Green Barriers to Reduce Pollution: Results of a Long-Term Experiment

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Co-authors:, Mori J., Massa D., Burchi G., Zammarchi F., Moura B.

Hong Kong 2022 International Urban Forestry Conference

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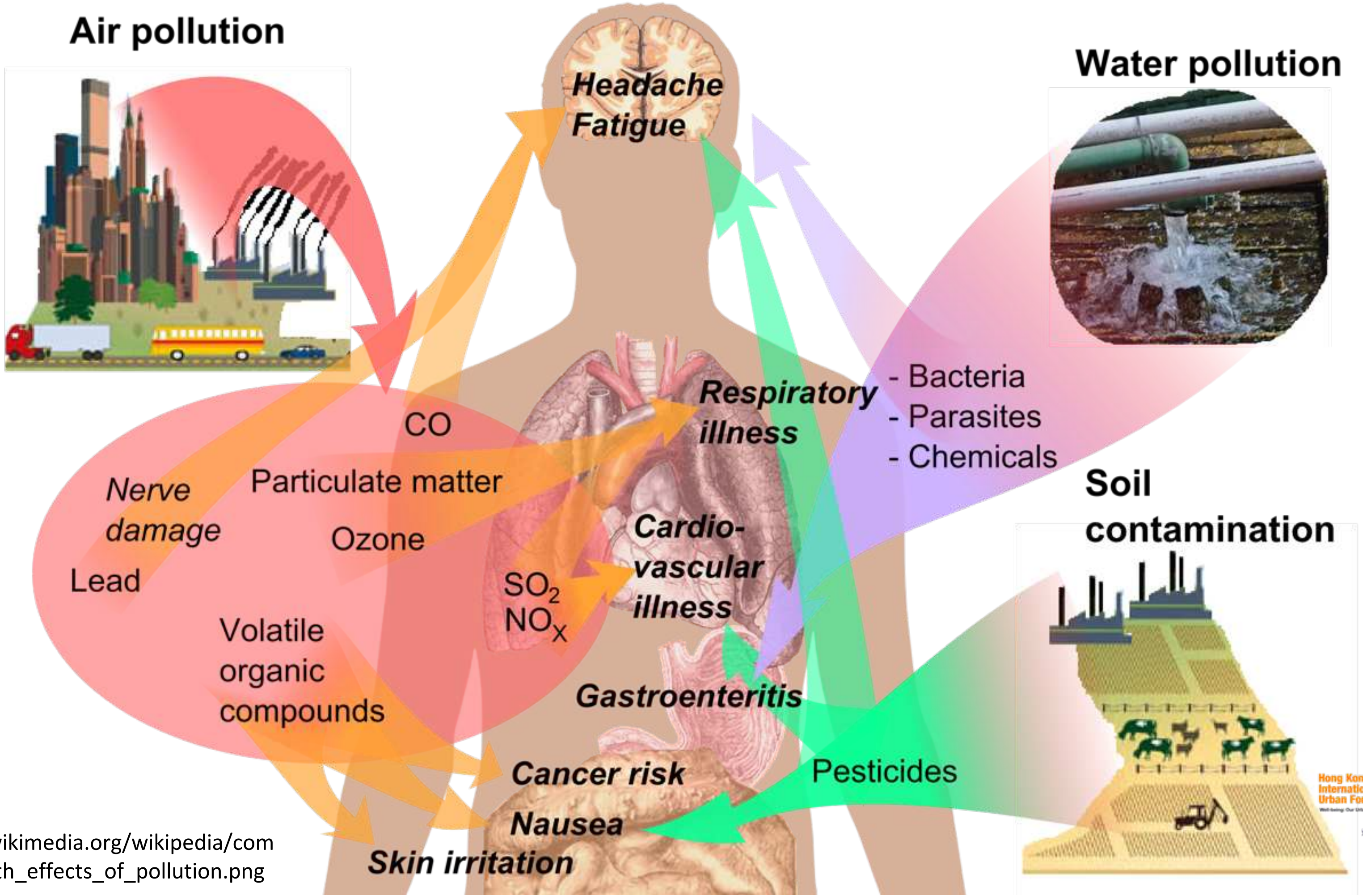
3Bmeteo

Health effects of pollution



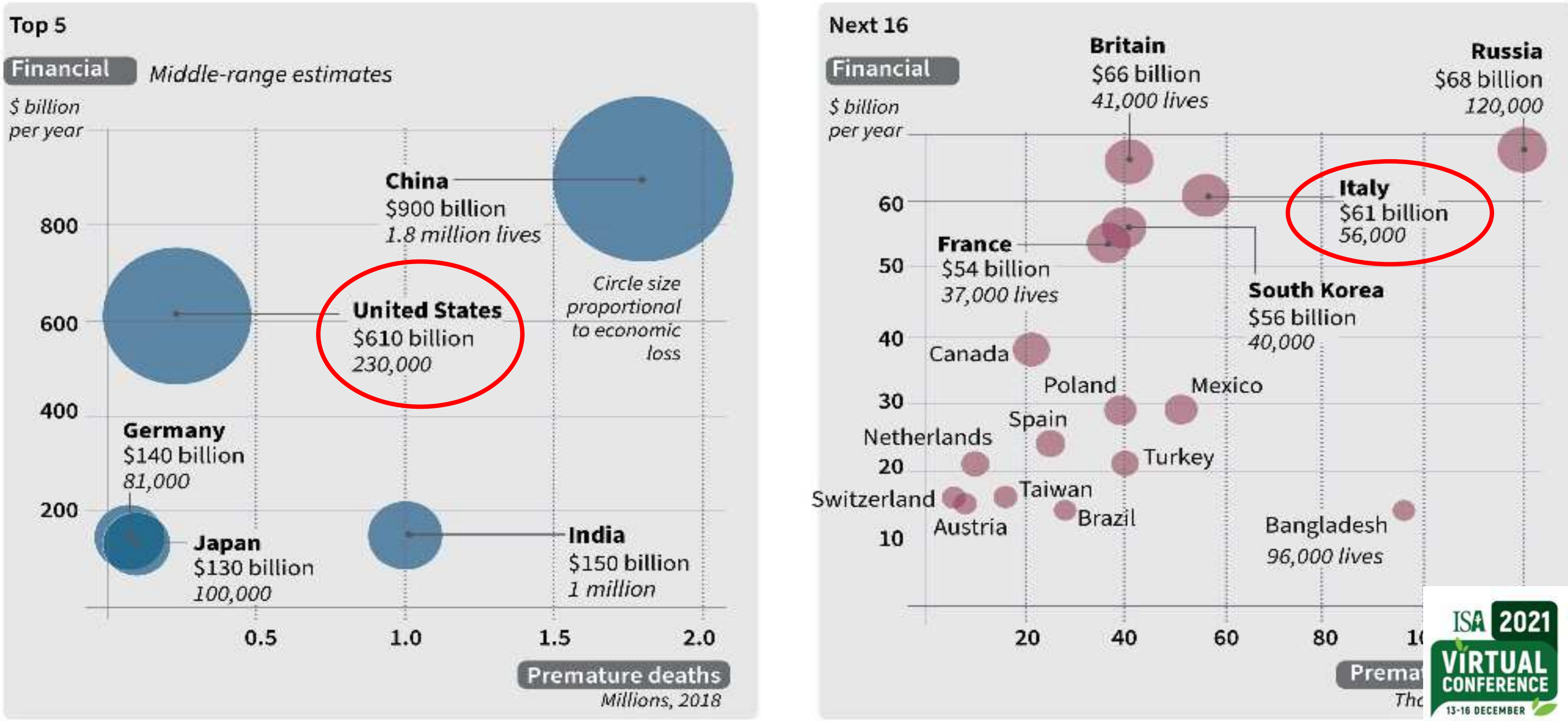
https://upload.wikimedia.org/wikipedia/commons/d/df/Health_effects_of_pollution.png

Cash and lives: the global cost of air pollution

Air pollution costs $2.9 trillion a year worldwide and causes 4.5 million premature deaths: NGO report

Findings from the CREA* and Greenpeace Southeast Asia *Assessesment of costs from burning oil, gas and coal*

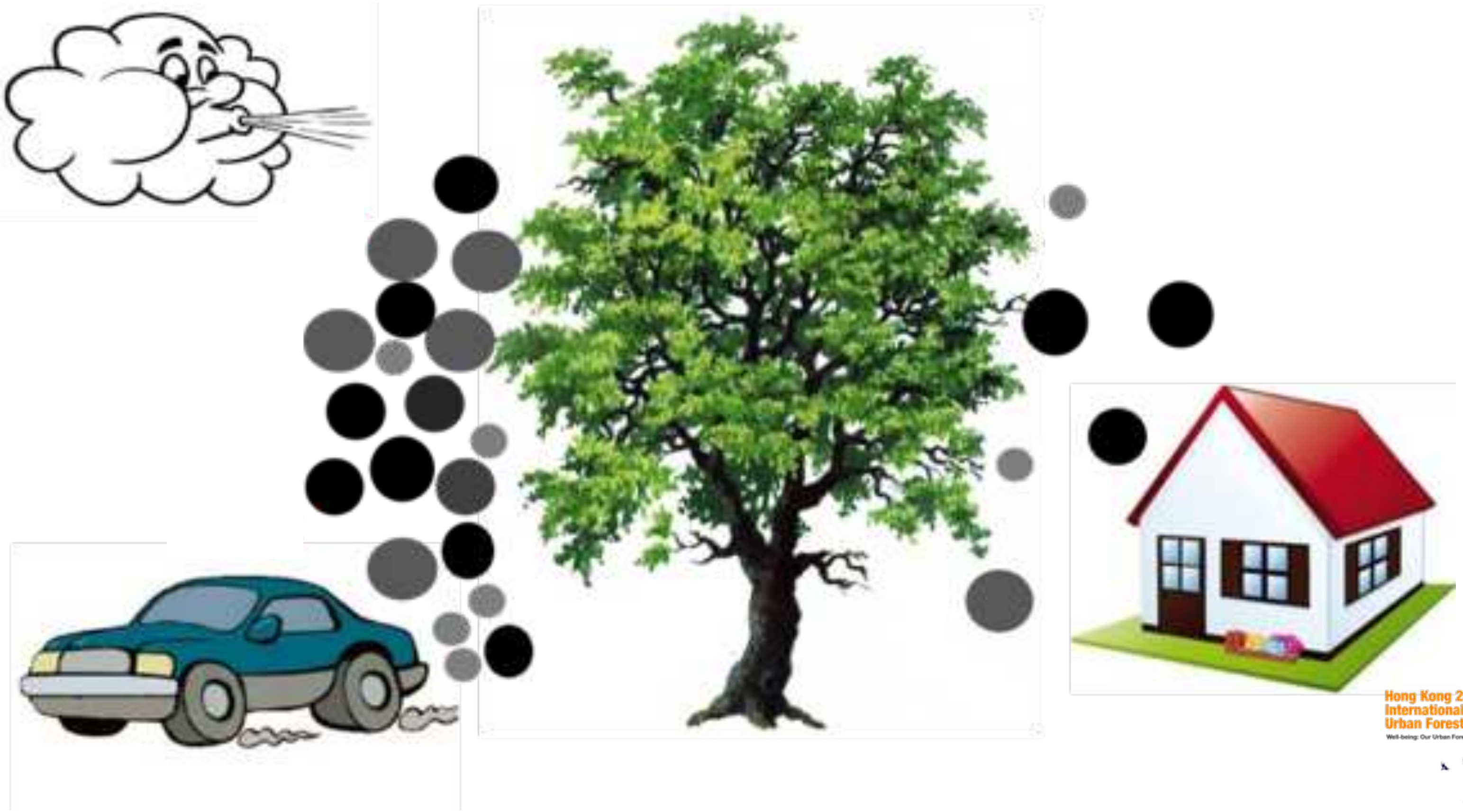
Countries paying the highest costs



Source: *Centre for Research on Energy and Clean Air/Greenpeace Southeast Asia


IF YOU ONLY FOCUS ON THE
PROBLEM
YOU MIGHT MISS THE EASY
SOLUTION

Plants improve air quality by adsorption and absorption of air pollutants on their surfaces and in their tissues.



The 2021 report of the *Lancet* Countdown on health and climate change: code red for a healthy future

Marina Romanello, Alice McGushin, Claudia Di Napoli, Paul Drummond, Nick Hughes, Louis Jamart, Harry Kennard, Pete Lampard, Baltazar Solano Rodriguez, Nigel Arnell, Sonja Ayeb-Karlsson, Kristine Belesova, Wenjia Cai, Diarmid Campbell-Lendrum, Stuart Capstick, Jonathan Chambers, Lingzhi Chu, Luisa Ciampi, Carole Dalin, Niheer Dasandi, Shouro Dasgupta, Michael Davies, Paula Dominguez-Salas, Robert Dubrow, Kristie L Ebi, Matthew Eckelman, Paul Ekins, Luis E Escobar, Lucien Georgeson, Delia Grace, Hilary Graham, Samuel H Gunther, Stella Hartinger, Kehan He, Clare Heaviside, Jeremy Hess, Shih-Che Hsu, Slava Jankin, Marcia P Jimenez, Ilan Kelman, Gregor Kiesewetter, Patrick L Kinney, Tord Kjellstrom, Dominic Kniveton, Jason K W Lee, Bruno Lemke, Yang Liu, Zhao Liu, Melissa Lott, Rachel Lowe, Jaime Martinez-Urtaza, Mark Maslin, Lucy McAllister, Celia McMichael, Zhifu Mi, James Milner, Kelton Minor, Nahid Mohajeri, Maziar Moradi-Lakeh, Karyn Morrissey, Simon Munzert, Kris A Murray, Tara Neville, Maria Nilsson, Nick Obradovich, Maquins Odhiambo Sewe, Tadj Oreszczyn, Matthias Otto, Fereidoon Owfi, Olivia Pearman, David Pencheon, Mahnaz Rabbaniha, Elizabeth Robinson, Joacim Rocklöv, Renee N Salas, Jan C Semenza, Jodi Sherman, Liuhua Shi, Marco Springmann, Meisam Tabatabaei, Jonathon Taylor, Joaquin Trinanes, Joy Shumake-Guillemot, Bryan Vu, Fabian Wagner, Paul Wilkinson, Matthew Winning, Marisol Yglesias, Shihui Zhang, Peng Gong, Hugh Montgomery, Anthony Costello, Ian Hamilton

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https://doi.org/10.1016/S0140-6736(21)02281-9

