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

COST Action TD1105

Special Session: *Measuremetns of PM Pollutants Accumulated on Plant Leaves in Poland*

Duisburg, Germany, 4 - 6 March 2013

Action Start date: 01/07/2012 - Action End date: 30/06/2016

Year: 2012-2013 (*Starting Action*)

Helena Gawrońska

Function in the Action : replacement for MC Member of WG 3 - Stanislaw W. Gawronski

Laboratory of Basic Research in Horticulture

Faculty of Horticulture, Biotechnology and Landscape Architecture

Warsaw Univesrity of Life Sciences-SGGW, Warsaw, Poland

COST is supported by the EU Framework Programme

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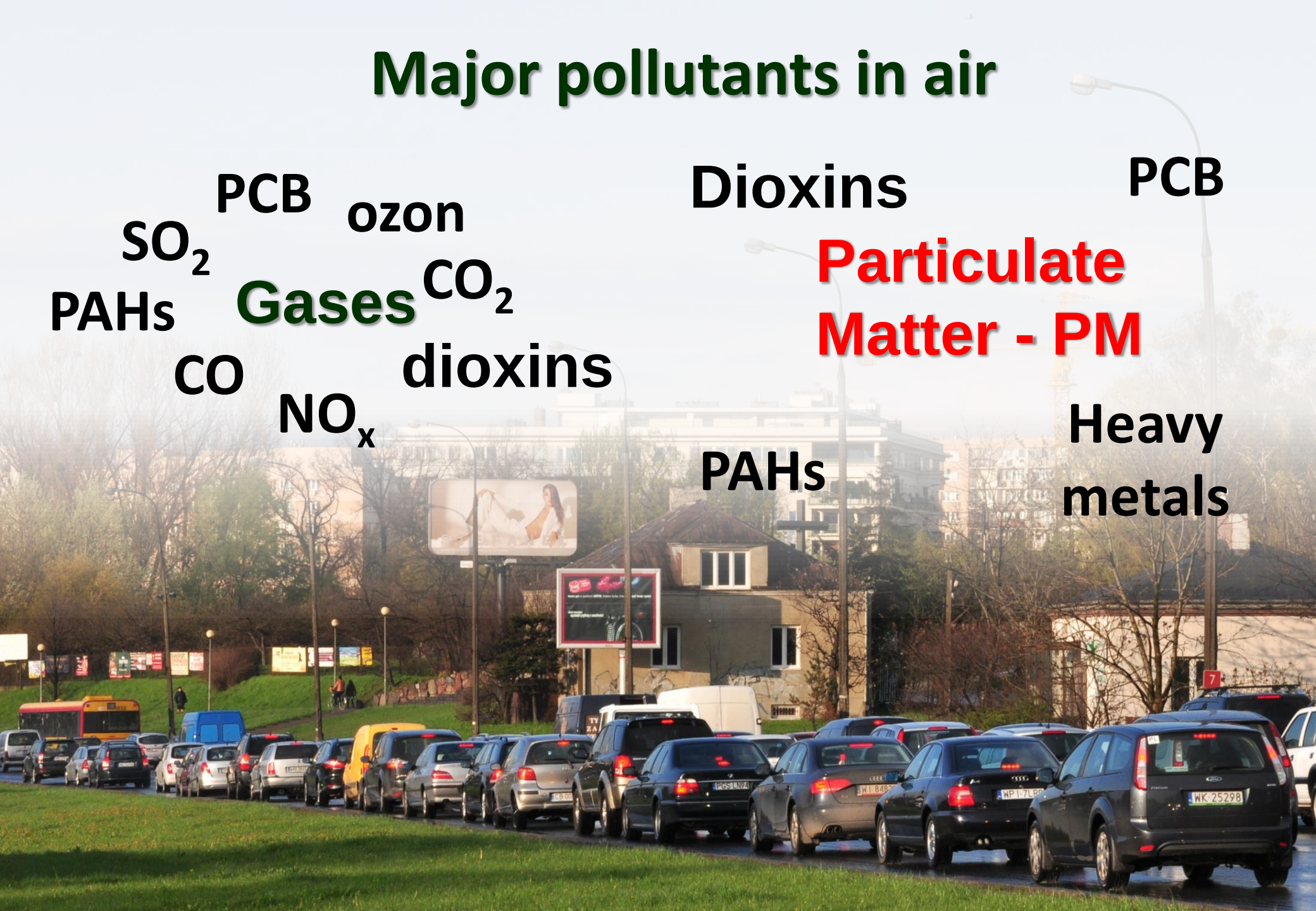
Major pollutants in air



Background/Problem statement:

- - Particulate matter (PM) are harmful for man, being responsible for various allergic, respiratory and cardiovascular systems diseasis including cancer of both
  - PM is the 2nd after nicotine factor causing lung cancer
  - PM, on average, shortens Europeans life expectancy by 8 months, in cleanest part like Finland only by 4 months but in some sites in Europe even by 3 years (Silesia, Poland; Po Valey, Italy; border Belgium and Germany).

