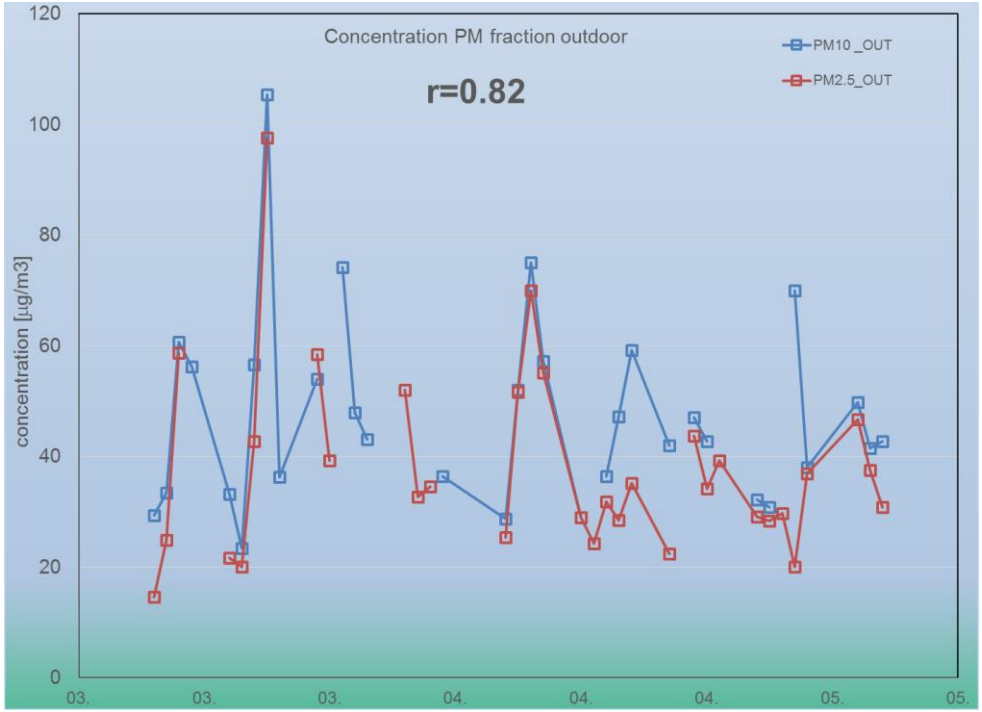


PM2.5

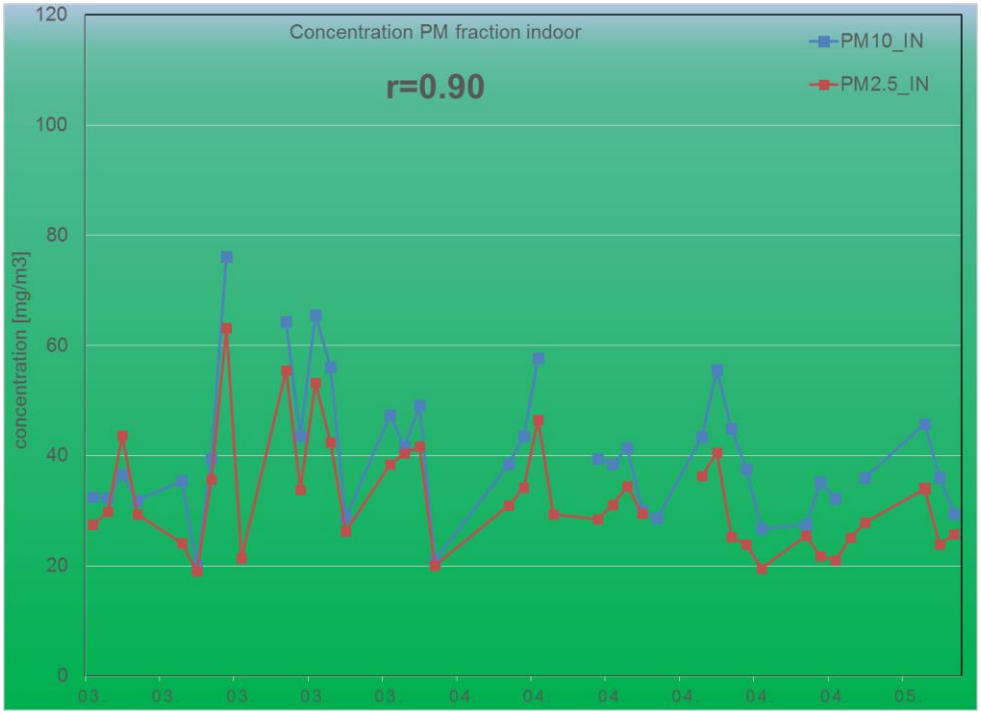


RESULTS: PM10 AND PM2.5 COMPARISON

outdoor



indoor



RESULTS: metals and methaloids

Al, Zn and Fe represent 90% measured elements, metals and methaloids, in both PM fractions.