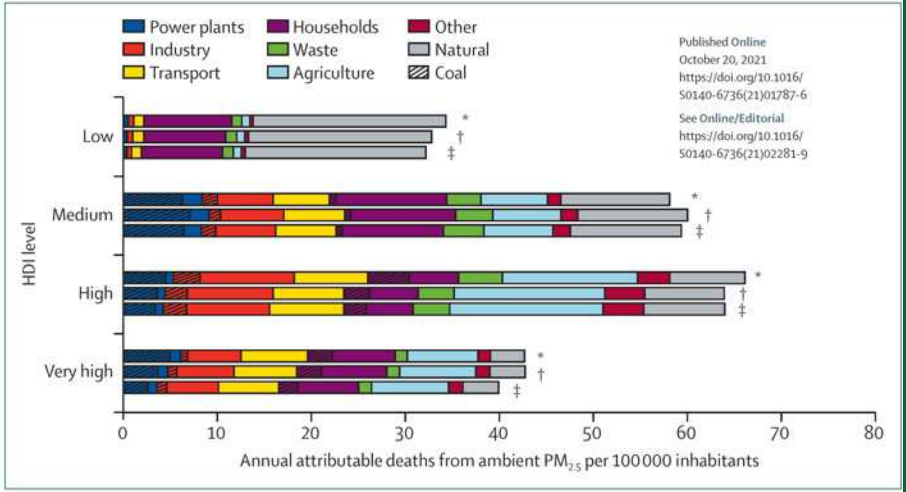
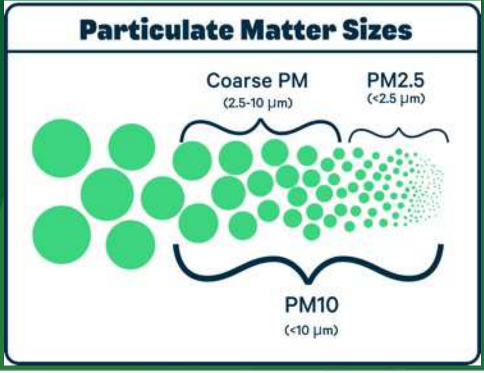
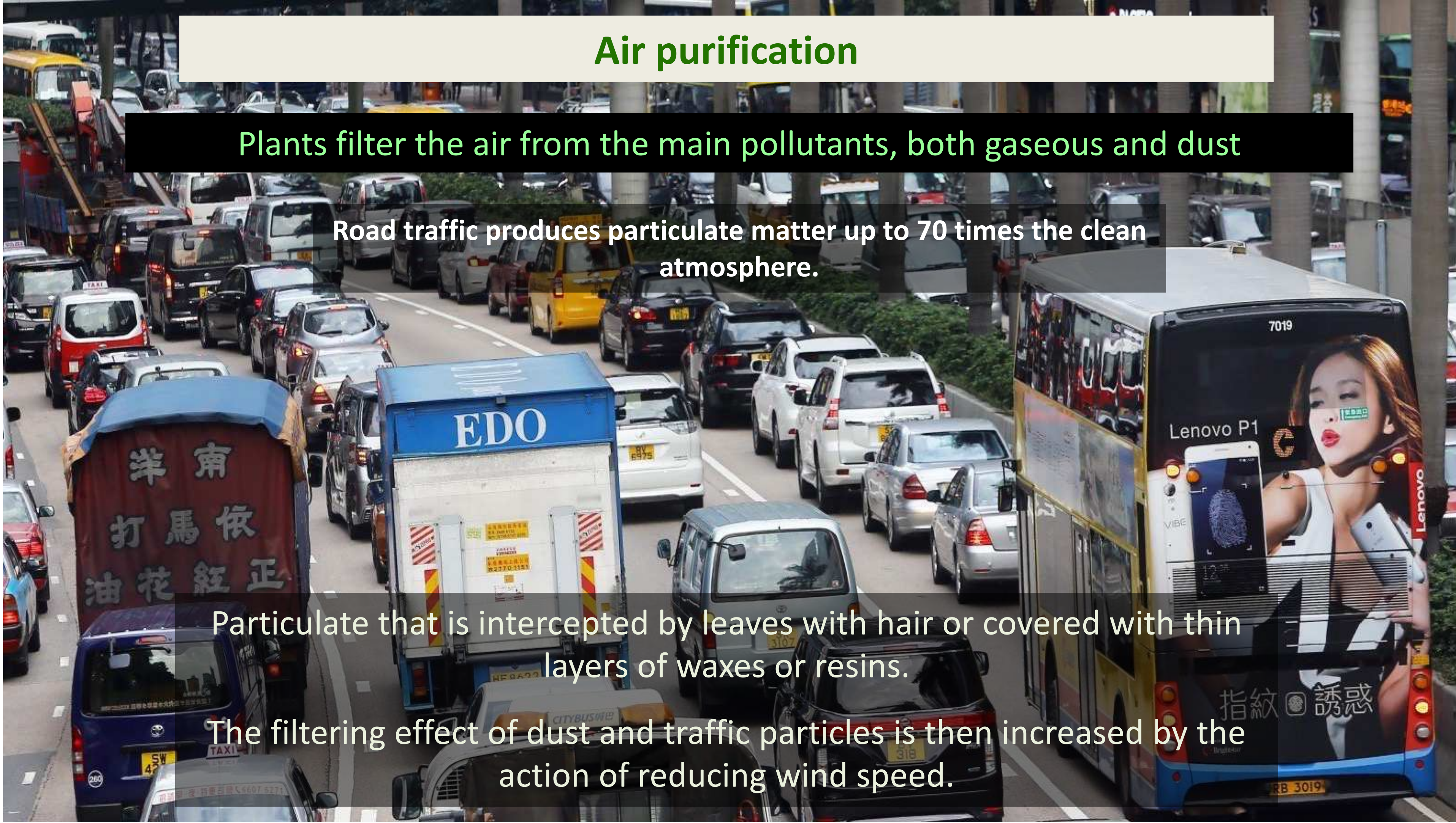


Figure 13: Deaths attributable to exposure to $PM_{2.5}$ in 2015, 2018, and 2019 by key sources of pollution and 2019 HDI groups



Air purification



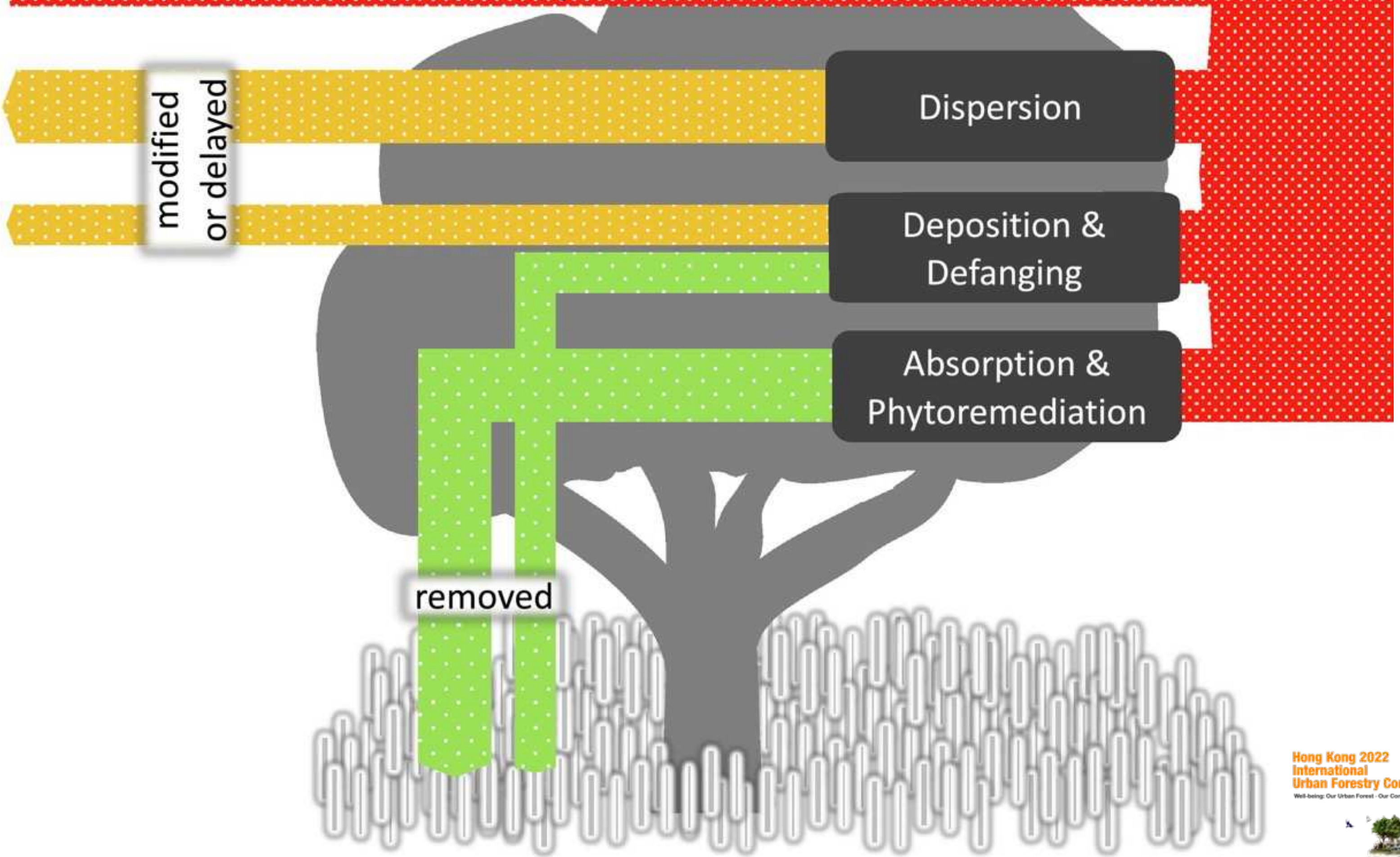
Plants filter the air from the main pollutants, both gaseous and dust

Road traffic produces particulate matter up to 70 times the clean atmosphere.

Particulate that is intercepted by leaves with hair or covered with thin layers of waxes or resins.

The filtering effect of dust and traffic particles is then increased by the action of reducing wind speed.

Mechanisms of particulate interception



From Diener&Mudu, Nov. 2021

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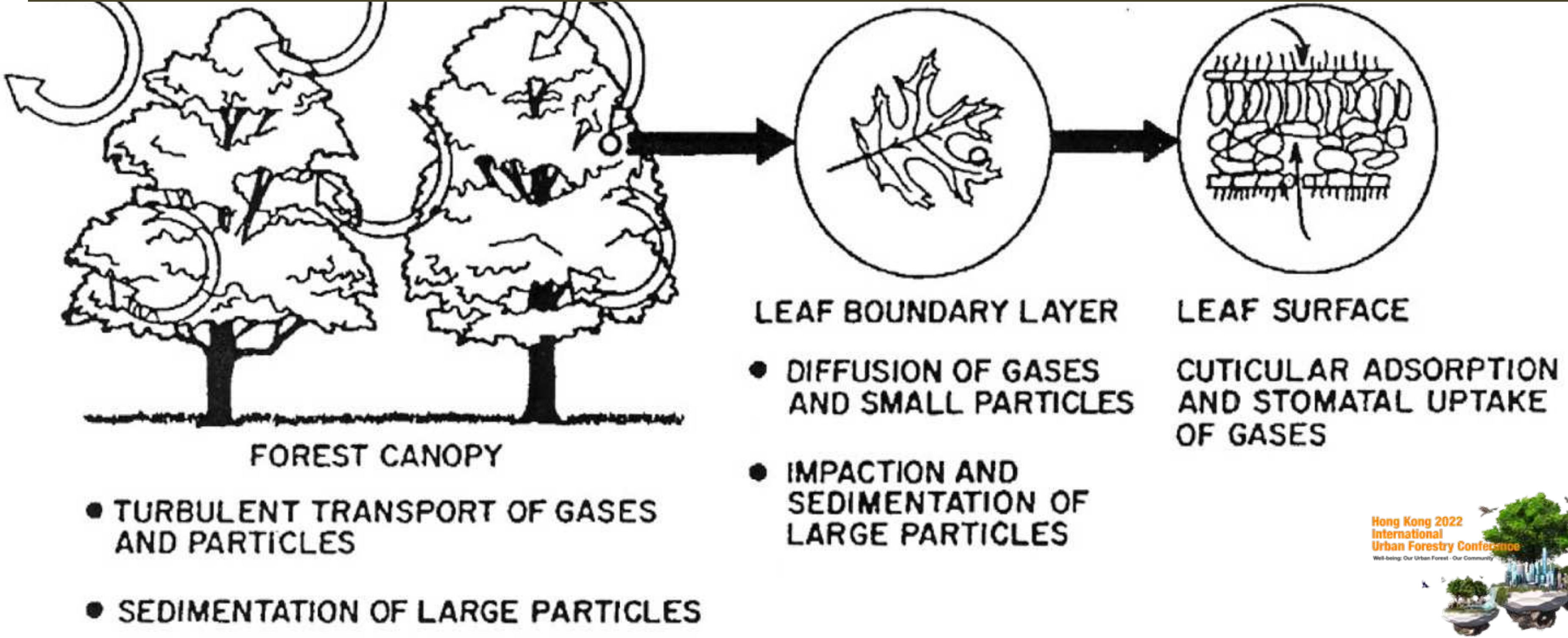
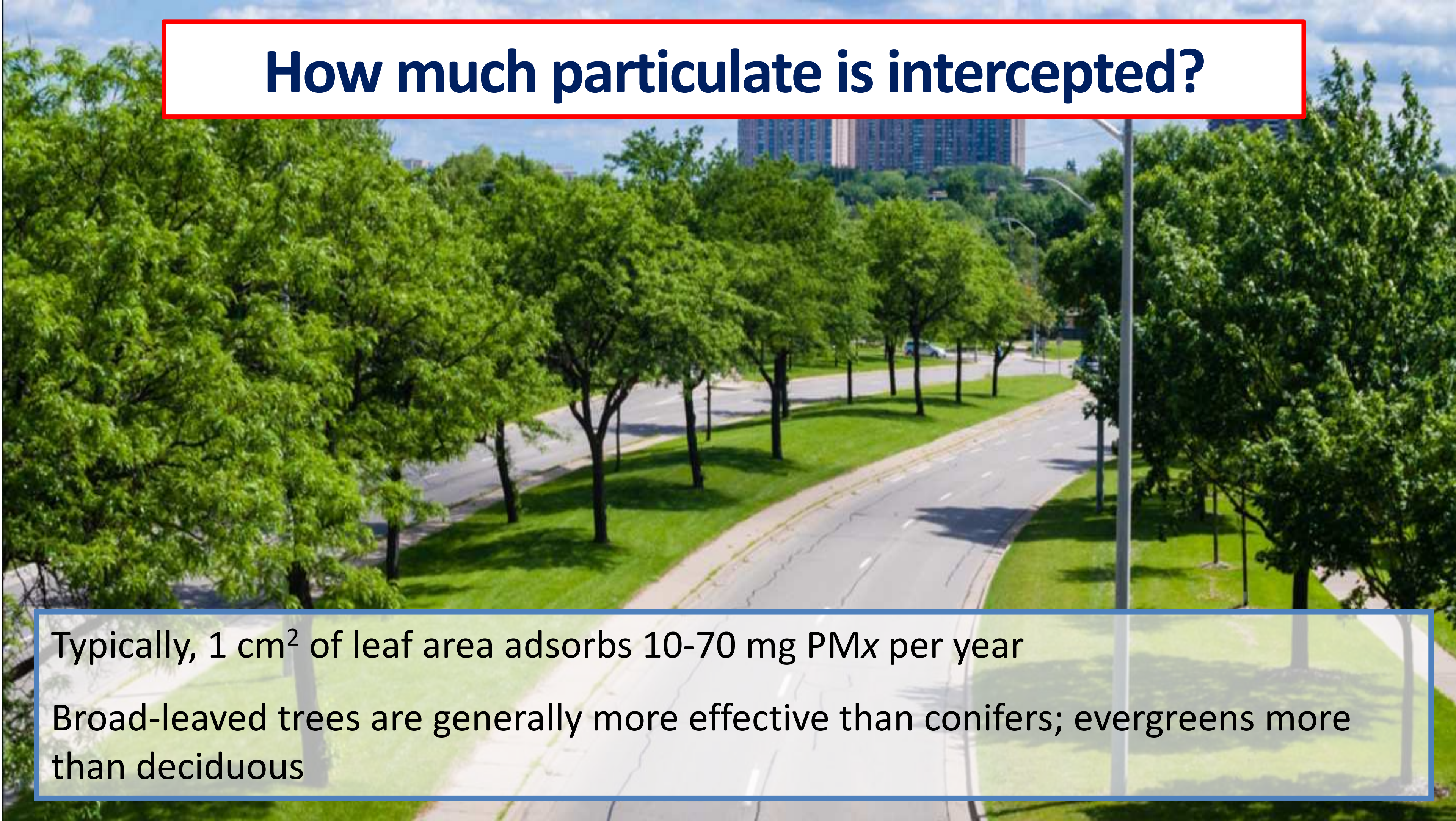
Mechanisms of particulate interception

In the dry deposition process, particles and gases are collected or are deposited on solid surfaces and this decreases the concentration in the air. Atmospheric particles and gases that are intercepted by vegetation can be either absorbed into plant tissues or retained on the surface of leaves, twigs, branches and the trunk (adsorbed). Pollutants absorbed by plant tissues can sometimes be turned into organic compounds stimulating the development of the plant (Sanderson, 2008; Lockwood et al., 2008).



How much particulate is intercepted?