Challenge(s): Improving air quality and reduce human health risk by phytoremediation of PM from the air

- **Objectives of our studies were/are to:**

  (i) compare genetic ability of various plant species in PM capturing

  (ii) estimate potential of selected species for „harvesting” PM from air

  (iii) evaluate effect of PM presence on leaves on leaf vital processes and

  (iv) using plants to clean up air in places where we live, work and play including indoor

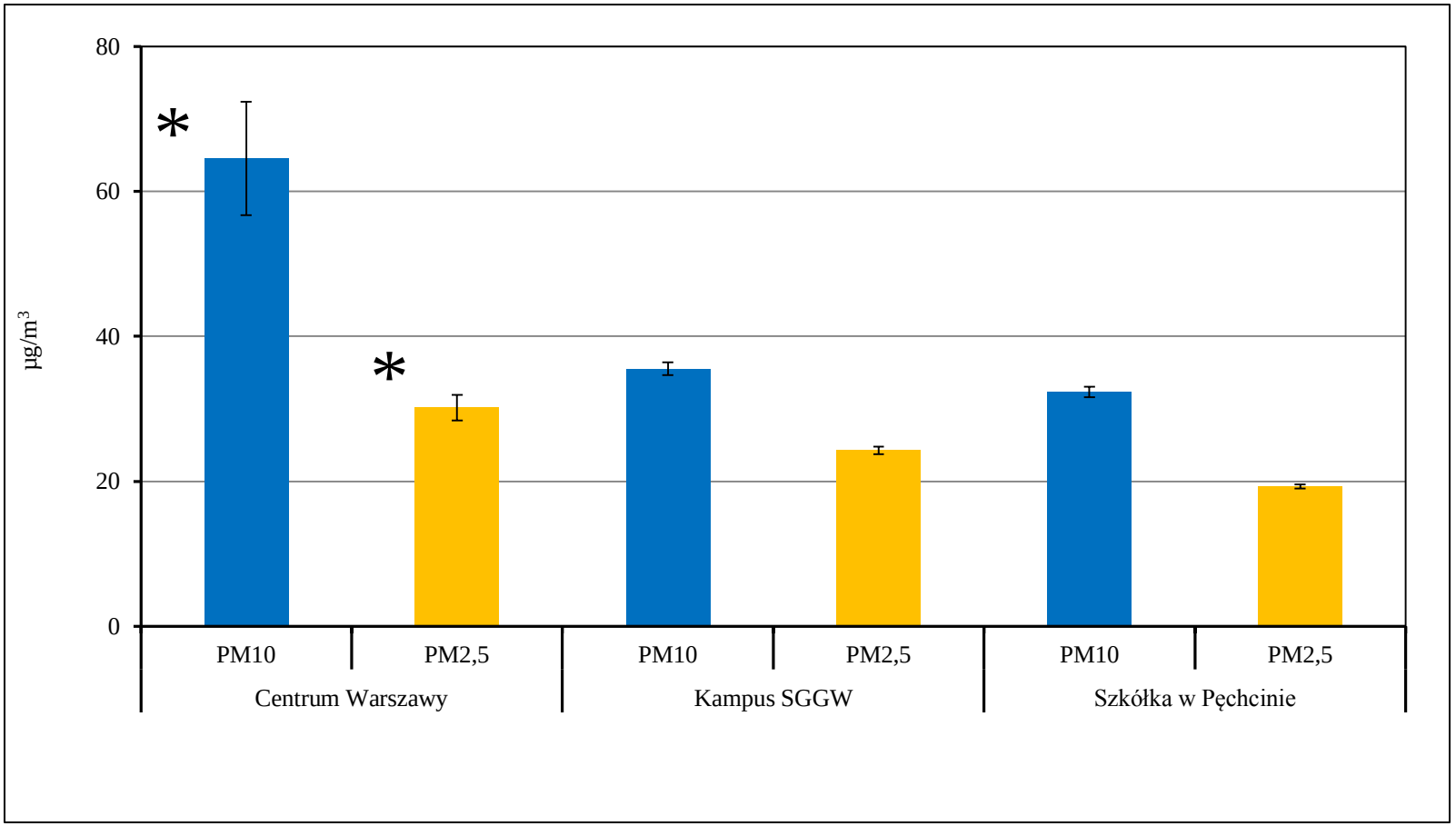
- **Involvement in WP3 of this COST Action**

Current activities:

(i) Measurements of PM accumulated on leaves of selected, for urban areas, 22 trees species exposed to nearly the same level of PM in air

(ii) Searching for relationships between amount of PM accumulated on leaves and selected leaves characteristics: amount of waxes, leaf shape, hairiness

Concentration of PM in the air in 3 locations used in this study



Current activities:

(iii) Comparative study on amount of PM accumulated on leaves of 7 selected plant species grown in locations varying in the level of PM (high/ medium and low) in the air (locations as above)

(iv) Evaluation of the effect of PM on leaves functions based on some physiological processes on leaves of 7 selected plant species grown in locations varying in the level of PM (locations as above) and

(v) Estimation of the potential of selected species for PM „harvesting" PM from air

LBRH of WULS is eguipped with: apparatus for PM_{10} and $PM_{2.5}$

Aspirator Bravo Plus HV measures PM_{10} and $PM_{2.5}$ in the air

$1m^3$ of air on WUSL campus contains :

PM_{10} - 34,6 $\mu g\ m^{-3}$

$PM_{2,5}$ - 29,0 $\mu g\ m^{-3}$

UE norm:

