CLAIRO CONFERENCE: LIVABLE AND CLIMATE RESILIENT EUROPEAN CITIES

Improving air quality with the use of greenery

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Air pollution, that is the leading environmental cause of mortality globally, **kills an estimated 7 million people worldwide every year**. This mortality is mostly due to exposure to **fine particulate matter** of 2.5 microns or less in diameter ($PM_{2.5}$).

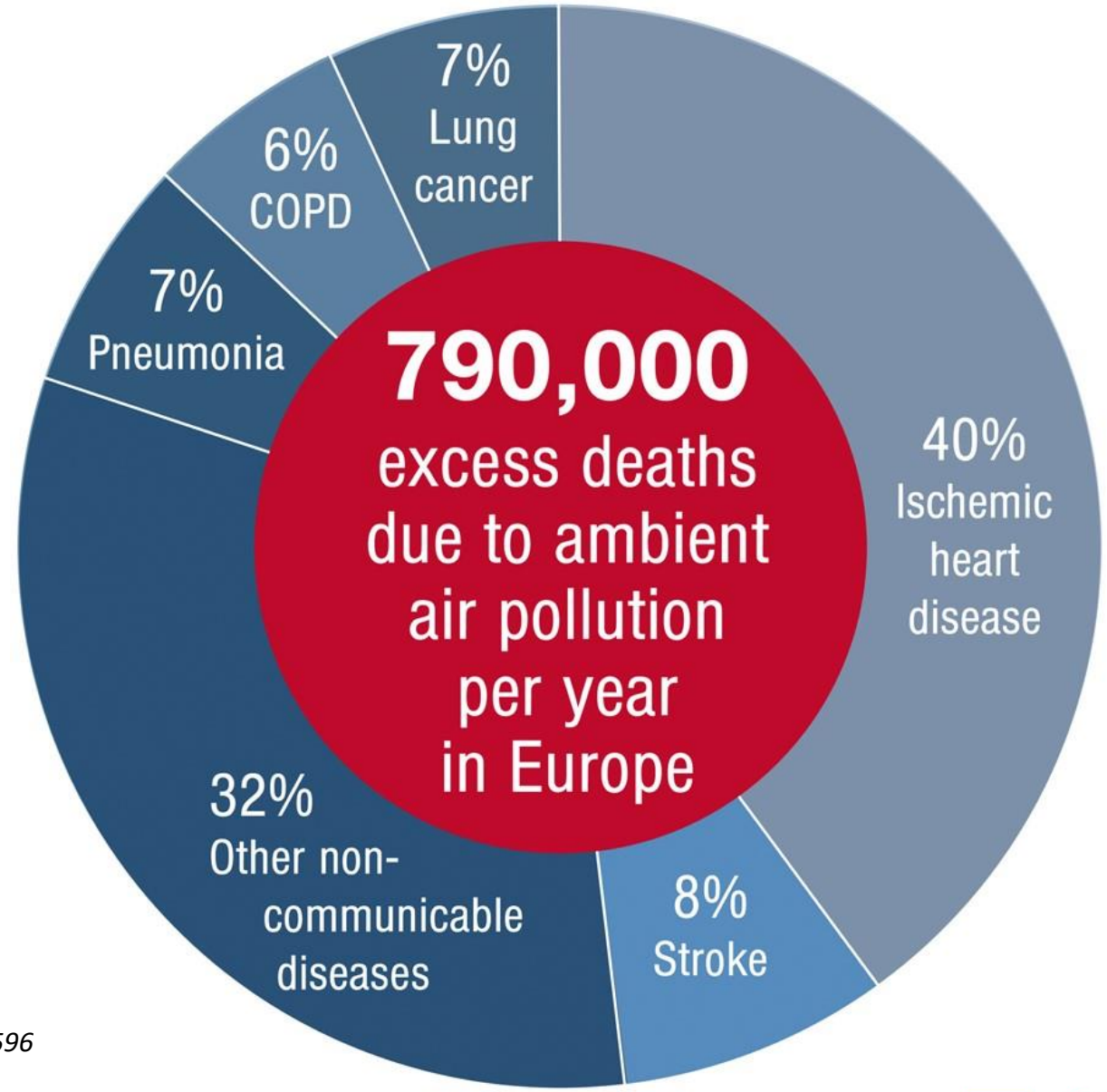
Source: World Health Organisation

Image: Nick van den Berg, Unsplash

Air quality situation in the EU

Infringement cases against **18 Member States** related to air quality standards!

How does air pollution kill?