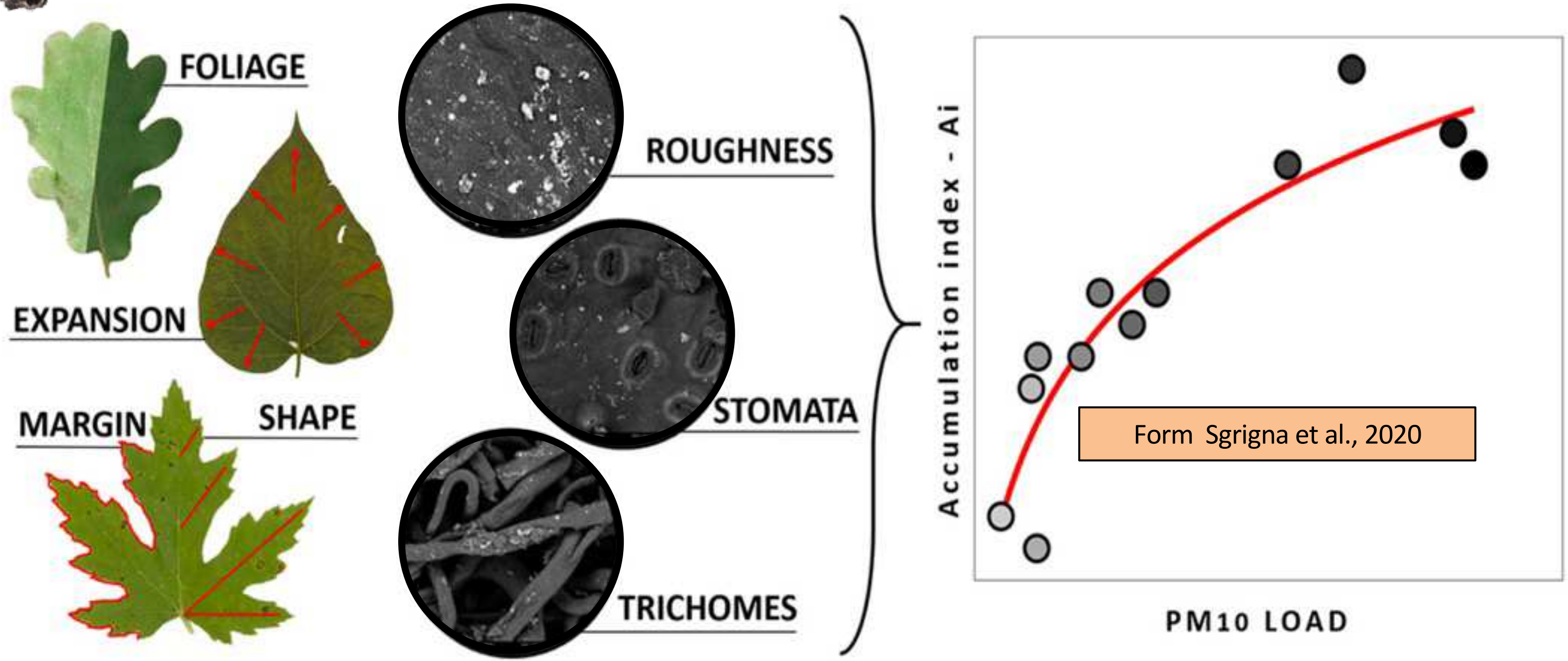
Typically, 1 cm^2 of leaf area adsorbs 10-70 mg PM*x* per year

Broad-leaved trees are generally more effective than conifers; evergreens more than deciduous

The importance of species selection

Quercus hypoleucoides

Pollution



The combination of different traits is a key factor in improving the effectiveness on PM reduction. Rough leaves with complex shapes, high stomata density and greater leaf persistence have been correlated with higher PMx deposition values. (from Sgrigna et al., 2020). The characteristics of the bark should also not be underestimated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Urban Forestry & Urban Greening

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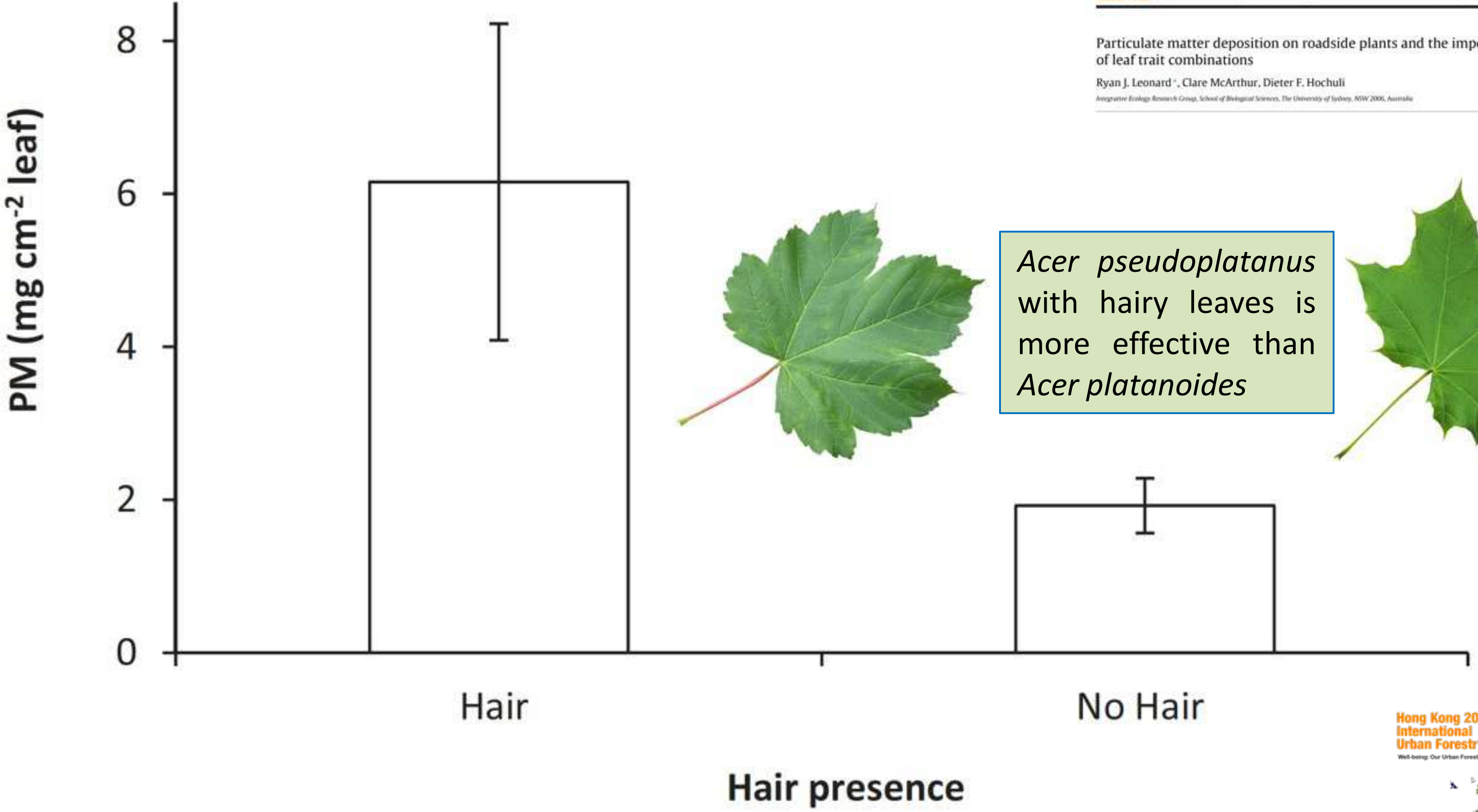
Particulate matter deposition on roadside plants and the importance of leaf trait combinations

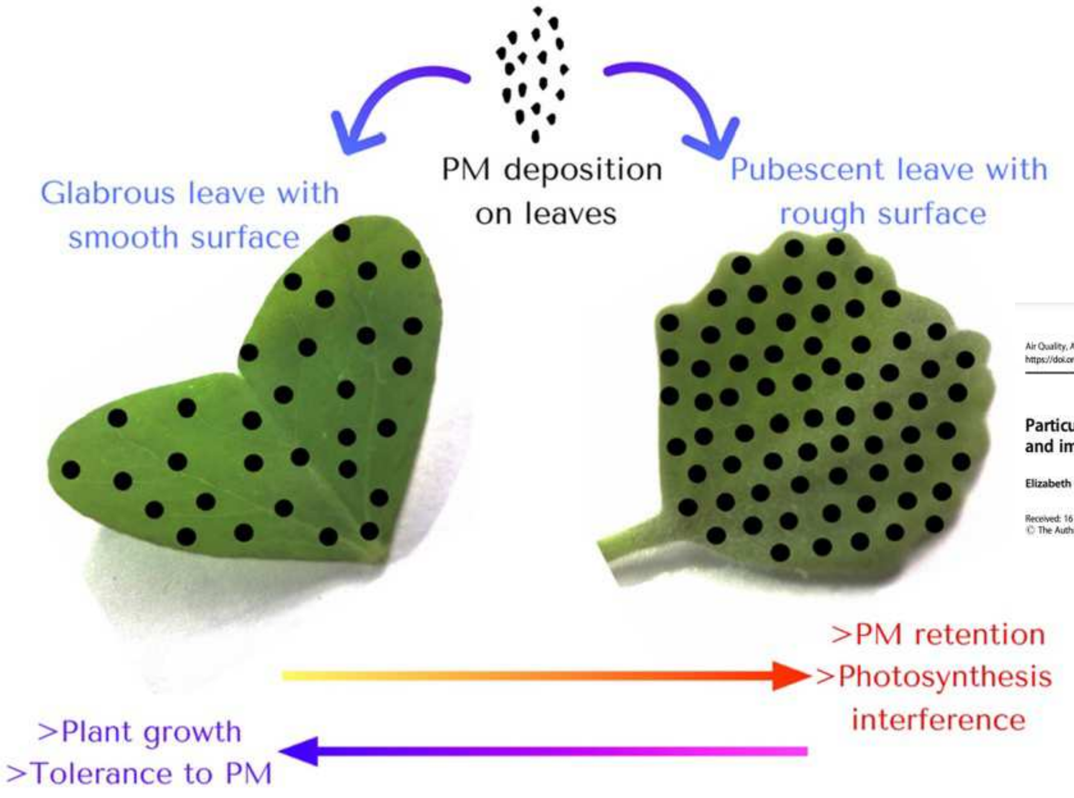
Ryan J. Leonard *, Clare McArthur, Dieter F. Hochuli

Integrative Ecology Research Group, School of Biological Sciences, The University of Sydney, NSW 2006, Australia



Acer pseudoplatanus with hairy leaves is more effective than *Acer platanoides*

PM deposition on leaves with different morphology. Glabrous leaves are expected to have less PM retention and by consequence less photosynthesis interference, major plant growth, and major tolerance to PM. The opposite could happen in leaves with rough blades



Air Quality, Atmosphere & Health (2021) 14:1433–1454
https://doi.org/10.1007/s11869-021-01032-8

Particulate matter and foliar retention: current knowledge and implications for urban greening

Elizabeth Chávez-García[1] · Blanca González-Méndez[2,3]

Received: 16 February 2021 / Accepted: 15 April 2021 / Published online: 24 April 2021

Species matter!

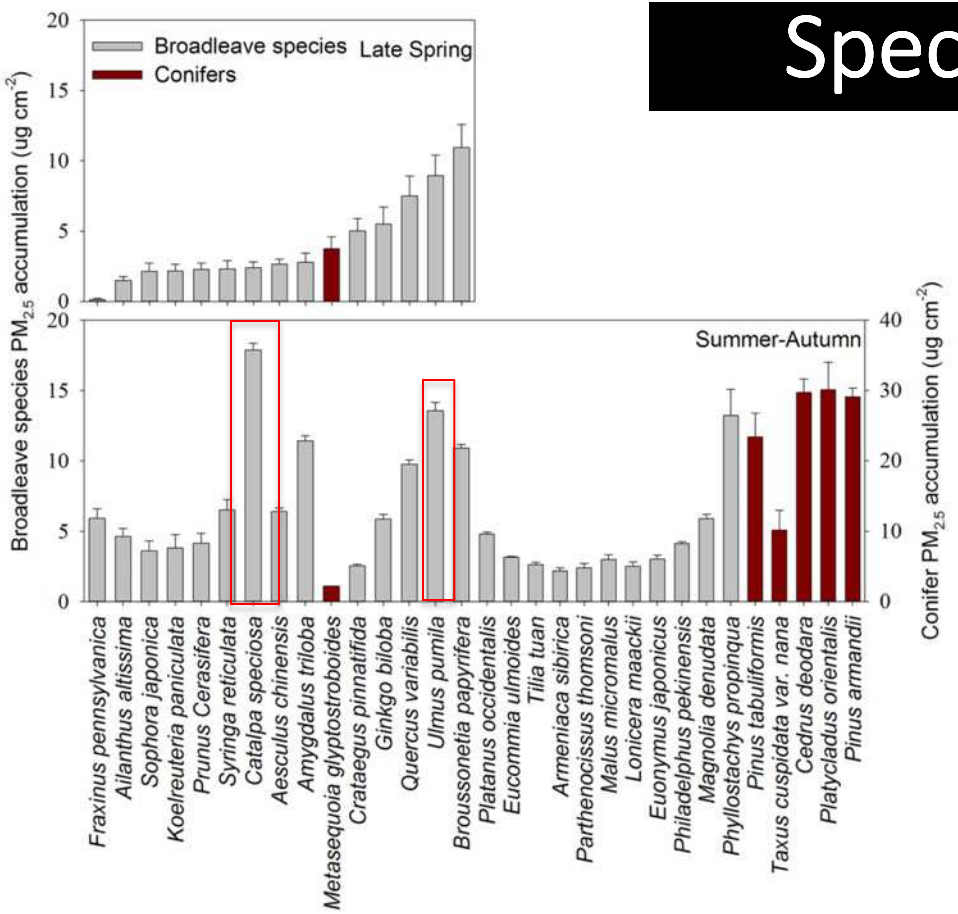
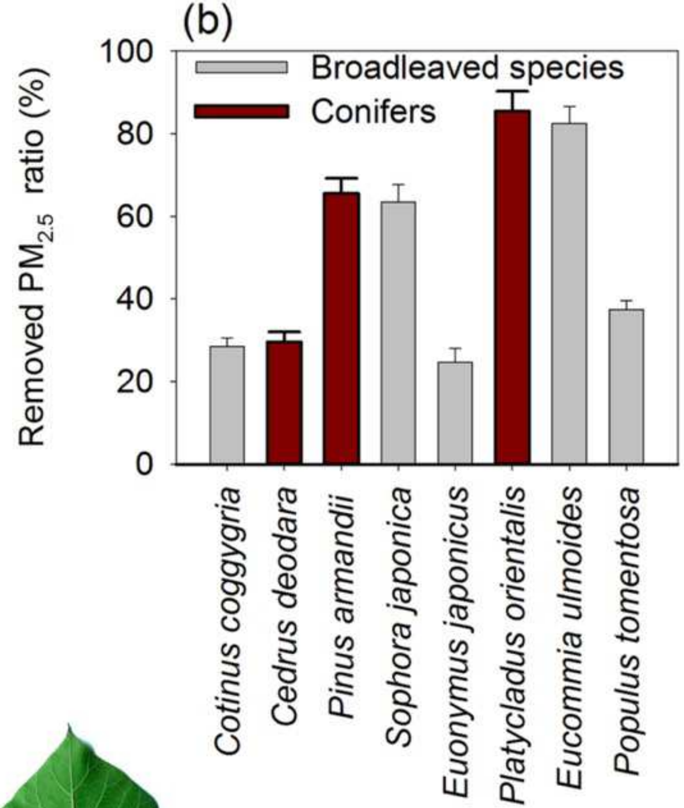
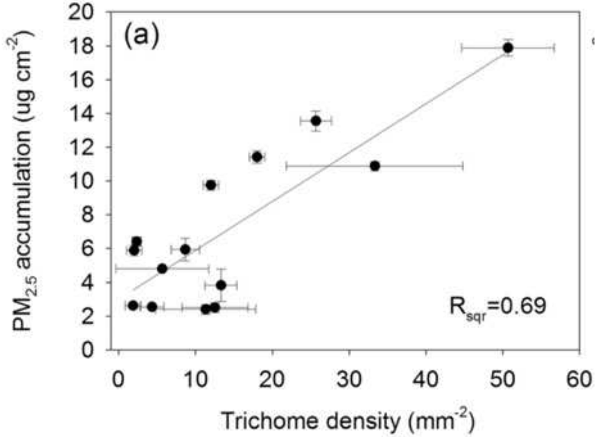


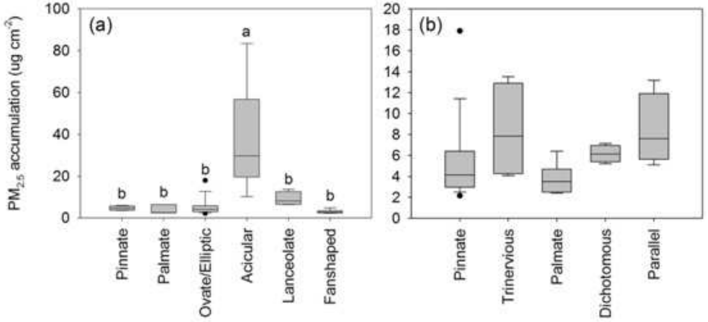
Figure 1. Comparison of foliar accumulation of atmospheric $PM_{2.5}$ among by different tree species (coniferous and broadleaved) measured in (**a**) late spring and (**b**) summer through autumn. The within-sample variability of $PM_{2.5}$ of each species presented as error bars.