Metals had higher average concentration in both fractions in outdoor environment in comparsion with indoor microenvironment.

Observed mean values of daily concentrations, in indoor and outdoor environment, for Pb, As, Cd and Ni in PM10 were below EU annual limit values.

It was notified ratio of I/O of analysed elements in PM10:

- Al > 1 (1,21)
- between 0.6 and 0.9 for next element

  0,60<Fe<Sb< Mn<**Pb**<Ti<Se<V<**As**<**Ni** <Co<0,90
- around 1, between 0.95 and 1.05, for Ba, **Cd**, Cr, Cu and Zn.

RESULTS: priority PAHs in PM10 and PM2.5

Average indoor daily values sum of 16 priority PAHs , ΣPAH, were 6,79 and 4,04 ng/m^3 in PM10 and PM2.5, respectively.

During campaign ΣPAH in were higher indoor than outdoor in 23% and 5% of PM10 and PM2.5 samples, respectively.

Characteristic of this sampling site, indoor and outdoor ambient of the kindergarten in city centre of Belgrade:

- content of PAH in Nap-*Naphthalene*, Ane- *Acenapthalene*, Any-*Acenapthene* , Fle-*Flourine,* and Daa-*Dibenzo(ahl)anthracene* were between 0,4 to 1 magnitude **lower** in PM2.5 than in PM10.

RESULTS: priority PAHs in PM10 and PM2.5

PAHs in PM10

Mean daily levels of assigned PAHs in PM10 were higher in indoor environment for all PAHs with 2 and 3 rings (Nap, Ane, Any, Fle, Phe) and one of PAH with 5 rings, that is Daa

For other 10 of 16 selected PAHs in PM10 mean values are higher at outdoor than in indoor environment,

PAHs in PM2.5

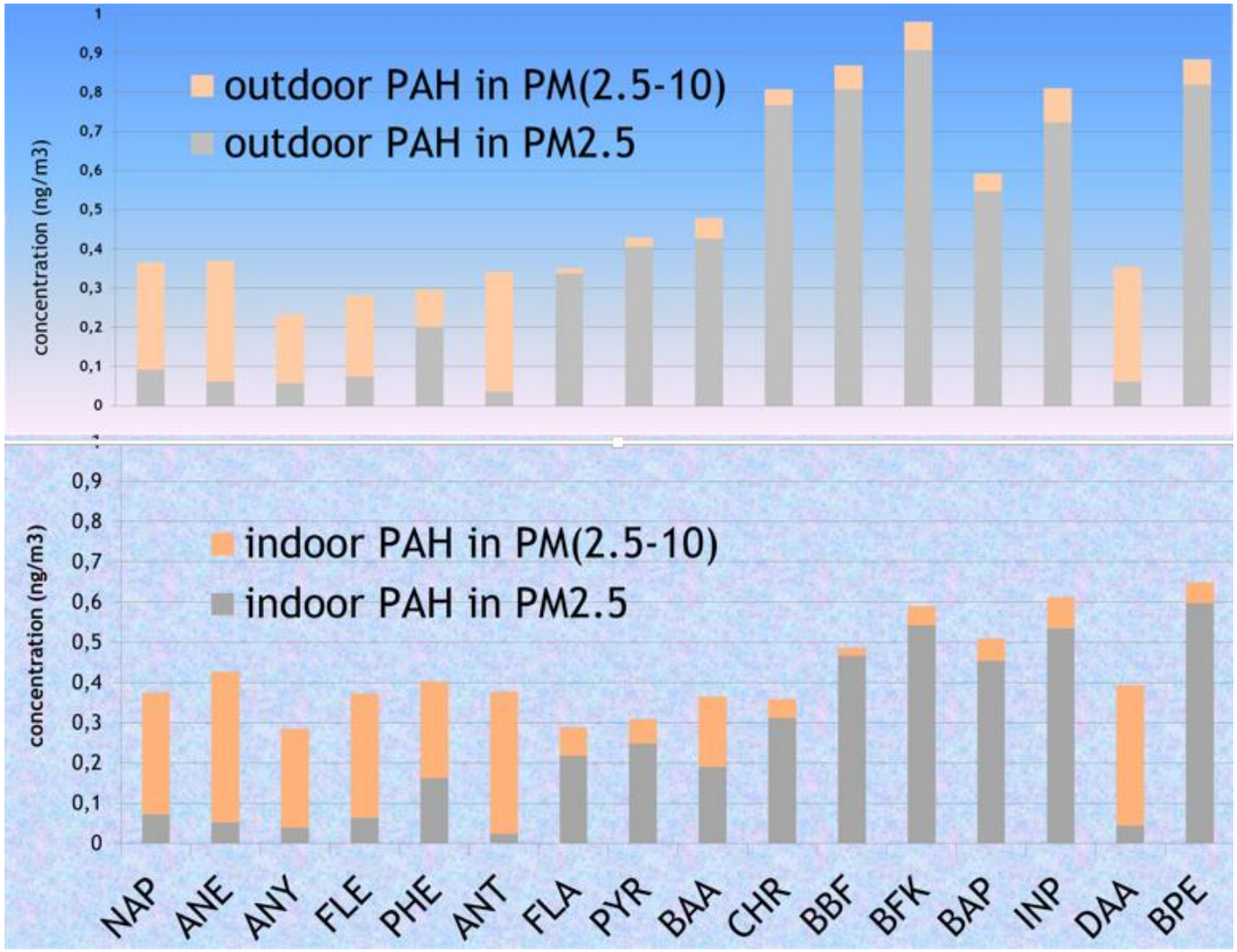
All PAHs in $PM_{2.5}$ were higher outdoor of the kindergarten