Source: Eur Heart J, Volume 40, Issue 20, 21 May 2019, Pages 1590–1596

Study from the UK:
‚Crime is in the Air'

air pollution is associated with
higher crime rates

Image: Amber Kipp, Unsplash

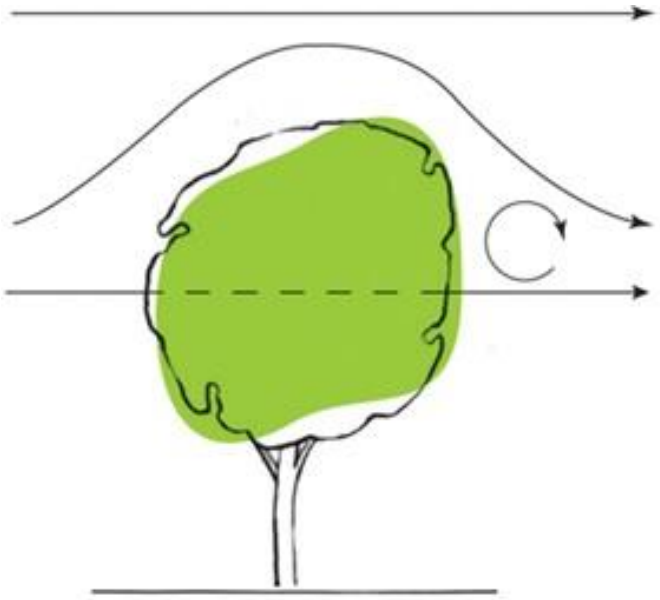
Greenery can protect from air pollution through
two key processes:

- **Dispersion**

- **Deposition**

Image: Yoksel Zok, Unsplash

dispersion



Source: Hewitt, C. N. et al

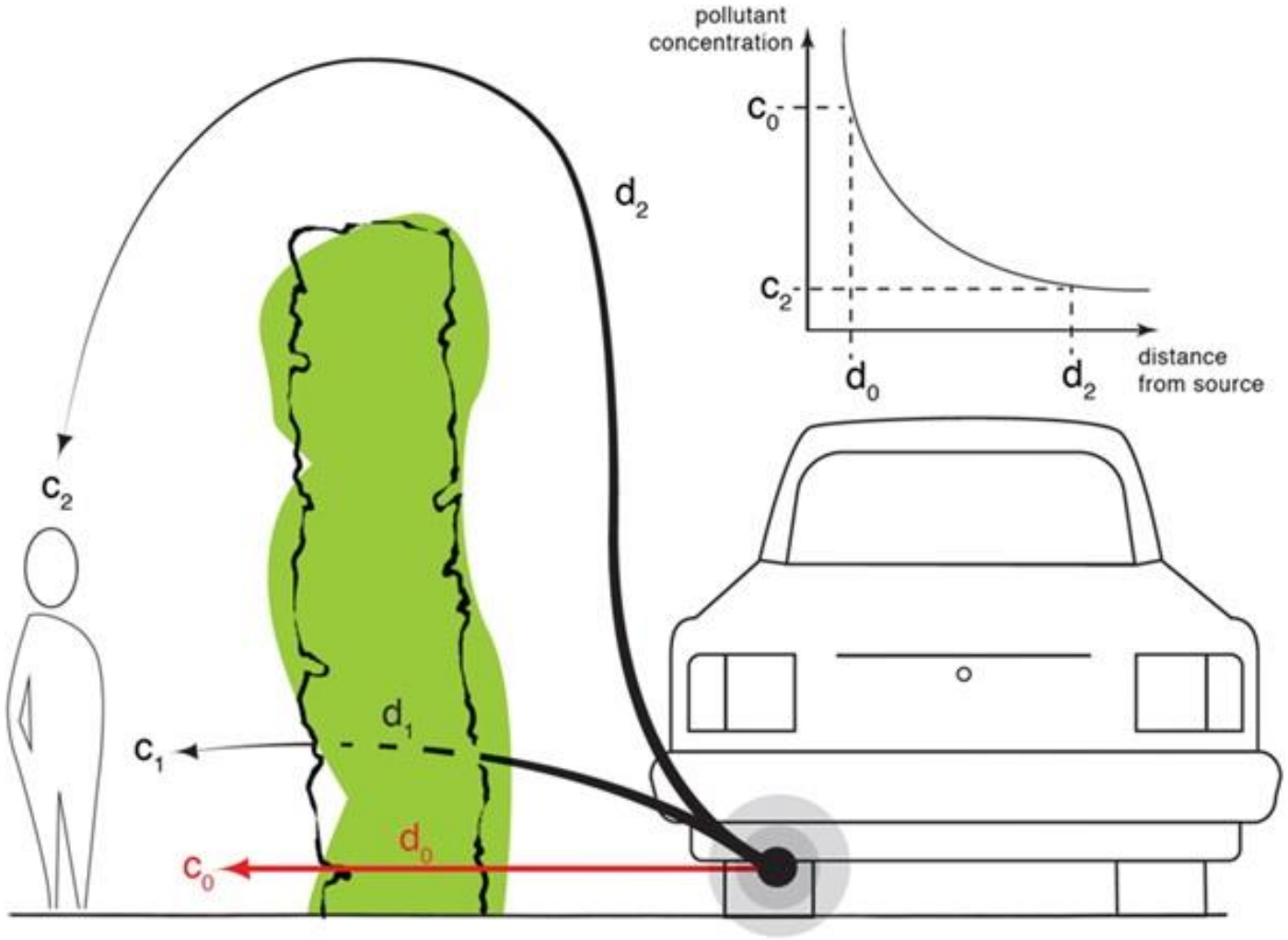
- Trees and hedges introduce turbulence and increase dilution of pollutants.