Broad-leaved trees are generally more effective than conifers; evergreens more than deciduous





Da Chen et al., 2017



Differences in the foliar accumulation of atmospheric PM2.5 depending on the shape and vein of the leaves

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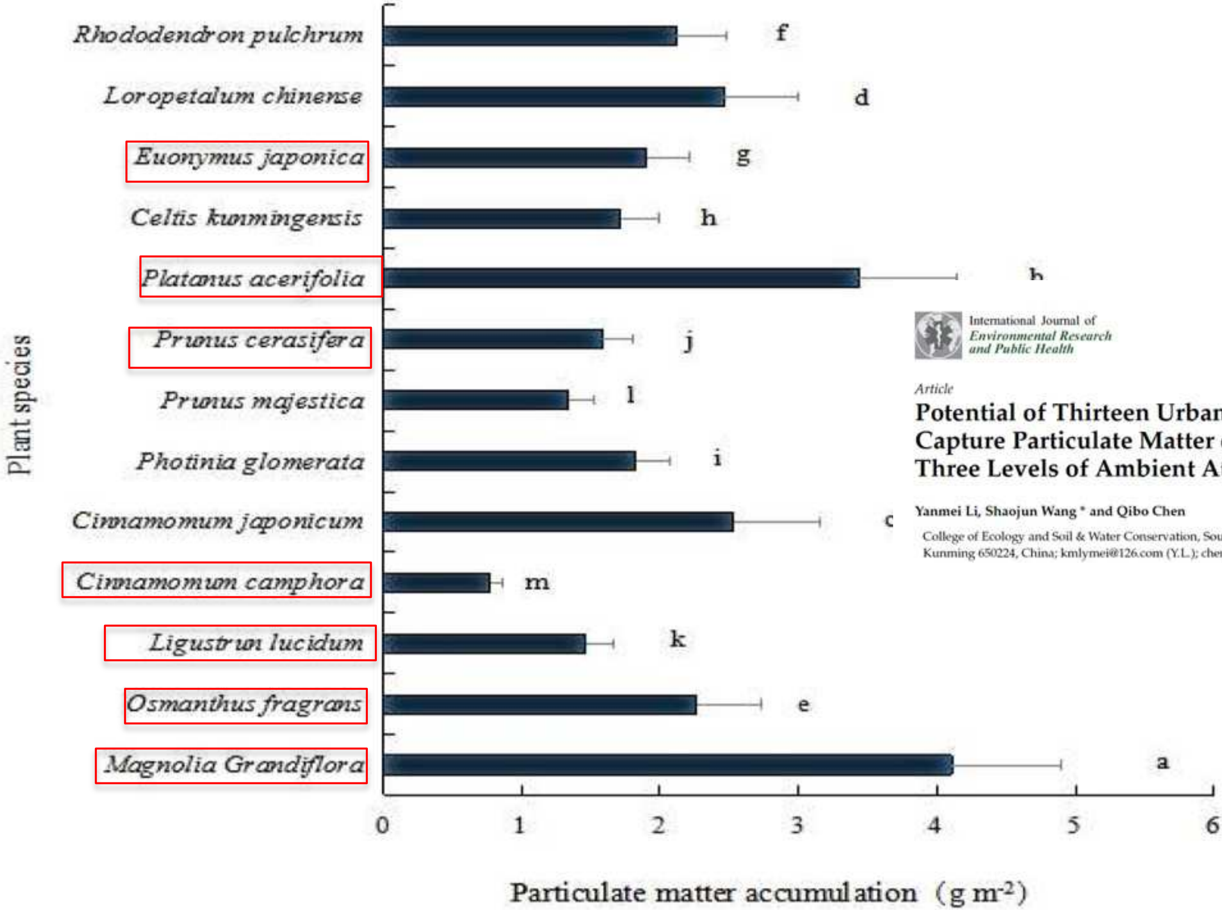
Int. J. Environ. Res. Public Health **2019**, *16*, 402



International Journal of *Environmental Research and Public Health*

MDPI

Article

Potential of Thirteen Urban Greening Plants to Capture Particulate Matter on Leaf Surfaces across Three Levels of Ambient Atmospheric Pollution

Yanmei Li, Shaojun Wang * and Qibo Chen

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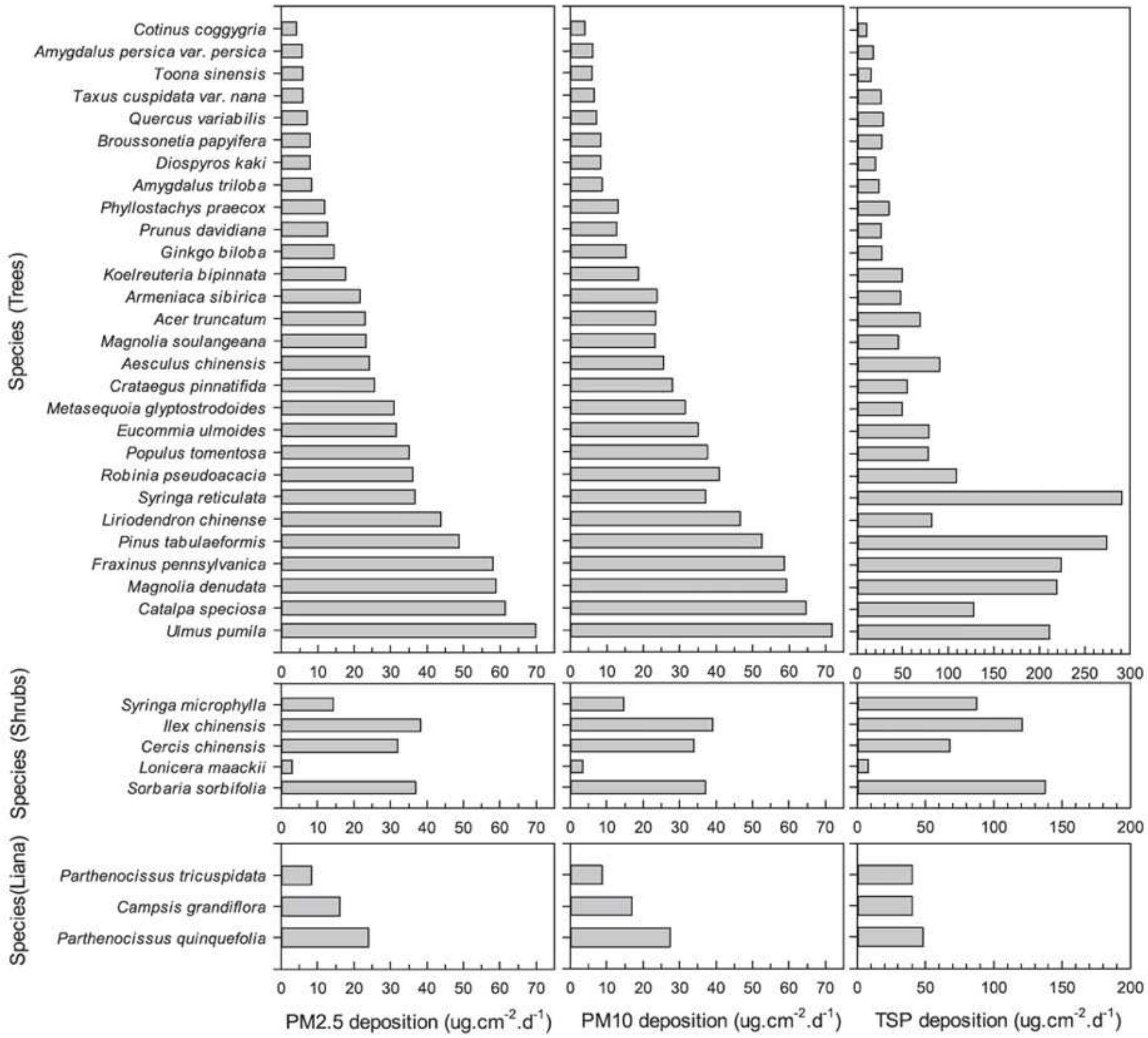

All the different system configurations examined have reduced the total PM **along the horizontal direction but not for the vertical one. Shrub and tree-lawn configurations were most effective for horizontal $PM_{2.5}$ reduction**.

The reduction capacity was found to be species-specific


Environmental Pollution 208 (2016) 198–208

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Environmental Pollution

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Experimental examination of effectiveness of vegetation as bio-filter of particulate matters in the urban environment

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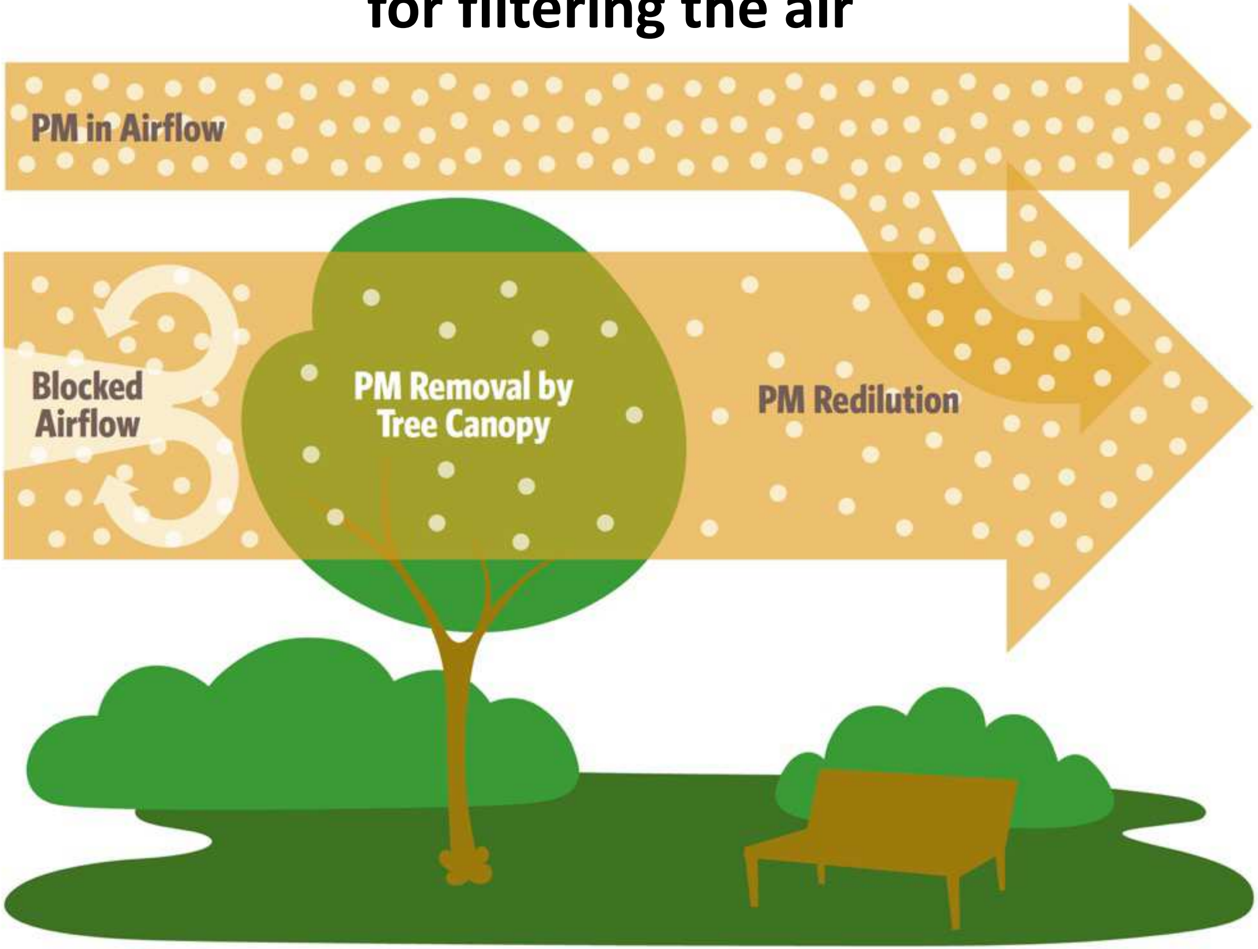
Method for ranking PM2.5 removal efficiencies of tree species:

From https://www.greenblue.com/na/how-trees-improve-air-quality/

Variable	Ratings and Criteria		
	1	2	3
Type	Evergreen conifer	Evergreen broadleaf	Deciduous
Size	Height of mature tree more than 20 m	Height of mature tree between 10 m and 20 m	Height of mature tree between 5 m and 10 m
Growth rate	Fast	Medium	Slow
Canopy structure	Dense canopy, fine texture	Canopy with medium density, medium texture	Open canopy, coarse texture
Leaf complexity	Bi-or tri-pinnately compound, or scale-like leaves in conifer	Pinnately or palmately compound; deeply-divided or lobed	Intact single leaf
Leaf size	Average size of leaf less than or equal to 5 cm	Average size of leaf between 5 cm and 20 cm	Average size of leaf more than 20 cm
Leaf surface feature	Rough, hairy, resinous, sticky, scaly, scurfy, glutinous, tufts	Ciliate, velvety, pubescent, waxy, glaucous, downy, slightly hairy, fuzzy	Smooth surface

The position and structure of the vegetation are important for filtering the air



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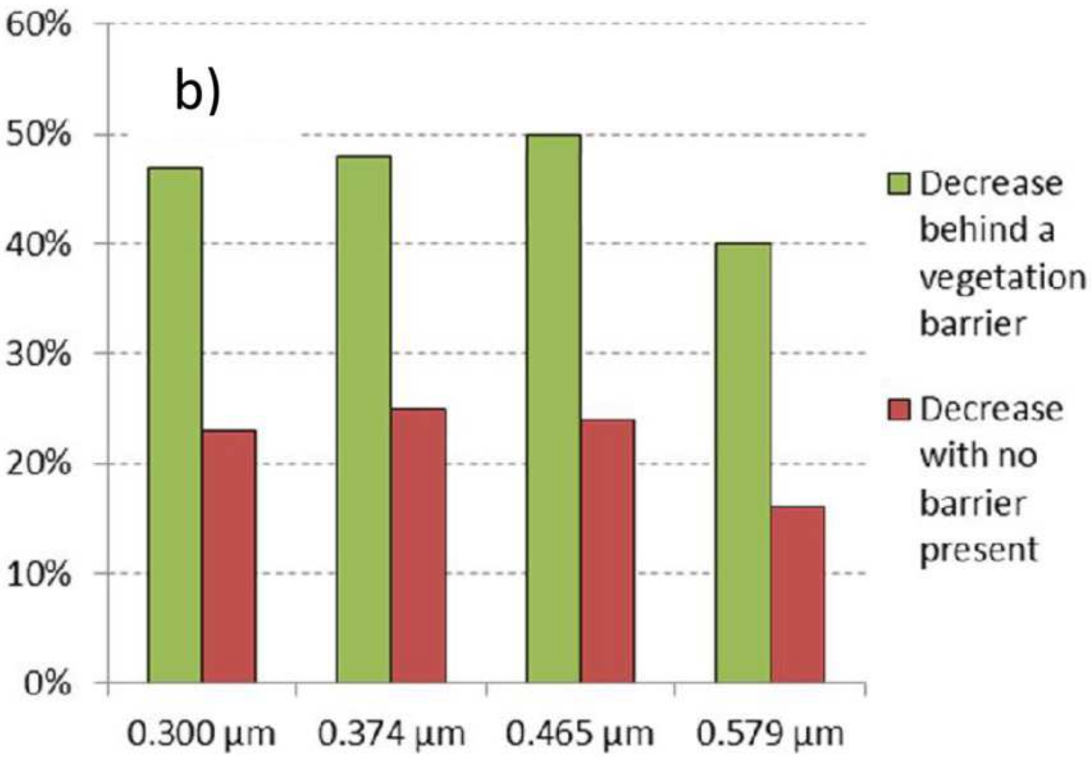
Effects of Vegetation on Traffic-Related Particulate Matter

Jovana Alkalaj and Throstur Thorsteinsson[1]

Environment and Natural Resources, University of Iceland, Sturlugata 7, 101 Reykjavik, Iceland



Atmospheric Pollution Research xxx (xxxx) xxx–xxx

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journal homepage: www.elsevier.com/locate/apr

Is the existing urban greenery enough to cope with current concentrations of $PM_{2.5}$, PM_{10} and CO_2?