40 $\mu g\ m^{-3}$ average per day in year

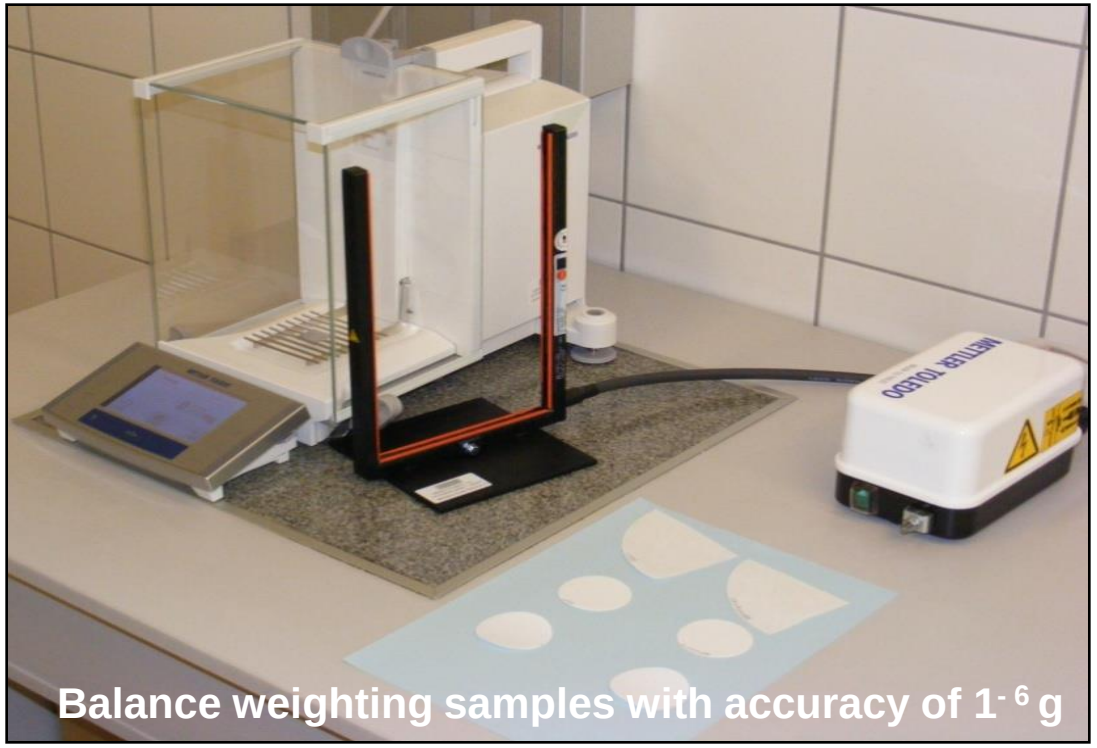
50 $\mu g\ m^{-3}$ maximum in day during 35 days a year

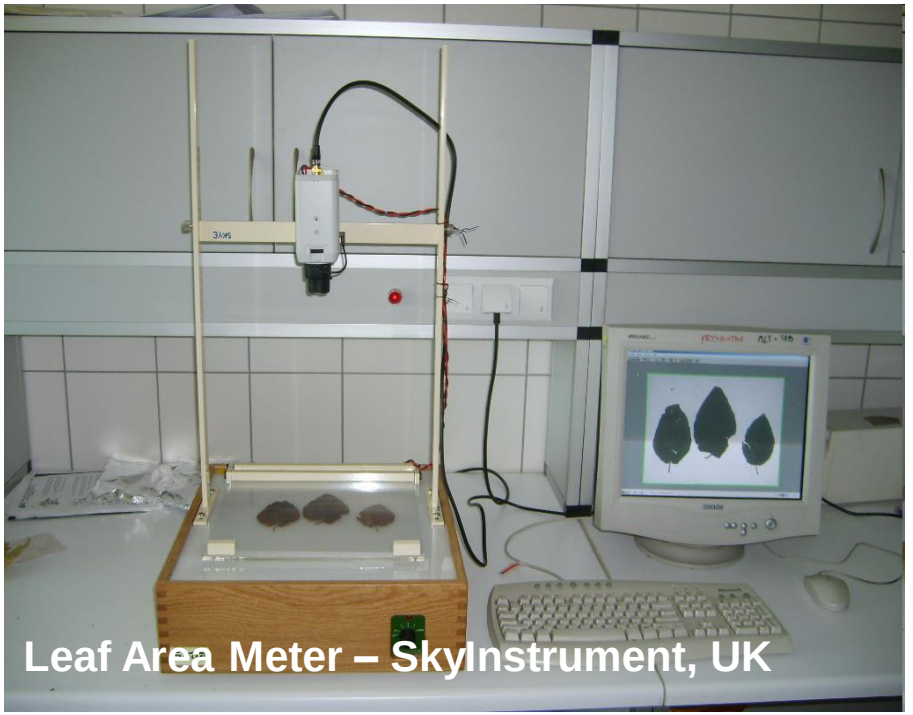
By 2020 it is planned to have limit of 20 $\mu g\ m^{-3}$