BaP as the most representative PAH

Almost all in PM2.5 with concentration of about 0,5 ng/m^3

Average particle bounded PAHs express as ΣBaPE exceeded 1 ng/m^3 for PAHs in PM10, while they were lower than 1 ng/m^3 for PAHs in PM2.5

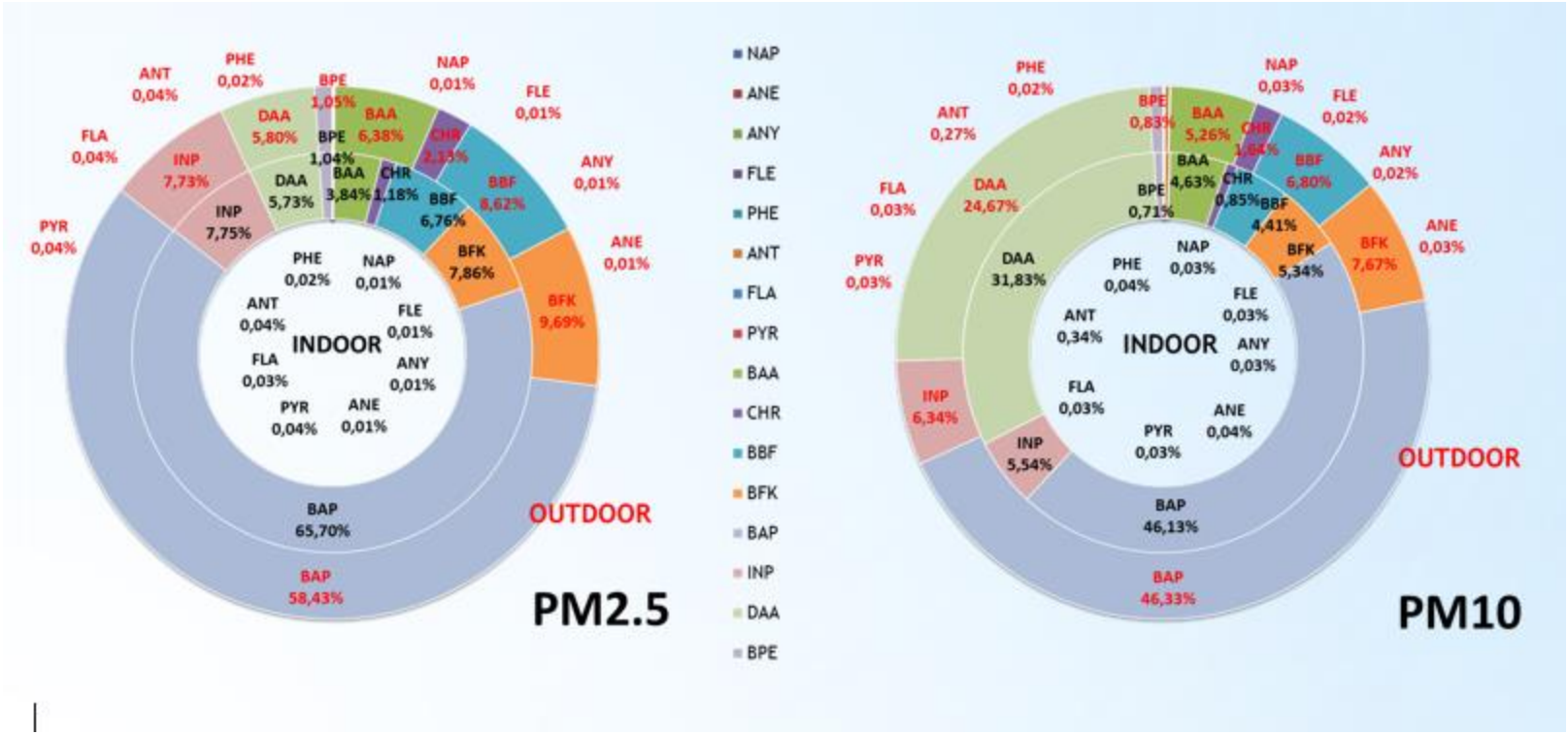
RESULTS: priority PAHs in PM10 and PM2.5