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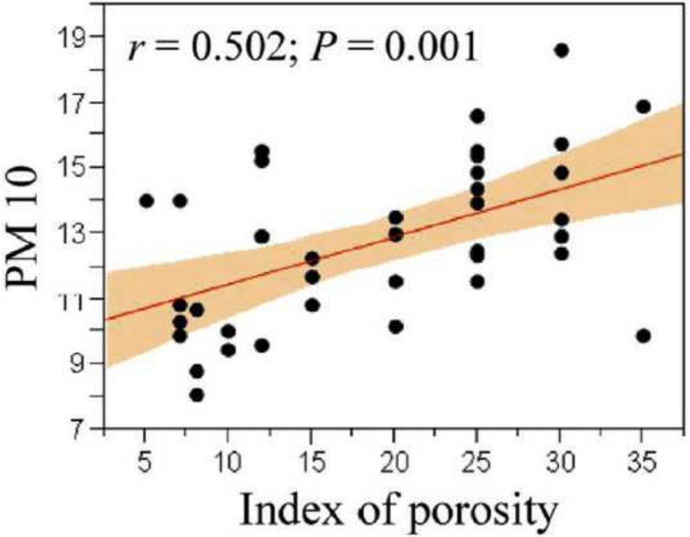
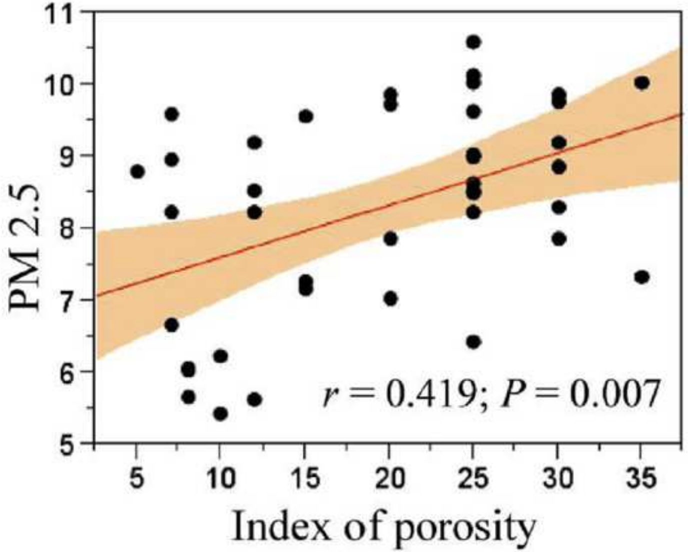
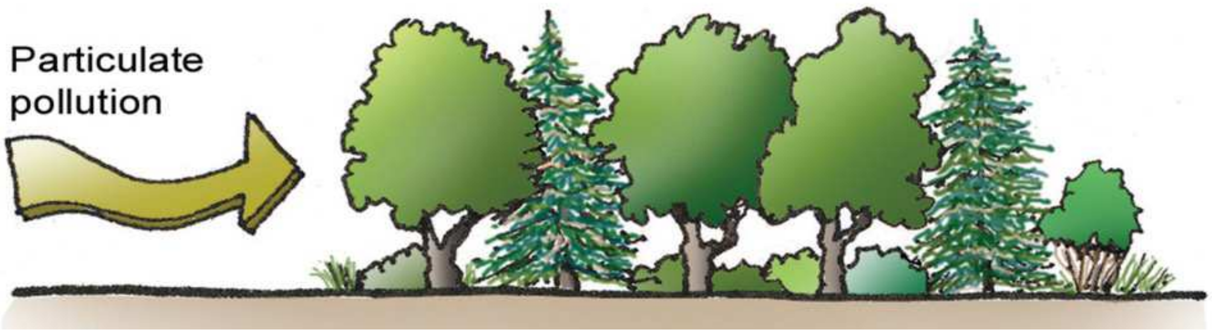
[b] Foundation for Silesia Park, Al. Różana 2, 41-501 Chorzów, Poland

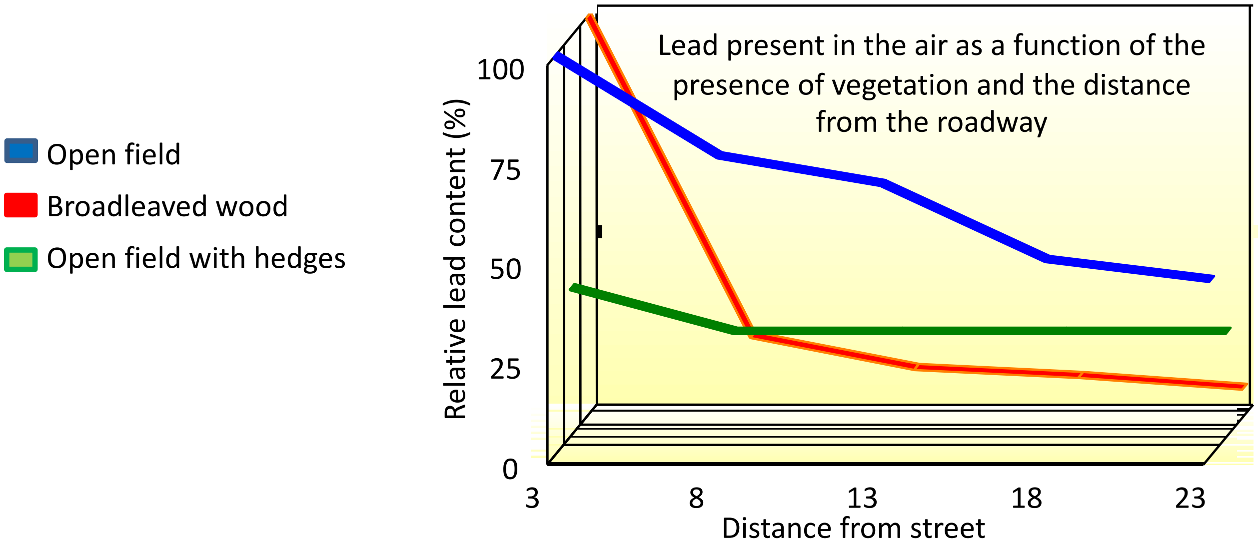
The density of the canopy and the distance from the emitting source are important parameters. Generally, the less dense the foliage, the lower the effectiveness





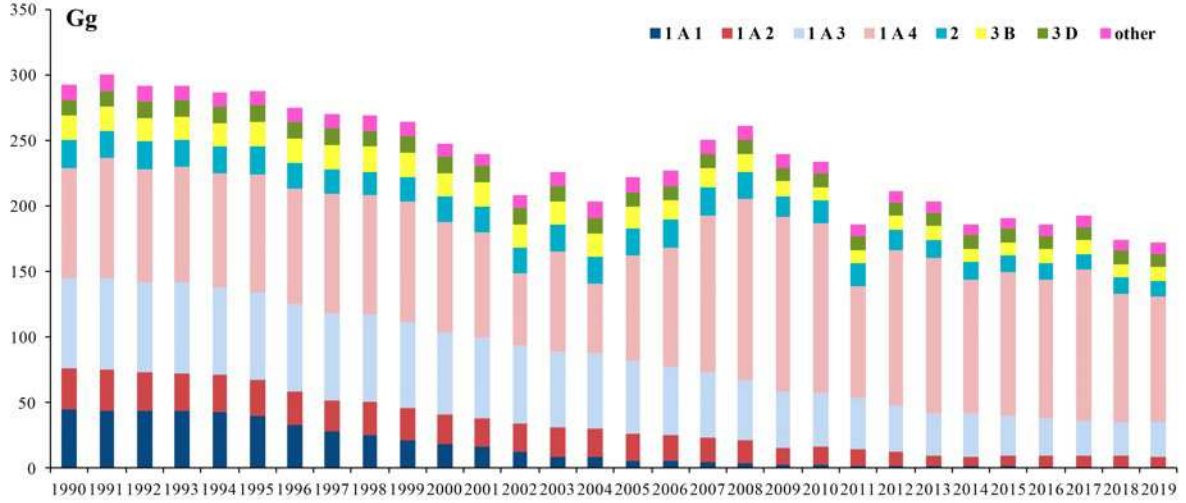
A 20 to 180m wide barrier can reduce particulate matter by 50 to 75% although many factors can affect this ability





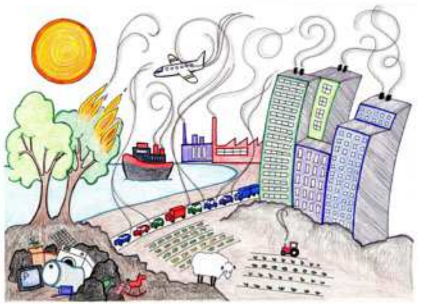
Why we did our studies?

The national atmospheric emissions of PM10 show a decreasing trend in the period 1990-2019, from 293 Gg to 172 Gg. Figure 2.6 and Table 2.6 illustrate the emission trend from 1990 to 2019. Figure 2.6 also illustrates the share of PM10 emissions by category in 1990 and 2019 as well as the total and sectoral variation from 1990 to 2019.



ISPRA

Italian Emission Inventory
1990 - 2019.
Informative Inventory Report 2021



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First experiment (Project MIA-MIPAAF)

Characterization of 7 evergreen plant species for their air pollution mitigation capacity

M & M

-Plants in open field, disposed in two belts (28x5 m), adjacent to a 4-lanes road

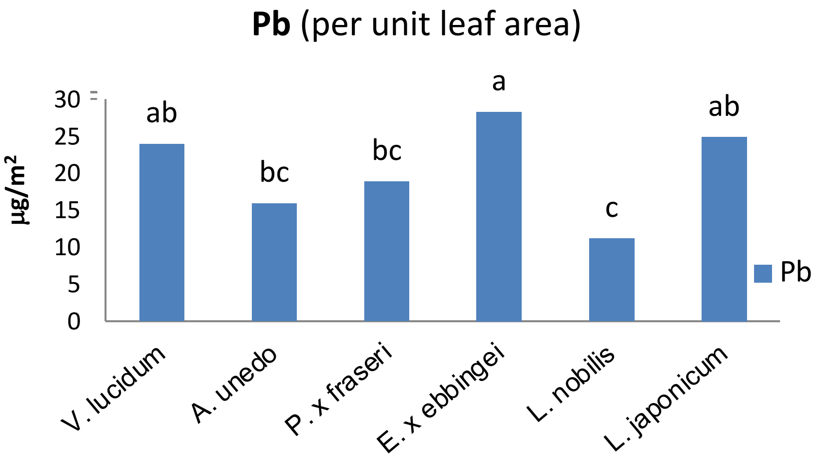
-Leaf metal deposition (Zn, Cd, Pb, Ni, Cu) during 3 samplings (June, August, October)

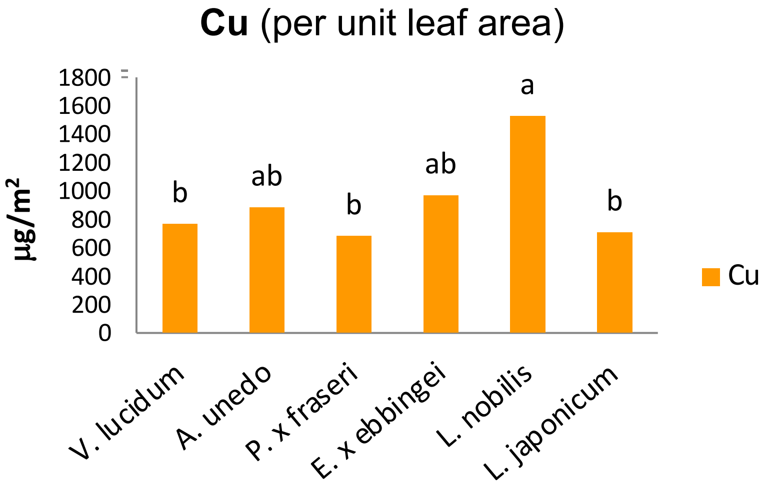
-Content of metals in rainwater collected at the base of the different species

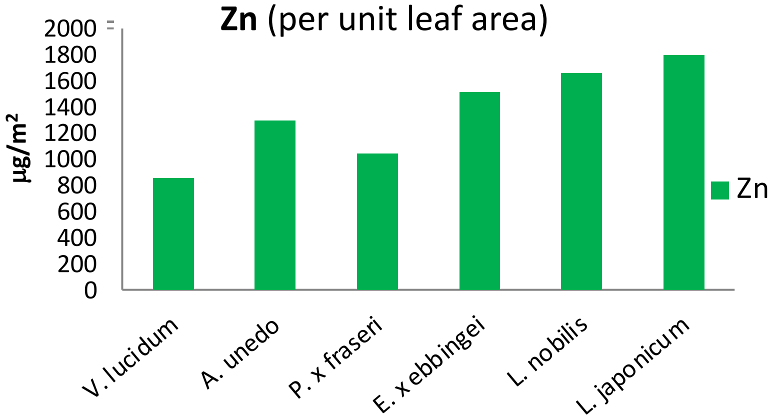
-Growth parameters (biomass, leaf area, height of plants, crown diameter, LAI)

-Relation between metal deposition and meteorological parameters

First experiment - Metal adsorption per unit leaf area



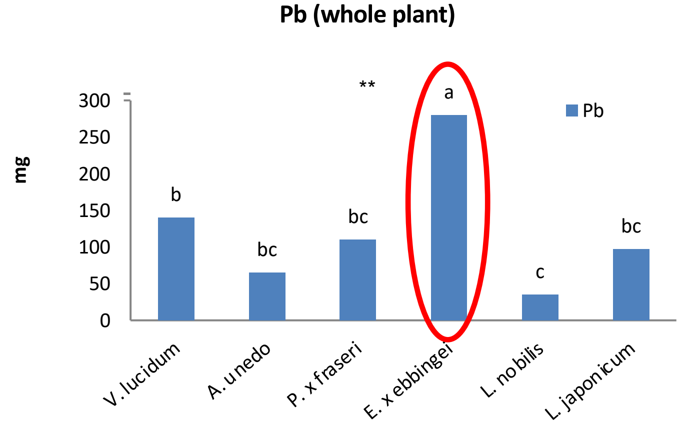


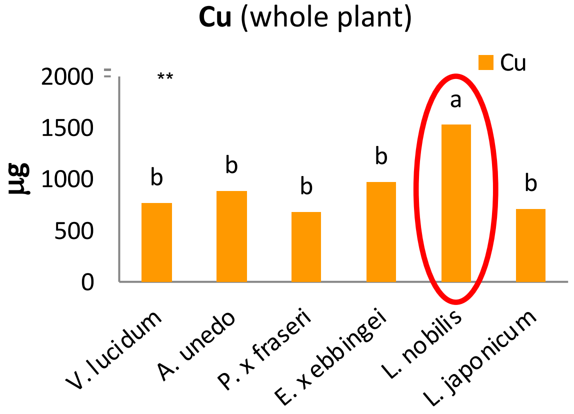


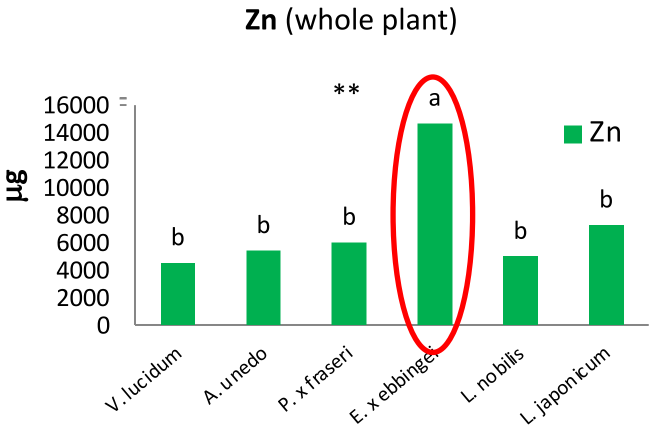
As for zink, removal (per unit leaf area) of cadmium and nichel was similar across species

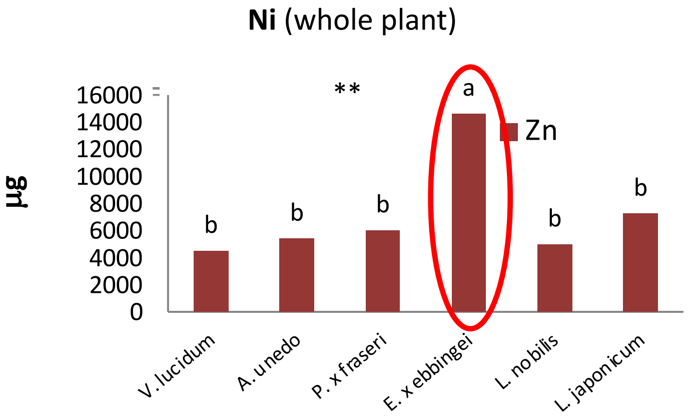
First experiment - Metal adsorption of the whole plant

Leaf area differed among species: *E. x ebbingei* (Bohemian olive) had, on average, two- or three-times larger leaf area if compared to the other species









Results

- ***E. x ebbingei***, ***V. lucidum*** and ***L. japonicum*** showed the highest Pb deposition per unit area (1.9 -2.3 x 10^{-3} µg cm^{-2}). ***E. x ebbingei*** showed the highest values per whole plant.
- ***E. x ebbingei***, had the highest whole plant leaf accumulation of almost all the measured metals mainly due to the faster and higher growth.
- **Rain** and **Wind speed** were found to influence the metal deposition (Data not shown).