Equipment and utensils used for PM measurements

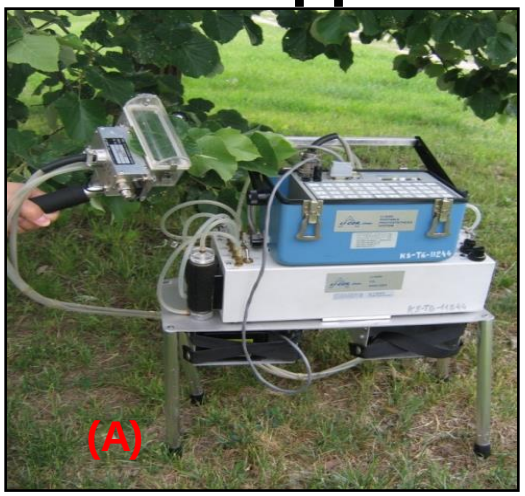

Unit for filtration

Filters with collected PM

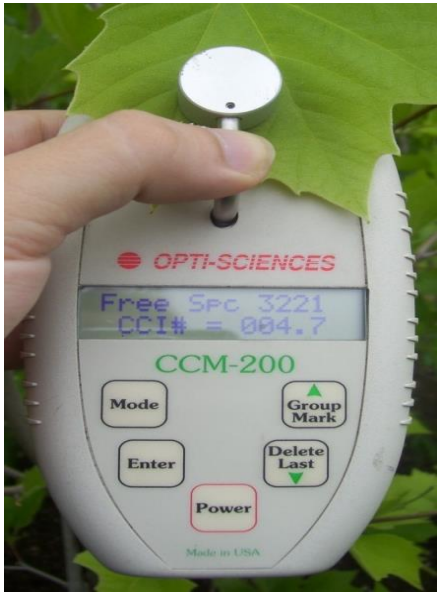

Balance weighting samples with accuracy of 1^{-6} g


Leaf Area Meter – SkyInstrument, UK

Equipment for evaluation of efficency of photosynthetic apparatus and plant water status



Portable Photosynthesis System LICOR model 6200 (A) and 6400 (B) (Lincoln, Nebraska, USA)



Chlorophyl Meter CCM 200, OPTI SCIENCES, USA

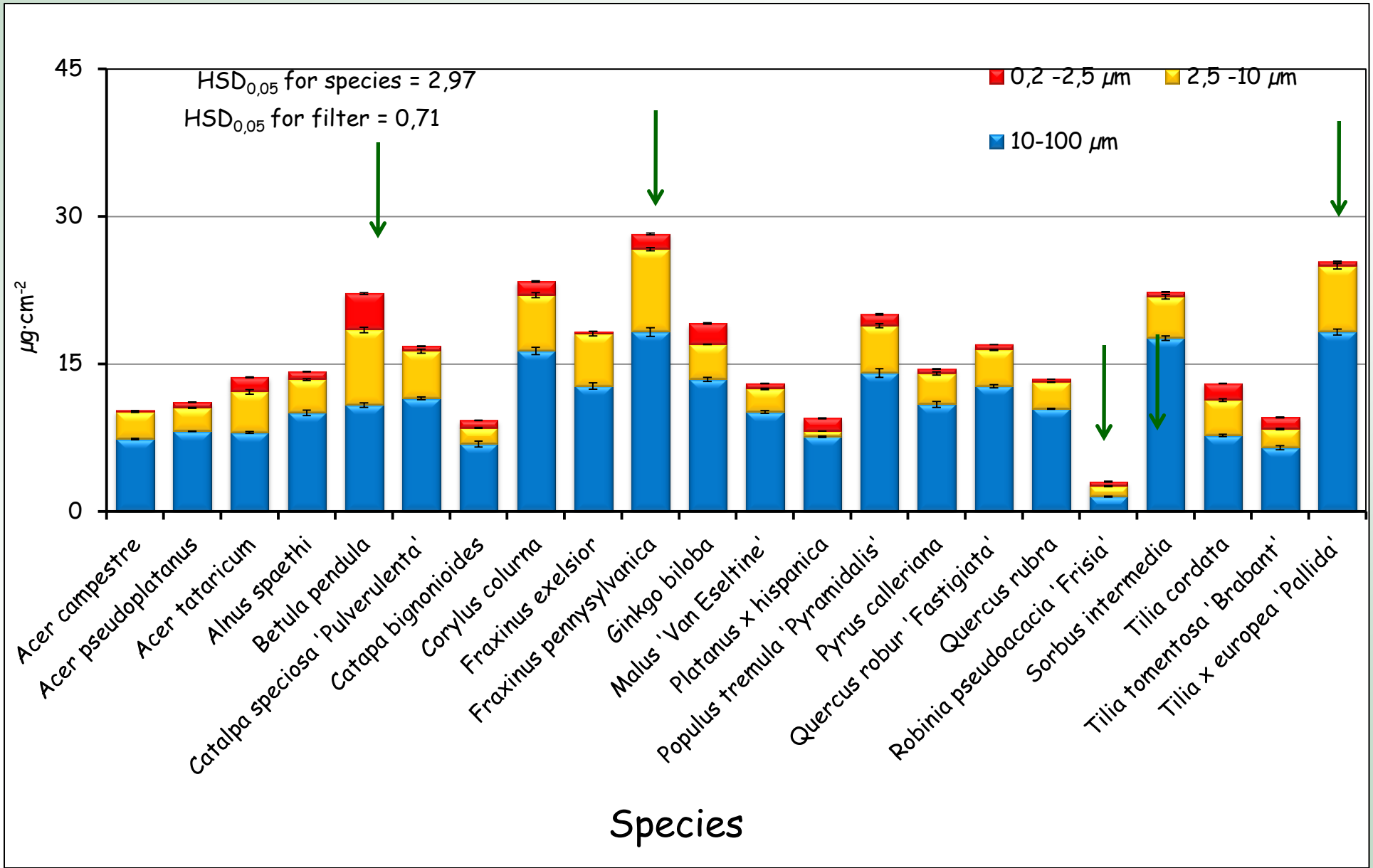
Fluorimeter Handy PEA, (Hansatech, UK)