RESULTS: priority PAHs in PM10 and PM2.5

PAH	TEF	BaPE in $PM_{2.5}$		BaPE in PM_{10}	
ng/m^3		Outdoor	Indoor	Outdoor	Indoor
NAP-Naphthalene	0.001	0.0001	0.0001	0.0004	0.0004
ANE-Acenapthalene	0.001	0.0001	0.0001	0.0004	0.0004
ANY-Acenapthene	0.001	0.0001	0.0000	0.0002	0.0003
FLE-Fluorene	0.001	0.0001	0.0001	0.0003	0.0004
PHE-Phenanthrene	0.001	0.0002	0.0002	0.0003	0.0004
ANT-Anthracene	0.01	0.0003	0.0002	0.0034	0.0038
FLA-Fluoranthene	0.001	0.0003	0.0002	0.0004	0.0003
PYR-Pyrene	0.001	0.0004	0.0002	0.0004	0.0003
BAA-Benz(a)anthracene	0.14	0.0597	0.0265	0.0673	0.0512
CHR-Chrysene	0.026	0.0200	0.0081	0.0210	0.0093
BBF-Benzo(b)fluoranthene	0.1	0.0807	0.0467	0.0869	0.0487
BFK-Benzo(k)fluoranthene	0.1	0.0908	0.0543	0.0980	0.0589
BAP-Benzo(a)pyrene	1	0.5471	0.4539	0.5921	0.5092
INP-Indeno(1.2.3-cd) pyrene	0.1	0.0724	0.0535	0.0810	0.0612
DAA-Dibenzo(ah)anthracene	0.89	0.0543	0.0396	0.3152	0.3514
BPE-Benzo(ghi)pyrene	0.012	0.0098	0.0072	0.0106	0.0078
∑ BaPE		0.9363	0.6909	1.2779	1.1038

RESULTS: contribution of BaPE in indoor and outdoor PB-PAHs fractions



CONCLUSIONS

- Data from this study prove that PM10 as well as fine PM concentration exceed limit and target values set in current WHO guideline and EU regulative.
- Average daily PM mass as well as ΣPAHs were higher outdoor than indoor in both PM10 and PM2.5.
- According to the EU regulative, annual limit value for PAHs in PM10 expressed by BaP is 1 ng/m3. During 40 days of sampling campaign PAHs expressed by ΣBaPE exceeded 1 ng/m3 in PM10 in both, indoor and outdoor kindergarten ambient.

CONCLUSIONS AND FURTHER ACTIVITES

- Findings above proved that beside sources from outdoor, such as vehicular emission and combustion sources, in indoor ambient of the kindergarten happened generation or/and resuspansion PM from indoor surfaces that may contribute to higher exposure to selected spices.
- Our preliminary results order to follow analyses of PAH diagnostic ratio and investigations of source apportionment of metals, methaloids and PAHs in kindergarten microenvironment.