E. x ebbingei

L. japonicum

V. lucidum

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journal homepage: www.elsevier.com/locate/ufug

Deposition of traffic-related air pollutants on leaves of six evergreen shrub species during a Mediterranean summer season

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[b] Dipartimento di Scienze delle Produzioni Agroalimentari e dell'Ambiente–Università di Firenze, Viale Delle Idee 30, 50019, Sesto Fiorentino (FI), Italy
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ARTICLE INFO

Keywords:
Element leaf depositions
Enrichment factor
Growth parameters
Meteorological parameters
Particulate matter
Seasonal trend

ABSTRACT

Six evergreen broad-leaved shrub species (*Viburnum tinus* subsp. *lucidum* L., *Arbutus unedo* L., *Photinia × fraseri* Dress., *Laurus nobilis* L., *Elaeagnus × ebbingei* L., *Ligustrum japonicum* Thunb.) were tested for their capacity to accumulate pollutants on the surface of their current season leaves in a Mediterranean environment. Plants were planted along a road in 2010 and exposed to traffic pollution. Leaf element deposition (Al, As, Ba, Ca, Cd, Co, Cr, Cu, Fe, K, Li, Mg, Mn, Mo, Ni, Pb, Sb, Se, Tl, V, Zn) was analyzed six times from early summer to early autumn 2012. Particulate matter on leaves, element concentration of particulate matter in the air and meteorological parameters were measured. Elements on leaves were related to meteorological conditions to study the inter-relations. *E. × ebbingei*, *P. × fraseri* and *V. lucidum* were found to accumulate more pollutants, while *L. nobilis* and *A. unedo* were the lowest accumulators. A common trend of element depositions was found. Generally, elements increased from the first to the second sampling (28 June to 19 July) and, thereafter, decreased until the early autumn. Element depositions depended on species and meteorological parameters. Rain decreased the element accumulation on leaves, whilst an increase in wind velocity and element concentrations (in the air) tended to increase the presence of elements on leaves. Meteorological conditions were confirmed to be important factors modifying the dynamics of pollution deposition and their removal from leaves during a season.

Arboriculture & Urban Forestry 42(5): September 2016 329

Arboriculture & Urban Forestry 2016. 42(5): 329–345

Carbon Uptake and Air Pollution Mitigation of Different Evergreen Shrub Species

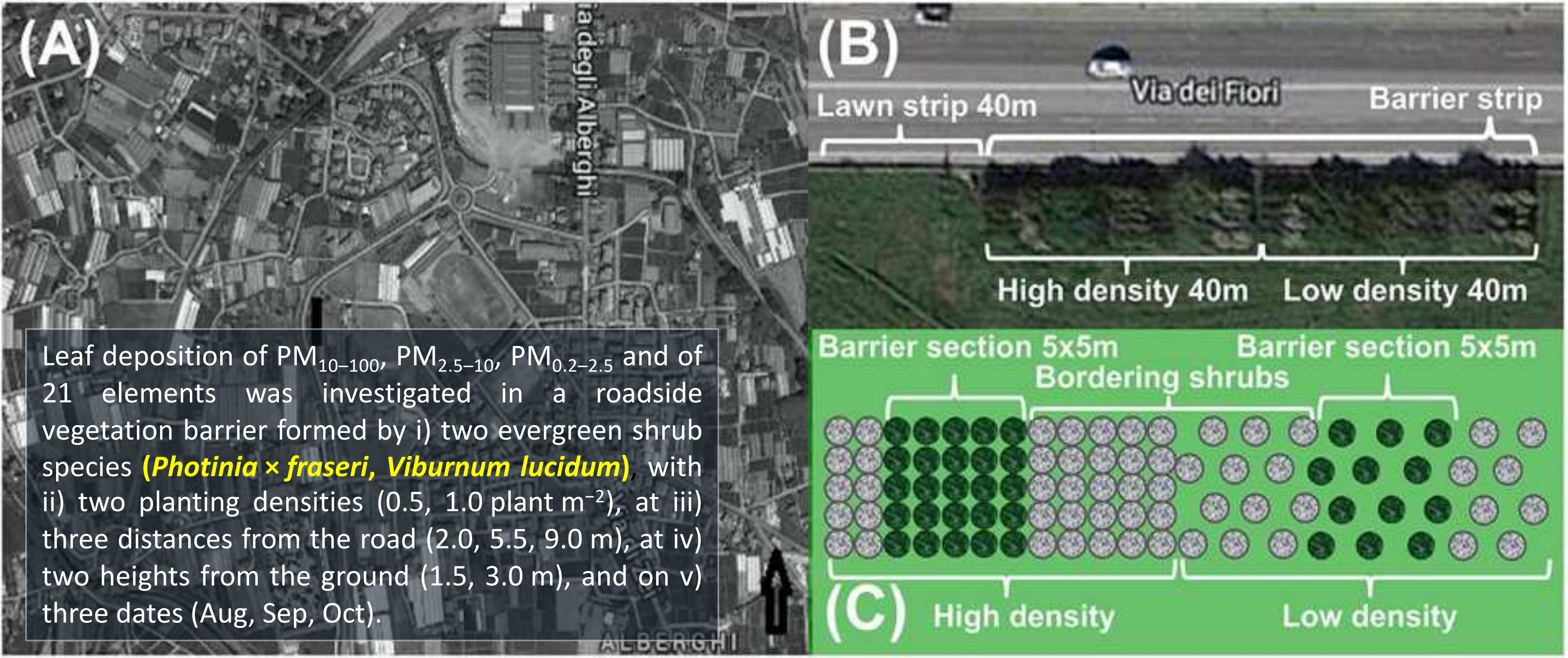
Jacopo Mori, Alessio Fini, Gianluca Burchi, and Francesco Ferrini

Abstract. Three independent experiments assessed CO_2 assimilation and metals leaf deposition of seven evergreen shrub species (*Arbutus unedo* L., *Elaeagnus × ebbingei* L., *Laurus nobilis* L., *Ligustrum japonicum* Thunb., *Photinia × fraseri* Dress., *Viburnum tinus* subsp. *lucidum* L., and *Viburnum tinus* subsp. *tinus* L.). CO_2 assimilation and carbon allocation were determined in 2011 (Exp. 1) under optimal water availability and in 2012 (Exp. 2) under drought on potted plants. A third experiment (Exp. 3) measured seasonal leaf depositions of Cd, Cu, Ni, Pb, and Zn in 2011 on plants transplanted in proximity of a four-lane road.

E. × ebbingei showed the highest CO_2 assimilation under optimal water availability but one of the lowest under drought (Exp. 1, 2). Conversely, *P. × fraseri* had intermediate CO_2 assimilation but it declined less during drought compared to the other species. In Experiment 3, *E. × ebbingei* showed the highest metal deposition, mainly due to its greater leaf area. Greater rainfall and RH% decreased metal depositions, whilst greater wind velocity and air temperature increased leaf depositions. Species which drastically reduce CO_2 assimilation under drought (*V. tinus* subsp. *lucidum*, *L. japonicum*, *E. × ebbingei*) are not recommended in drought-prone environments, where drought-tolerant "mesic" species (*P. × fraseri*), should be preferred. *E. × ebbingei* could be used to optimize deposition of metals. The three experiments provide useful insights especially about CO_2 assimilation (Exp. 1, 2) and air pollution mitigation (Exp. 3) of widely used shrubs for application in urban areas and planning of roadside greening in southern Europe.

Key Words. *Arbutus unedo* L.; CO_2 Assimilation; Drought; *Elaeagnus × ebbingei* L.; Italy; *Laurus nobilis* L.; Leaf Deposition; *Ligustrum japonicum* Thunb.; Meteorological Parameters; *Photinia × fraseri* Dress.; Relative Growth Rate; Seasonal Trend; Shrub; Trace Metals; Traffic Pollution; *Viburnum tinus* subsp. *lucidum* L.; *Viburnum tinus* subsp. *tinus* L.

Second experiment: Air pollution deposition on a roadside vegetation barrier in a Mediterranean environment: Combined effect of evergreen shrub species and planting density



Leaf deposition of $PM_{10–100}$, $PM_{2.5–10}$, $PM_{0.2–2.5}$ and of 21 elements was investigated in a roadside vegetation barrier formed by i) two evergreen shrub species ***(Photinia × fraseri, Viburnum lucidum)***, with ii) two planting densities (0.5, 1.0 plant m^{-2}), at iii) three distances from the road (2.0, 5.5, 9.0 m), at iv) two heights from the ground (1.5, 3.0 m), and on v) three dates (Aug, Sep, Oct).

- *V. lucidum* had more $PM_{2.5–10}$ and $PM_{0.2–2.5}$ on leaves than *P.* × *fraseri*, while most elements were higher in *P.* × *fraseri*.

- Most pollutants decreased at increasing distances from the road and were higher at 1.5 m from the ground compared to 3.0 m.

- Higher planting density in *P.* × *fraseri* enhanced the deposition of $PM_{10–100}$ and $PM_{2.5–10}$, while in *V. lucidum*, the planting density did not affect the depositions.

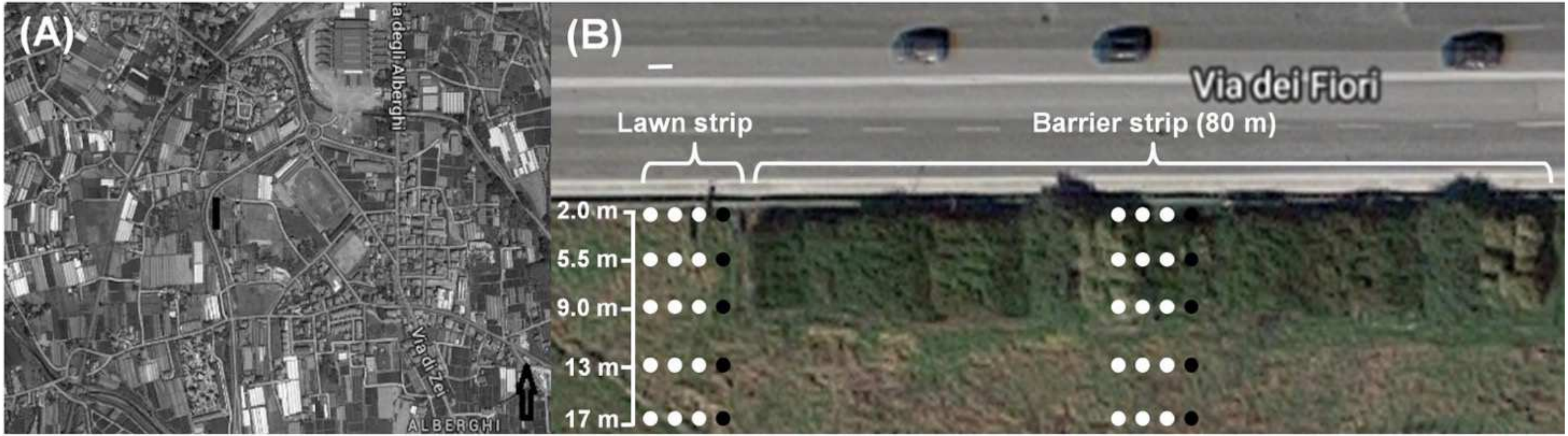
- Black $PM_{10–100}$ decreased a long distance from the road and was entirely composed of carbon and oxygen, which was thus identified as black carbon from fuel combustion.

- The vegetation barrier had a higher deposition of most PM fractions at 5.5–12.5 m, while in the lawn area, depositions did not change. At 19.5 m, the $PM_{10–100}$ was 32% lower behind the barrier than in the lawn area.

- In conclusion, the vegetation barrier changed the deposition dynamics of pollutants compared to the lawn area. These results strengthen the role of vegetation barriers and shrub species against air pollution and may offer interesting insights for the use of new road green infrastructures to improve air quality.


Contents lists available at ScienceDirect
Science of the Total Environment
Air pollution deposition on a roadside vegetation barrier in a Mediterranean environment: Combined effect of evergreen shrub species and planting density
J. Mori, A. Fini, M. Galimberti, M. Ginepro, G. Burchi, D. Massa, F. Ferrini
HIGHLIGHTS
GRAPHICAL ABSTRACT

2018/19 third experiment (ongoing)

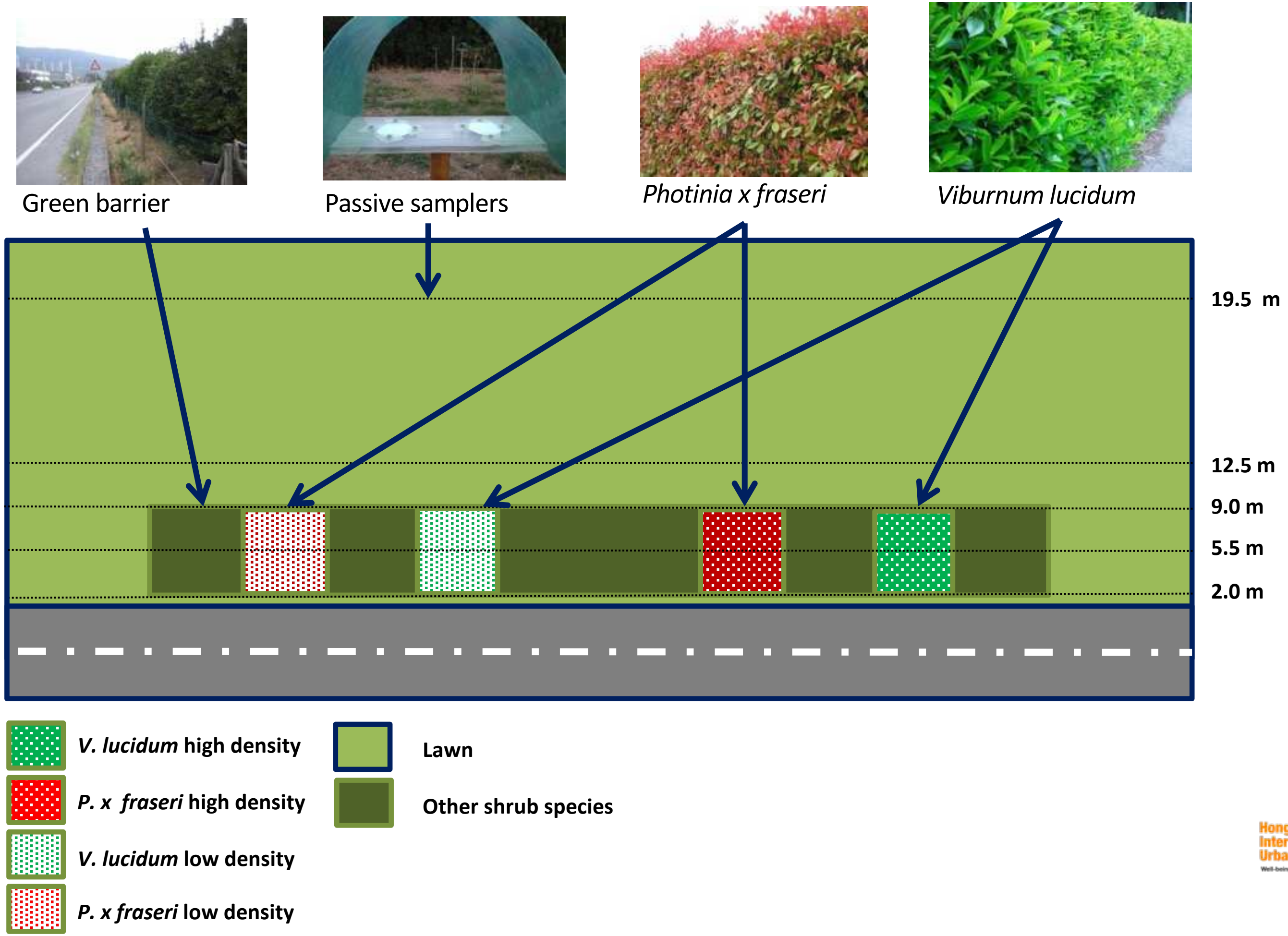


1) Monitoring for 9 consecutive months of concentrations in the air and depositions of PM_{10} and $PM_{2.5}$ in:

a) An area with a green barrier compared to a lawn area;