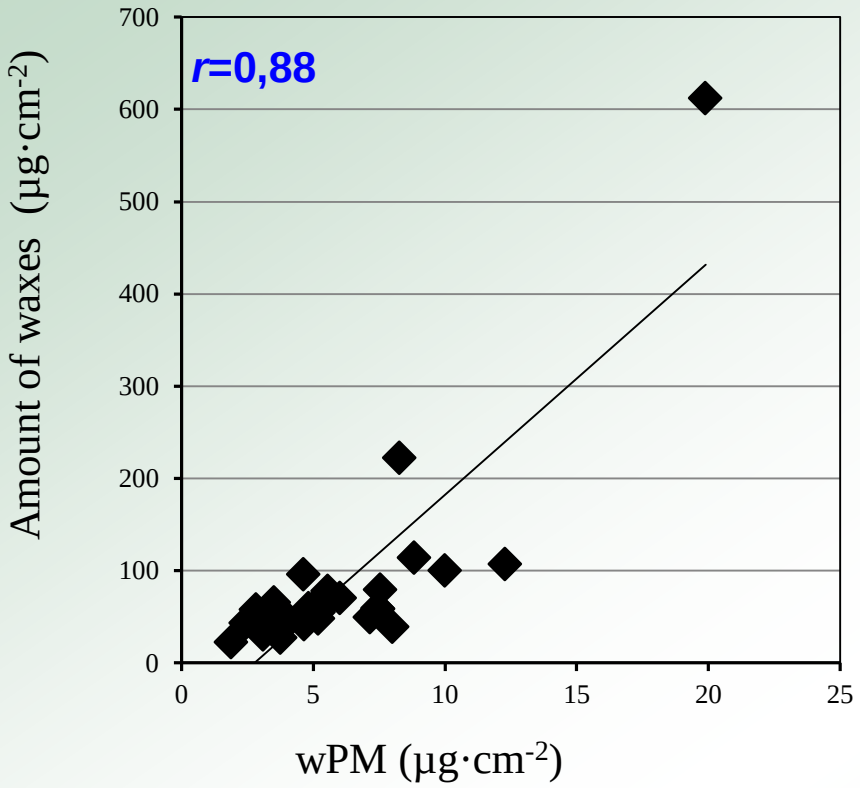
Achieved results:

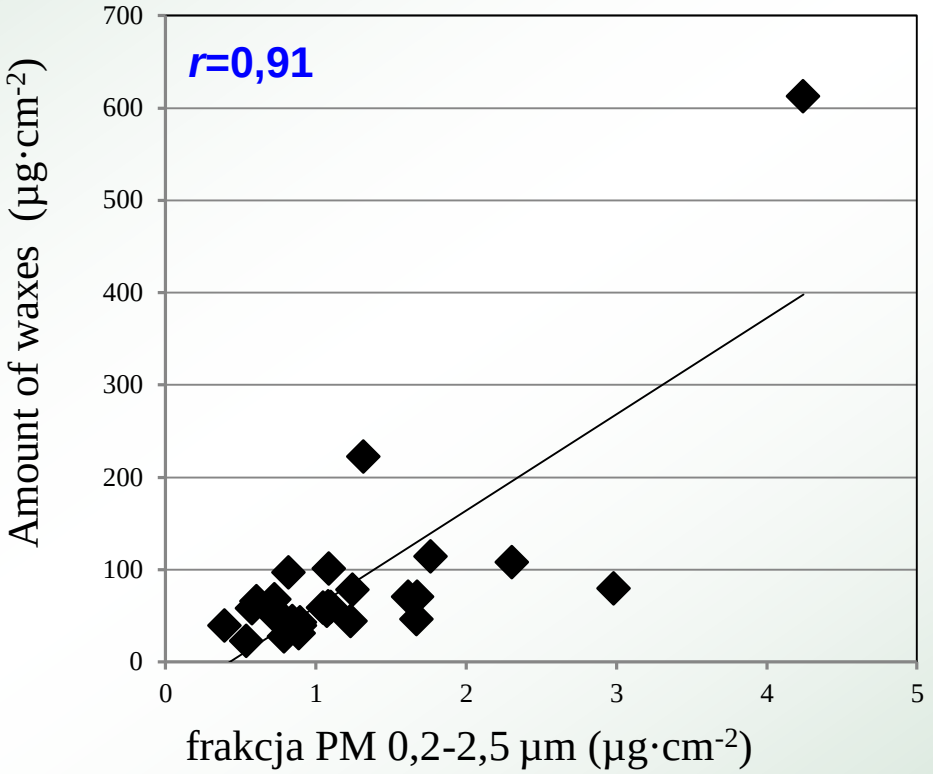
Particulate matter and waxes deposited on trees leaf surface (μg cm^{-2})

Species	PM			Waxes
	PM_{11}	$PM_{2,5}$	Σ	
Quercus rubra	12,0	2,8	14,8	110,6
Populus simoni	27,4	9,9	37,3	86,5
Betula pendula	34,3	9,5	43,8	645,7
Pyrus calleryana	33,4	10,0	43,4	157,2
Fraxinus excelsior	23,2	5,6	28,8	94,9
Sorbus intermedia	31,0	11,4	42,4	91,0
Cornus alba	15,5	5,3	20,8	122,3

Amount of particulate matter deposited on leaf surface and in waxes of 22 tree species

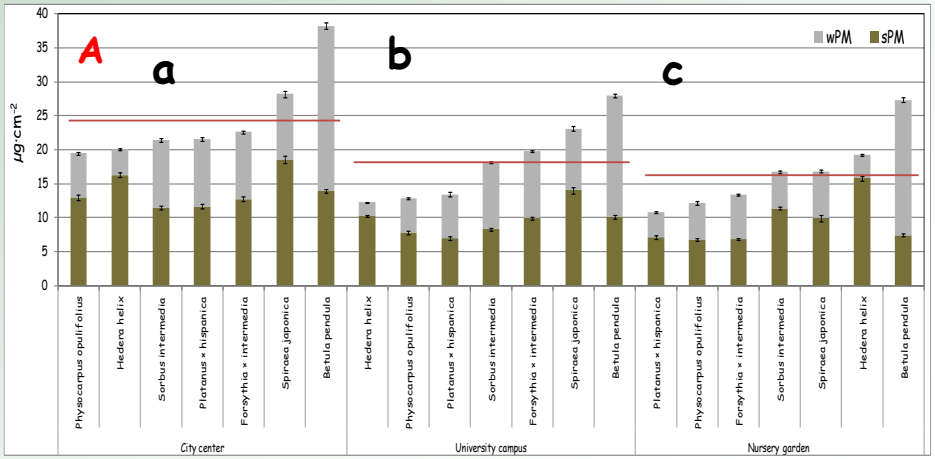


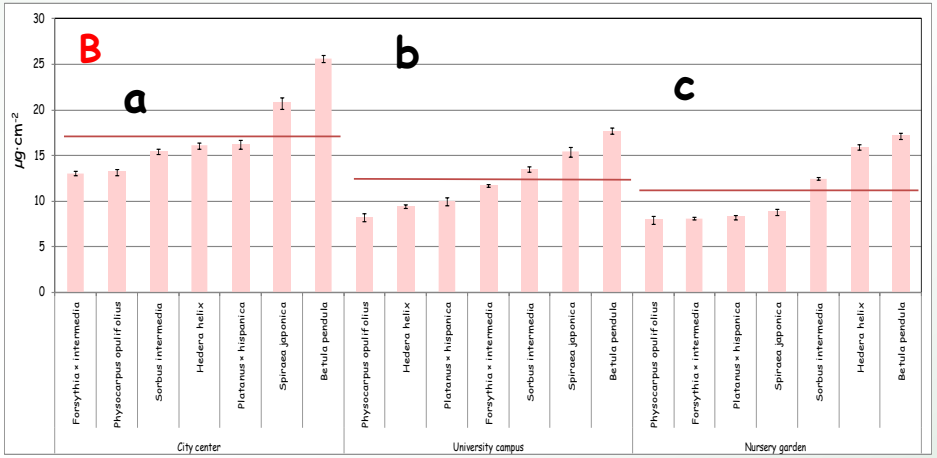


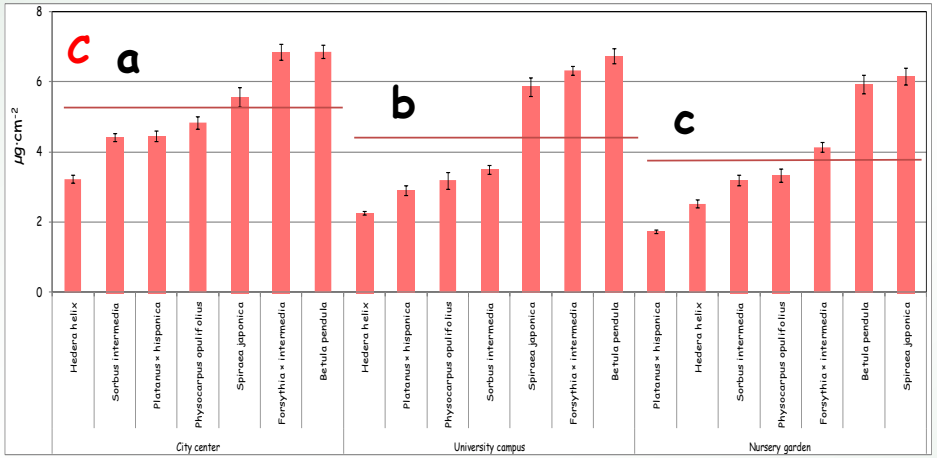


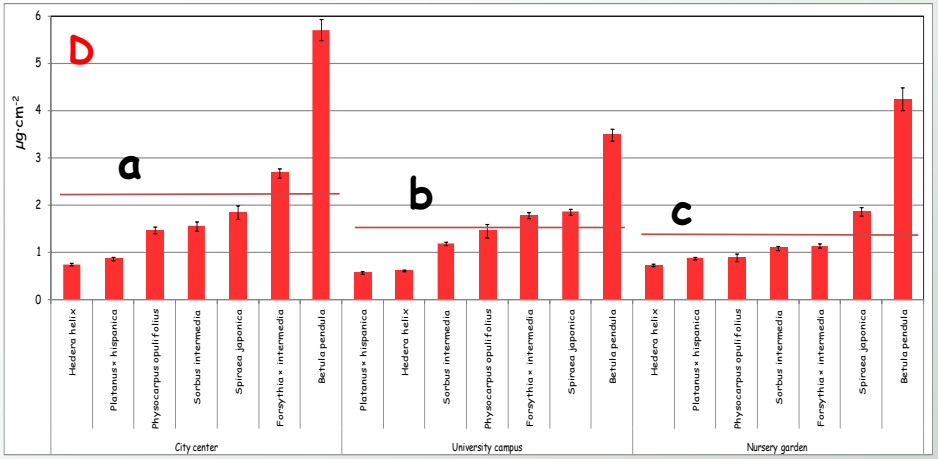
Correlation coeficient (r) between amount of waxes and amount of $_{w}$PM of all size fractions accumulated on leaves (A) and between amount of waxes and amount of PM of size fraction 2.5 - 0.25.

Amount of PM on leaves of seven woody species grown at three locations differing in level of PM in air. (A) total PM with specifying of sPM and wPM, (B) PM in size fraction 10 -100 μm, (C) PM in size fraction 2,5 -10 μm and (D) PM in size fraction 0,2 – 2,5 μm. Horizontal lines represents average for location.