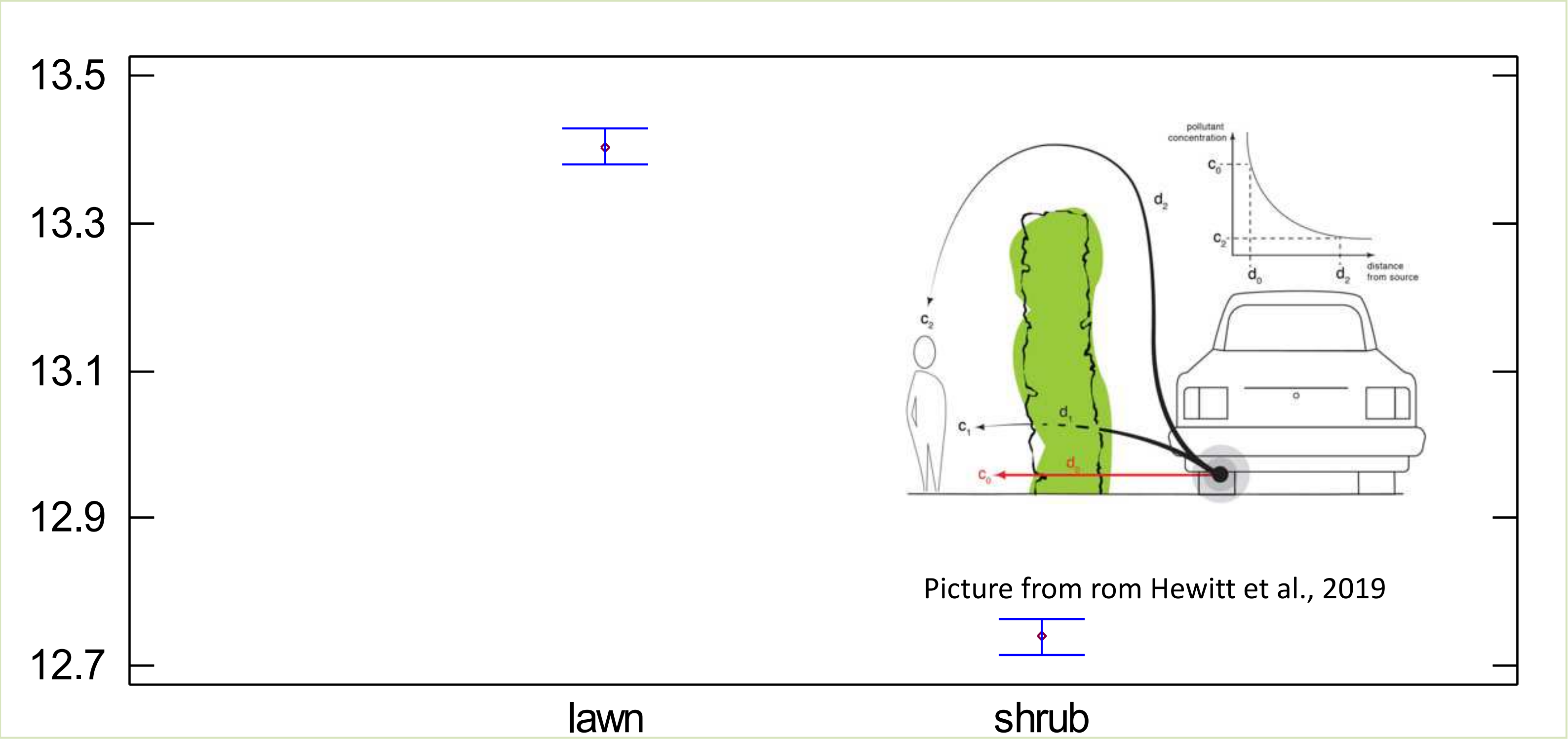
b) At 5 different distances from the road front

Expertimental site(2018)



Preliminary results: difference green barrier- vs lawn

PM_{10} (µg m^{-3})



Picture from rom Hewitt et al., 2019

Fourth experiment (ongoing):

Comparing different methodologies to quantify particulate matters accumulation on plant leaves funded by Fondazione Cassa di Risparmio di Lucca

Different methodologies for quantifying PMx were compared

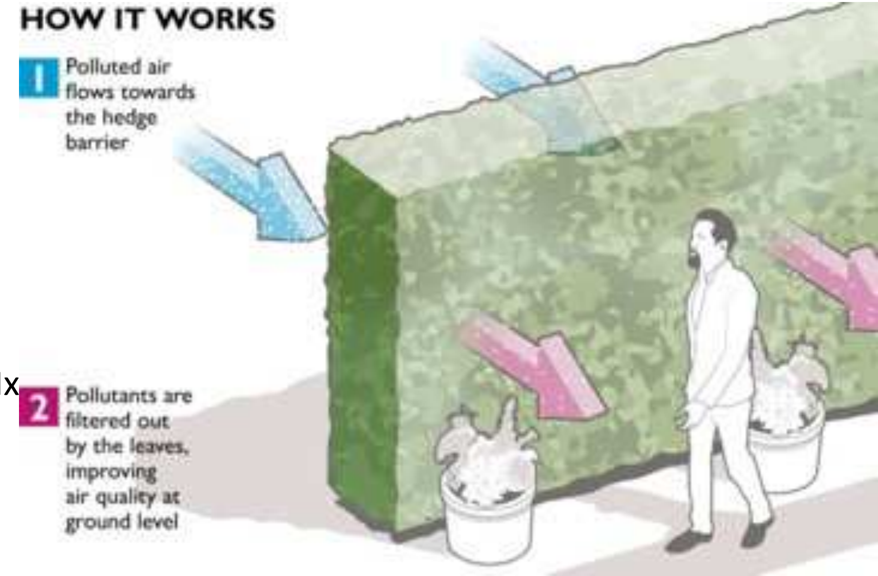
PMx quantification methods:

1. **Microscopical analysis**
2. **Filtration methods**

Leaf trait were correlated to the species capacity to accumulate PMx

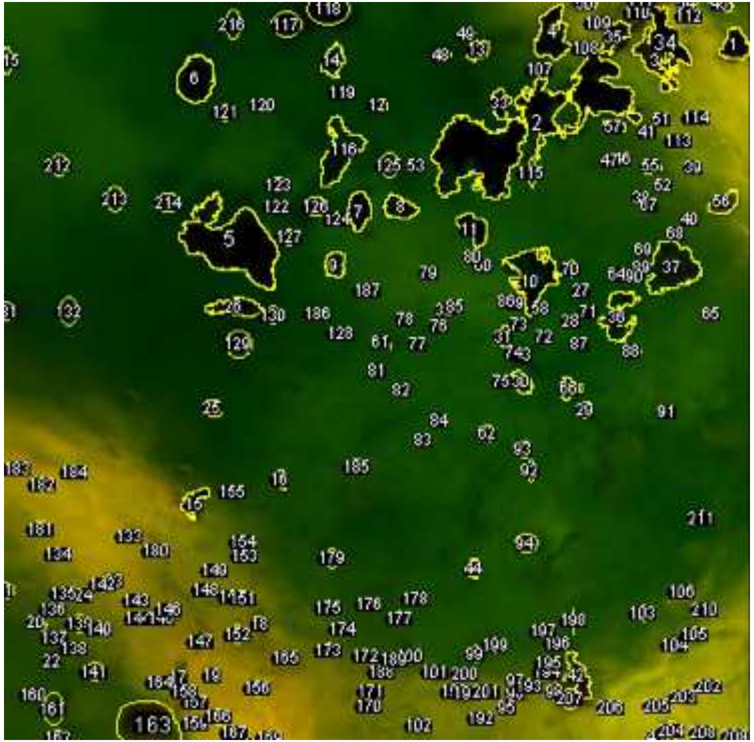
Leaf traits:

1. **Leaf area (LA)**
2. **specific leaf area (SLA)**
3. **leaf dissection index (LDI)**
4. **leaf roundness**



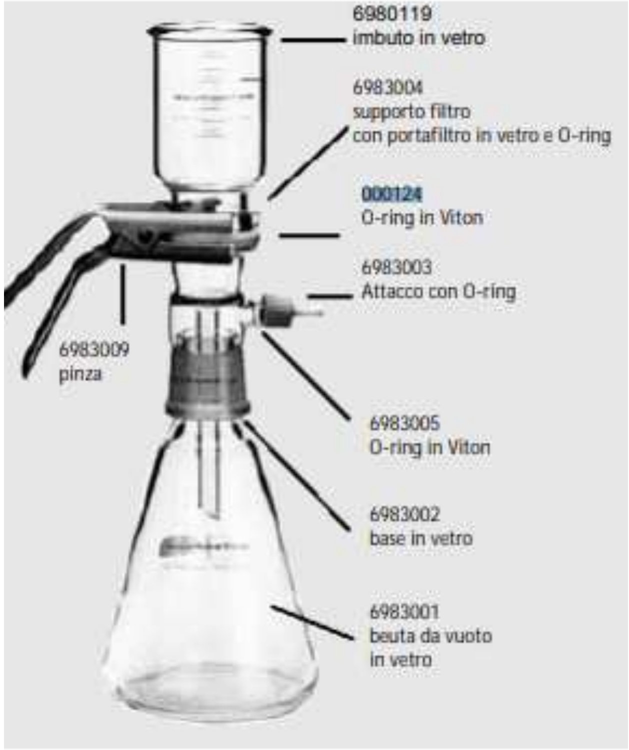
Microscopical analysis
Particle analysis using ImageJ

Filtration methods



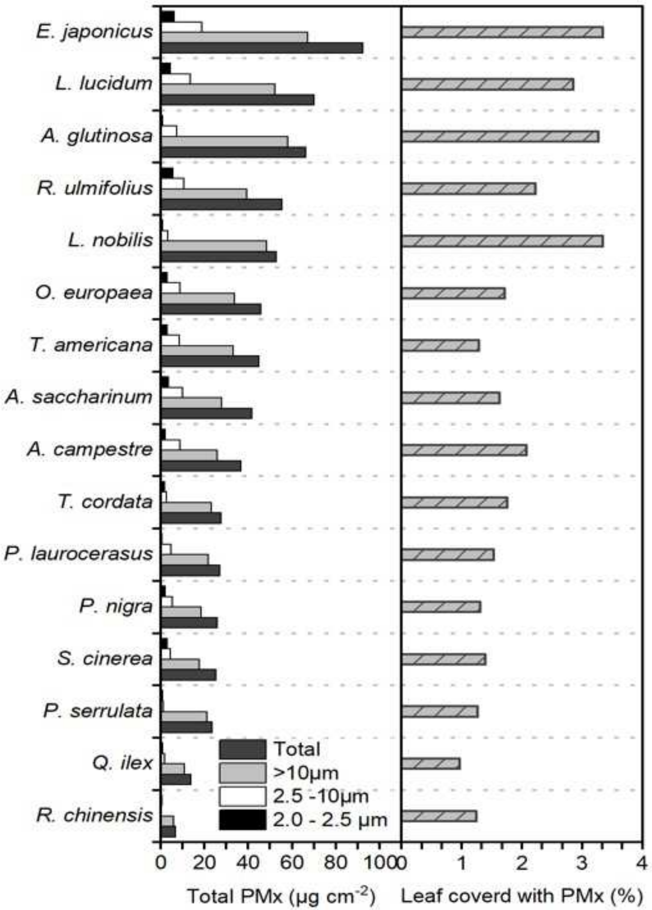
Left.: Particle analysis using ImageJ: images obtained by an optical microscope leaves analysis were used to identify Pmx.

Right.: Filtration was carried out using an apparatus equipped with a 47 mm glass filter funnel connected to a vacuum pump.



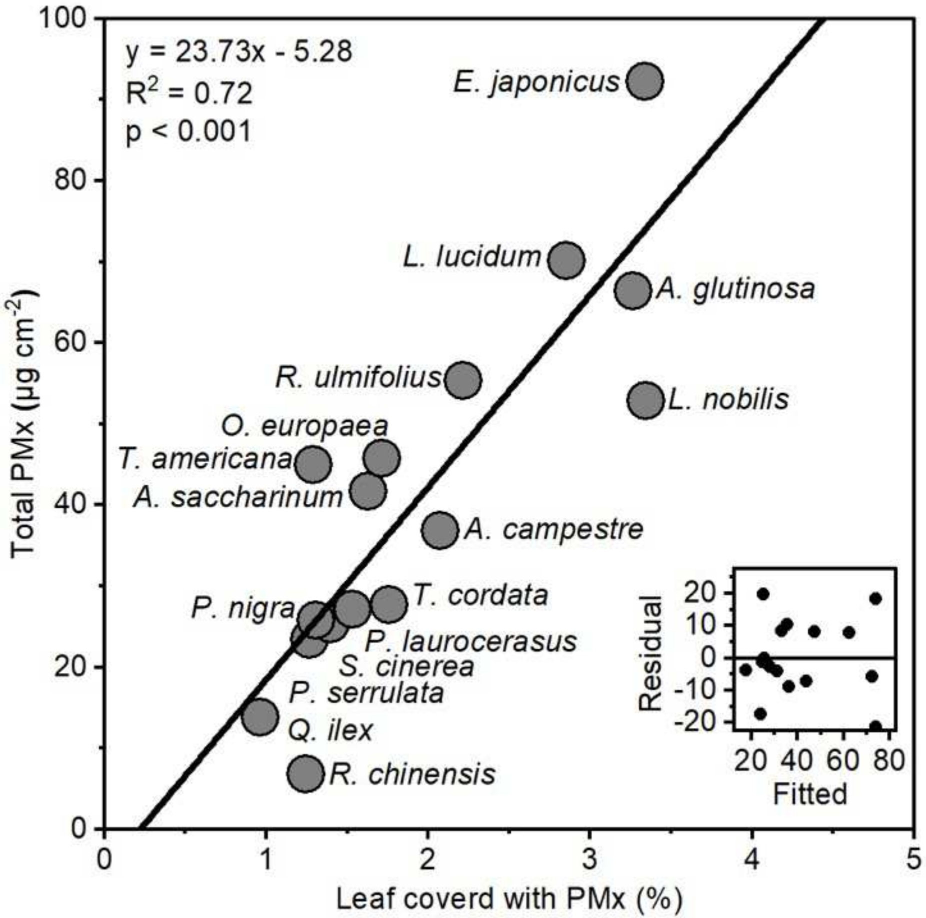
From the 32 species collected, 16 presented more them 1% of leaf area covered with PMx and were selected for the filtration methods

PMx divided by the particle size



Percentage of leaf surface covered to PMx (%)

Regression analysis between both methodologies



-The linear regression between both analyses presented a high coefficient of determination ($R^2 = 0.72$), a statistical significance of $p > 0.001$.

-Both methodologies are comparable at least when the leaves accumulate more than 1% of leaf-covered with PMx.

- Leaves with less the than 1% of leaf-covered with PMx could present a not significant regression due to an underestimation of the analysis with an optical microscope.

Leaf traits

Three leaves per sample were analysed using ImageJ, measuring the leaf traits shown in the table.