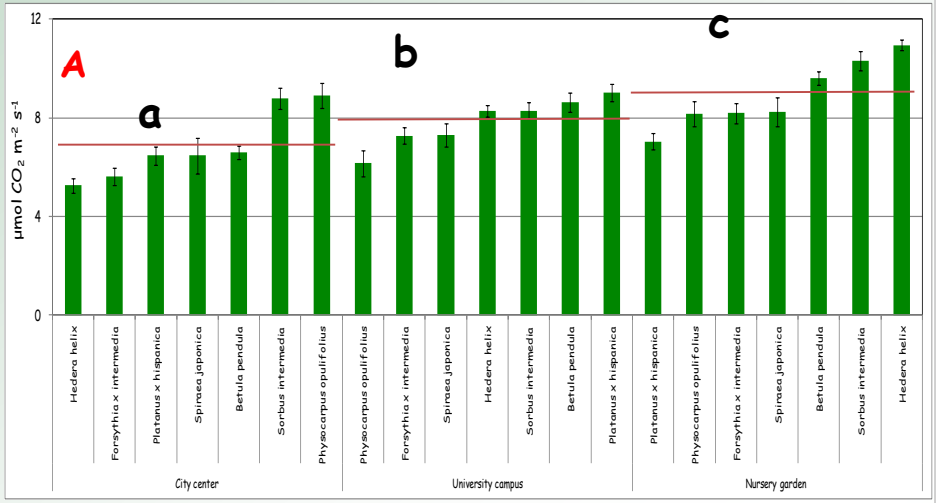


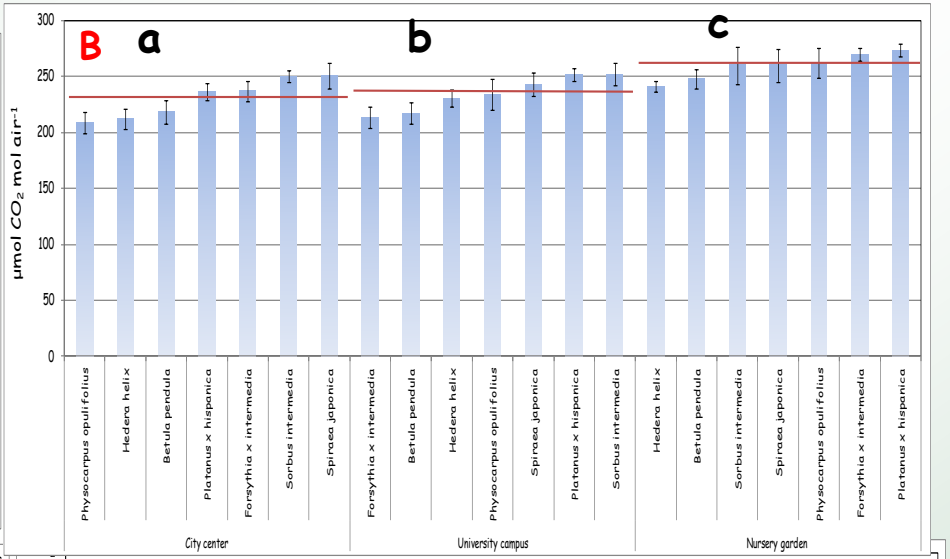


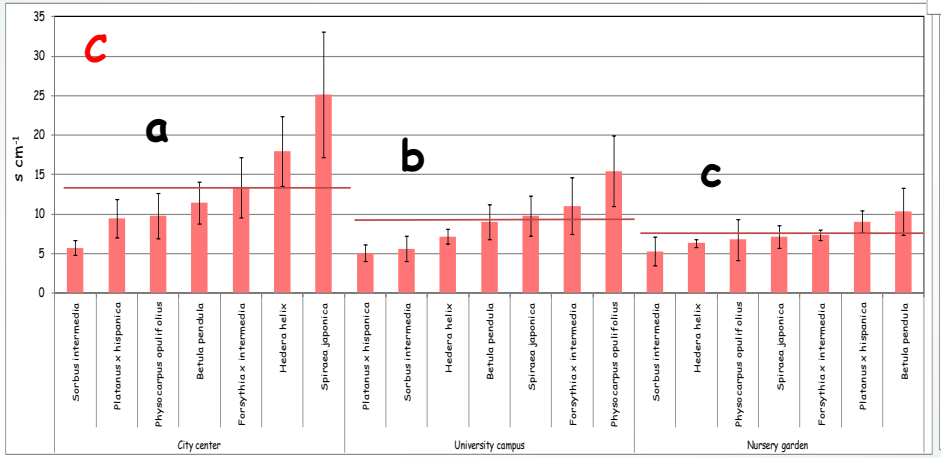


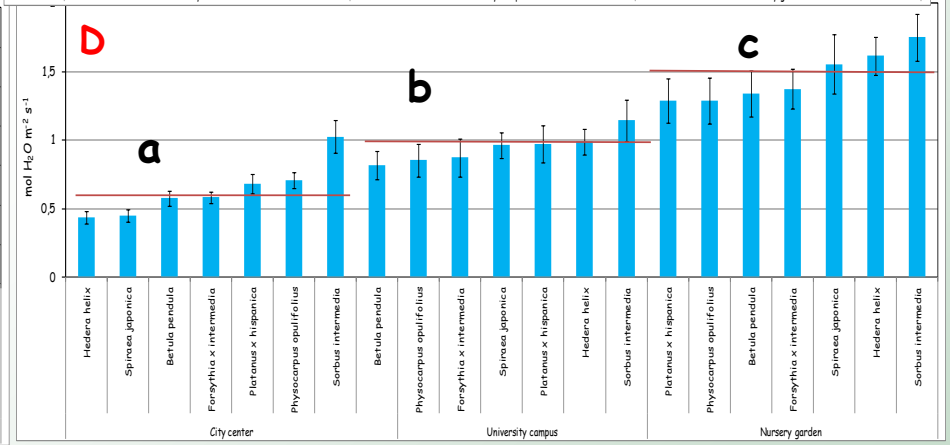


Effect of PM level recorded in 3 tested locations on intensity of photosynthesis (A), internal CO_2 concetration (B), stomatal resitance (C) and transpiration (D). Data are mean ±SE, (n= between 400 and 600 = 10 biological replications (iindividual plants), 5 measurements each, 4 months and 2 or 3 years), Horizontal lines represents average for location.









Permissible level of PM_{10}: 40 $\mu g\ m^{-3}$ of air

Annual emission of PM_{10} in Warsaw ~ **4 ton**

what means ~ **8 mg/m^2 of ground**

Linden tree of 5 m in height might accumulate on leaves ~ **2 g PM_{10}**

INNOVATIONS:

- Using, for cultivation in man surroundings, plant species with high ability for PM accumulation on leaf's surface and phytostabilization in waxes is recommended
- Phytoremedation of PM from environment, together with toxic compounds condensed on them, is possible via plant biomass composting and incineration in controlled manner.

Activities directions as future ACTIVITIES:

- Selection of plant species of high phytoremediation ability and suitable for cultivation in surrounding of roads with heavy traffic
- Evaluation of usefulnes of plants for indoor phytoremediation

CONCLUSIONS:

- Vegetation plays important role in uptake of particulate matter from air
- Plant species/cultivars significantly differ in ability to uptake particulate matter from air
- There are plant species which are able to survive in polluted city environment without inhibition of crucial vital processes as photosynthesis.

Recent, related to topic of this meeting, publications:

1. Popek R. Gawrońska H.; Wrochna M., Gawroński S.W., Sæbø A. 2013. Particulate matter on foliage of 13 woody species: Deposition on surfaces and phytostabilisation in waxes – a 3-year study. *Journal of Phytoremediation* 15, 3, 1: 245-256
2. Sæbø A., Popek R., Nawrot B., Hanslin H.M., Gawronska H.. Gawronski S.W. 2012. Plant species differences in particulate matter accumulation on leaf surfaces. Science of the Total Environment 427–428 (2012) 347–354
3. Gawroński S.W. Greger M., Gawrońska.2011. Plant taxonomy in metal phytoremediation. In: Eds. Sherameti I., Varma A. 2011. Detoxification of Heavy Metals, Springer-Verlag: 91-110.
4. Dzierżanowski K., Popek R., Gawrońska H., Sæbø A., Gawroński S.W., 2011. Deposition of particulate matter of different size fractions on leaf surfaces and in waxes of urban forest species. *International Journal of Phytoremediation* 13: 1037-1046.

Team:

Robert Popek
Kajetan Dzierżanowski
Helena Gawrońska
Stanisław W. Gawroński - team leader

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Thank you for your attention

Welcome to Warsaw University of Life Sciences-SGGW