Species	Leaf area (LA)	Specific leaf area (SLA)	Leaf dissection index (LDI)	Leaf roundness
E. japonicus	**5.59**	**7.49**	**6.35**	**0.62**
L. lucidum	**27.57**	**6.49**	**5.00**	**0.43**
A. glutinosa	**54.81**	**14.03**	**5.53**	**1.00**
R. ulmifolius	**6.37**	**9.29**	**4.97**	**0.39**
L. nobilis	19.27	8.17	5.16	0.29
O. europaea	5.19	7.15	6.60	0.17
T. americana	**47.39**	**18.69**	**6.65**	**0.83**
A. saccharinum	46.63	12.65	12.29	0.50
A. campestre	**32.85**	**14.22**	**5.79**	**0.68**
T. cordata	**75.56**	**15.95**	**6.13**	**0.99**
P. laurocerasus	**85.48**	**8.52**	**5.09**	**0.36**
P. nigra	39.02	12.08	7.29	0.77
S. cinerea	33.44	9.72	6.04	0.45
P. serrulata	29.42	8.17	4.85	0.56
Q. ilex	12.11	9.57	5.42	0.41
R. chinensis	8.21	21.20	4.71	0.60

Species highlighted are those selected to the multiple regression analysis (they were collected at the same place and time)

Multiple linear regression between PMx parameters and leaf traits, (p-value < 0.1)
A combination in the leaf traits influenced the PMx accumulation

	Variable	Correlation	R^2	p-level
% PMx	LA	-	0.26	**0.072**
	SLA	**-**	**0.69**	**0.022**
	LDI	ni	0.52	0.422
	Leaf roundness	+	0.66	**0.016**
Total PMx	LA	ni	0.26	0.104
	SLA	**-**	**0.69**	**0.093**
	LDI	ni	0.52	0.551
	Leaf roundness	ni	0.66	0.152
PM_{10}	LA	ni	0.26	0.188
	SLA	ni	0.69	0.112
	LDI	ni	0.52	0.809
	Leaf roundness	ni	0.66	0.121
$PM_{2.5}$	LA	-	0.26	**0.034**
	SLA	**-**	**0.69**	**0.072**
	LDI	+	0.52	**0.099**
	Leaf roundness	ni	0.66	0.745
$PM_{0.2}$	LA	-	0.26	**0.054**
	SLA	ni	0.69	0.541
	LDI	ni	0.52	0.347
	Leaf roundness	ni	0.66	0.655

-The % PMx was positively correlated with leaf roundness and negatively correlated with LA and SLA.
-Total PMx was negatively correlated with SLA.
-PM_{10} was not correlated to any leaf trait.
-$PM_{2.5}$ was positively correlated with LDI and negatively correlated with LA and SLA.
-$PM_{0.2}$ was negatively correlated with LA.

SLA is an easy-to-measure leaf trait recommended for distinguishing between low and high net particle accumulator species (Muhammad et al. 2019)

Leaf roundness (leaf length/leaf width)

Conclusions of this research

1. PMx accumulation is better understood when a combination of methods is applied

2. Multiple methods can be used as a preliminary study to choose the most appropriate for specific research goals

3. When working with large sample sizes, only the filtration methods can be promising and the microscopical method can be used as a screening tool to separate target samples

4. The relationship between PMx accumulation and the leaf traits can be better explained by a conjunction of leaf traits

5. The leaf traits have to be considered when choosing species for PMx quantification, especially when working in long-term monitoring programs

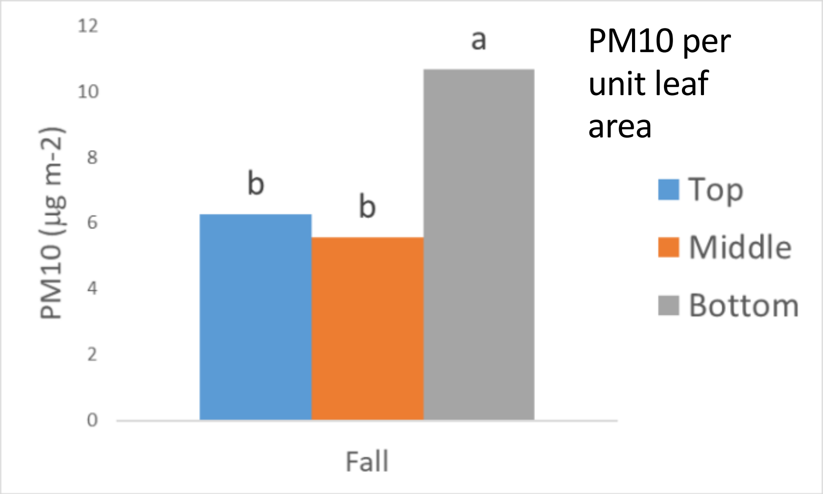
LIFE URBANGREEN

Measuring ecosystem services by urban species: the LIFE Urbangreen project

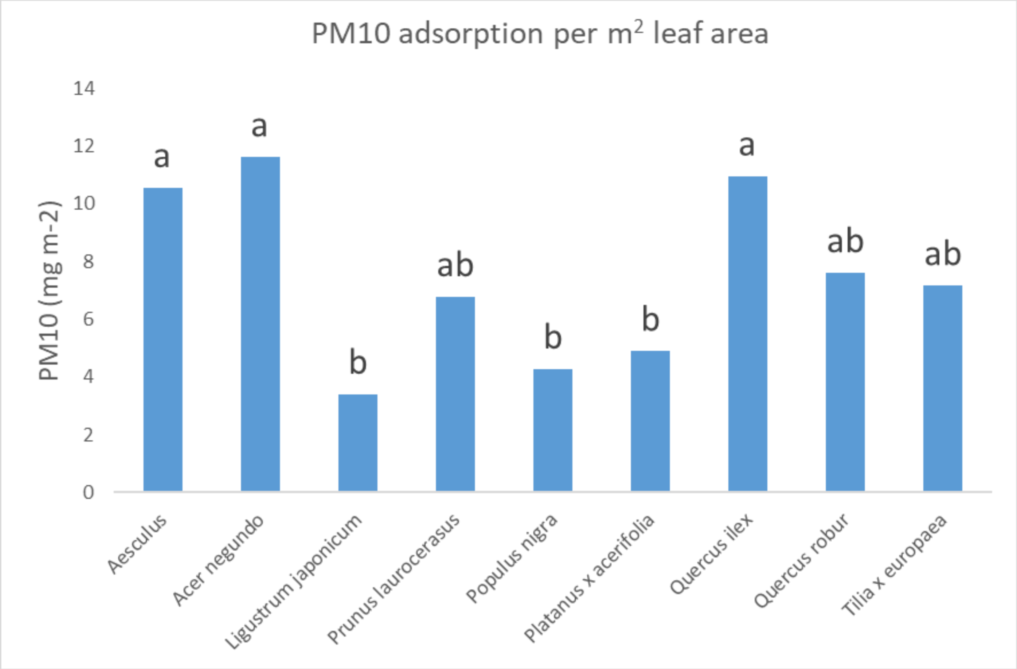
Preliminary results

Alessio Fini, Jacopo Mori, Irene Vigevani, Francesco Ferrini, Alice Pasquinelli, Marco Gibin, Piotr Wezyk, Osvaldo Failla, Paolo Viskanic

Pollution

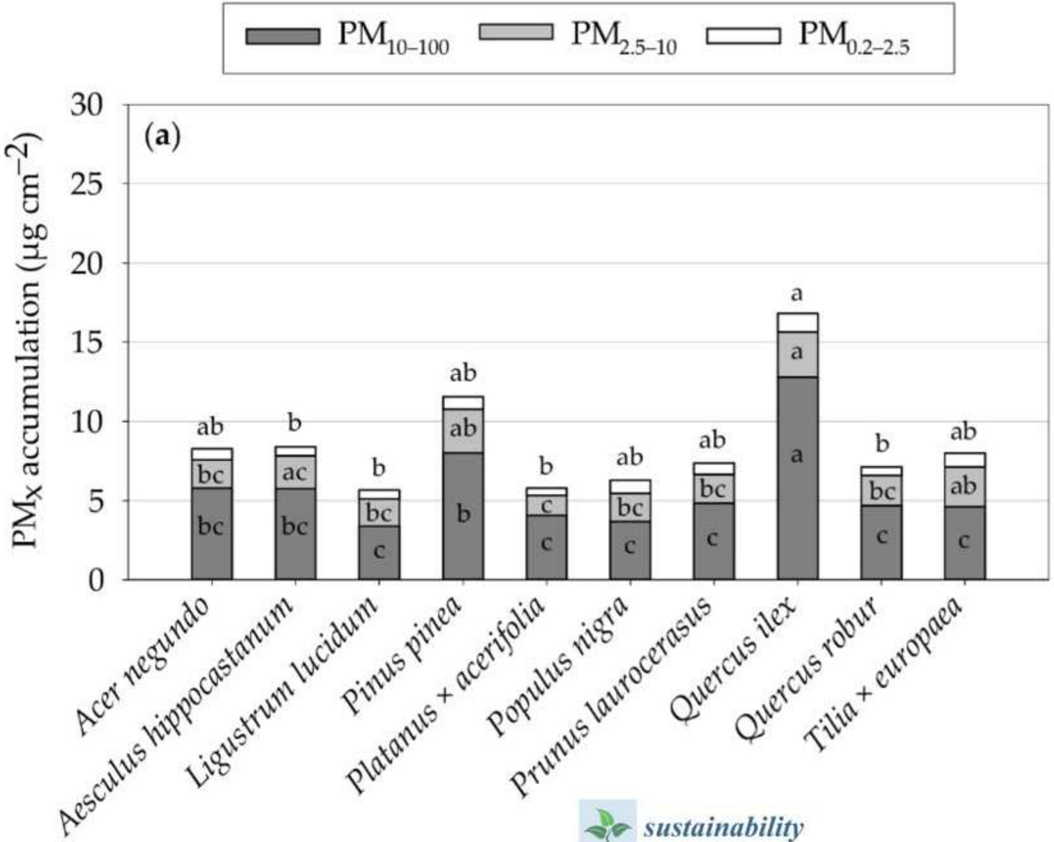


Aesculus, Acer and *Q. ilex* adsorbed more PM10 per unit leaf area than *Ligustrum, Populus*, and *Platanus*



Lower leaves are the most effective to capture PM

Strata was not significant



sustainability

MDPI

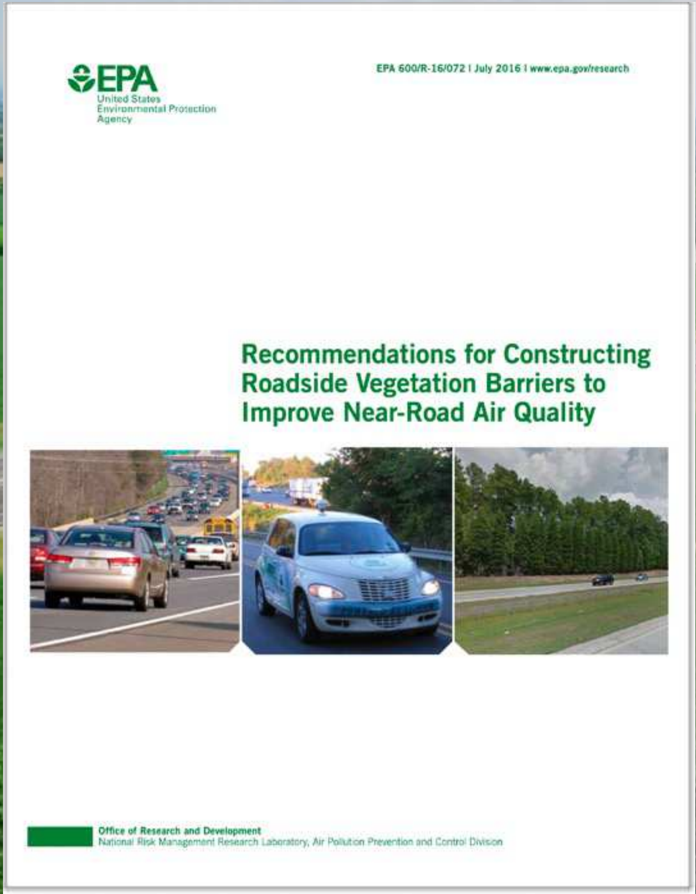
Article

Particulate Pollution Capture by Seventeen Woody Species Growing in Parks or along Roads in Two European Cities

Irene Vigevani [1,2,3,*], Denise Corsini [2], Jacopo Mori [2], Alice Pasquinelli [4], Marco Gibin [1], Sebastien Comin [1], Przemysław Szwałko [5], Edoardo Cagnolati [6], Francesco Ferrini [2] and Alessio Fini [1]

Vigevani et al., 2022. Sustainability, 14, 1113.
https://doi.org/10.3390/su14031113

Recommendations for constructing roadside vegetaion barriers to improve near-rpad air quality. EPA 600/R-16/072/July 2016. www.epa.gov/search. From EPA, 2016, mod.



EPA
United States
Environmental Protection
Agency

EPA 600/R-16/072 I July 2016 I www.epa.gov/research

Recommendations for Constructing Roadside Vegetation Barriers to Improve Near-Road Air Quality

Office of Research and Development
National Risk Management Research Laboratory, Air Pollution Prevention and Control Division

Roadside Vegetation Barrier

Results of the study of Hashbad et al., (2020) indicate that:

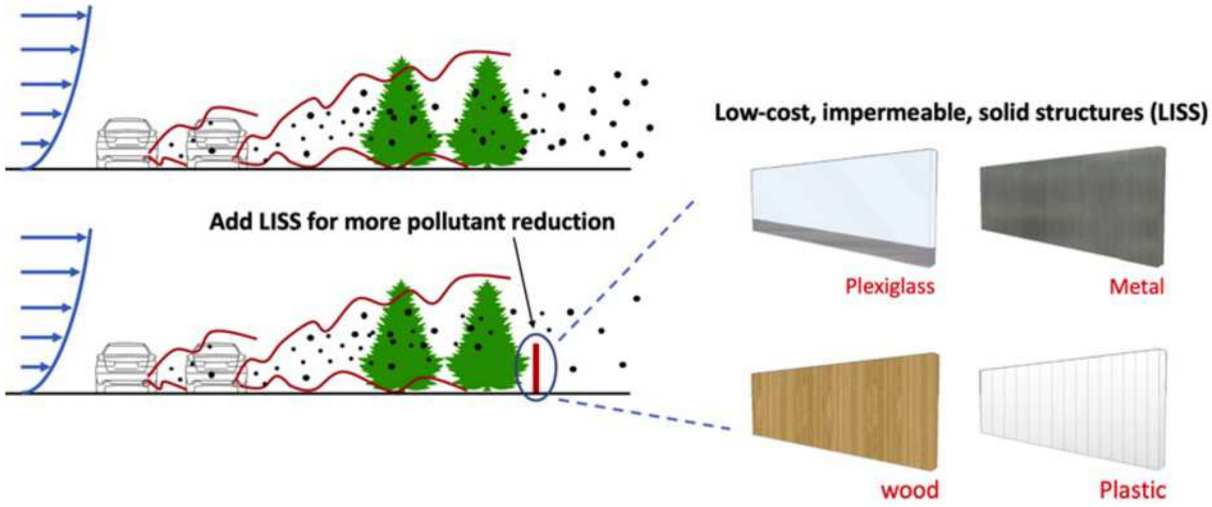
(i) Combining Low-cost, Impermeable, solid structures (LISS) and vegetation is more effective than either alone

(ii) Combining a less dense vegetation and LISS can be as effective as a dense vegetation barrier

(iii) In certain scenarios, depending on wind speed and particle size, vegetation barriers alonemight lead to elevated pollutant concentrations; however, combining LISS with vegetation can mitigate those negative impacts,

(iv) Placing LISS closer to the freeway and in front of the vegetation barrier enhances vertical dispersion of pollutants, and

(v) Increasing LISS height promotes pollutant concentration reduction.

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journal homepage: www.elsevier.com/locate/scitotenv

Enhancing the local air quality benefits of roadside green infrastructure using low-cost, impermeable, solid structures (LISS)

Khaled Hashad [a], Bo Yang [a], Richard W. Baldauf [b,c], Parikshit Deshmukh [d], Vlad Isakov [b], K. Max Zhang [a,*]

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[d] Jacobs Technology Inc., Durham, NC, USA

Hong Kong 2022 International Urban Forestry Conference
Well-being: Our Urban Forest - Our Community

Review n. 34 – *Italus Hortus* 25 (1), 2018: 13-22 doi: 10.26353/j.itahort/2018.1.1322

Air pollution mitigation by urban greening

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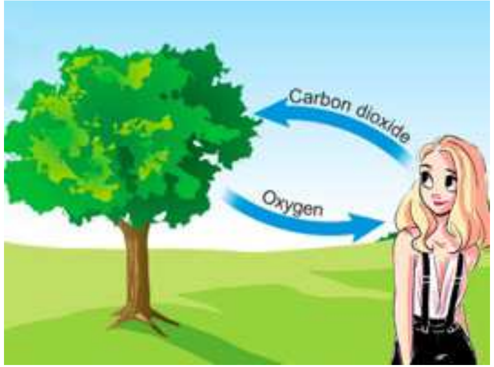
[2] *Norwegian Institute of Bioeconomy Research, NIBIO, Norway*

How to plan green areas for air quality improvement:

- Low-maintenance and fast-growing species with a medium to long-lifetime are preferable
- Evergreen species have generally a higher potential compared to deciduous species (beware to possible vulnerability to pollution)
- Species with hairs, thricomes and waxes have generally a greater interception of air pollutants, but total leaf area should have priority
- The environment surrounding the planting site should be highly considered (street canyons vs open roadside areas)
- Regarding roadside vegetation barriers, species with a considerable height, width and a high LAI (Leaf Area Index or high LAD - Leaf Area Density) are recommended



Thanks for the attention