- An average 8% reduction can be achieved in ground-level concentration of $PM_{2.5}$ due to the dispersive effect of trees.

dispersion, linear obstacles

Hedges: extended effective path-length of air from source to receptor

Hedges can cut exposure to black carbon by up to 63% (University of Surrey)



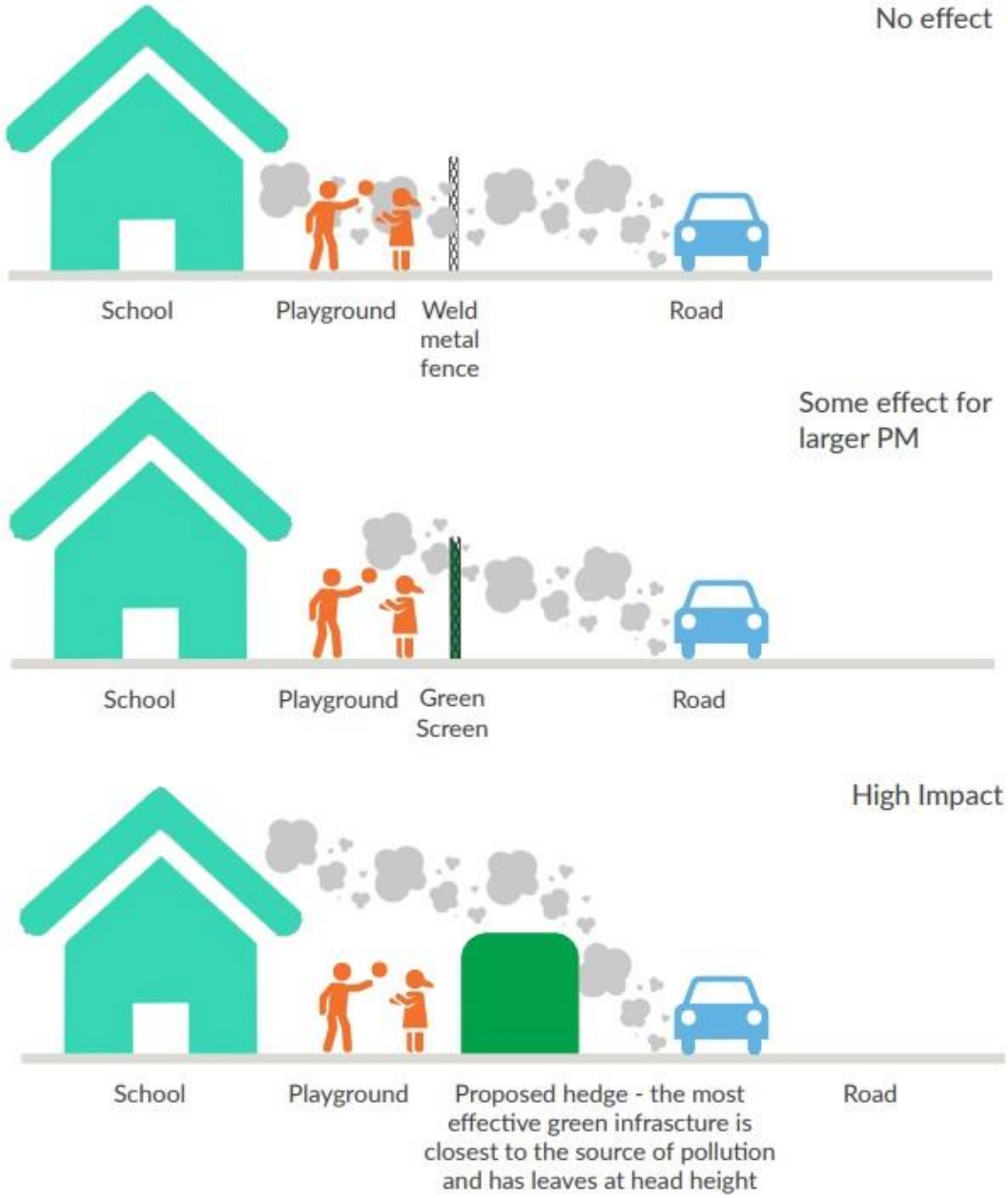
Source: Hewitt, C. N. et al

dispersion, hedges

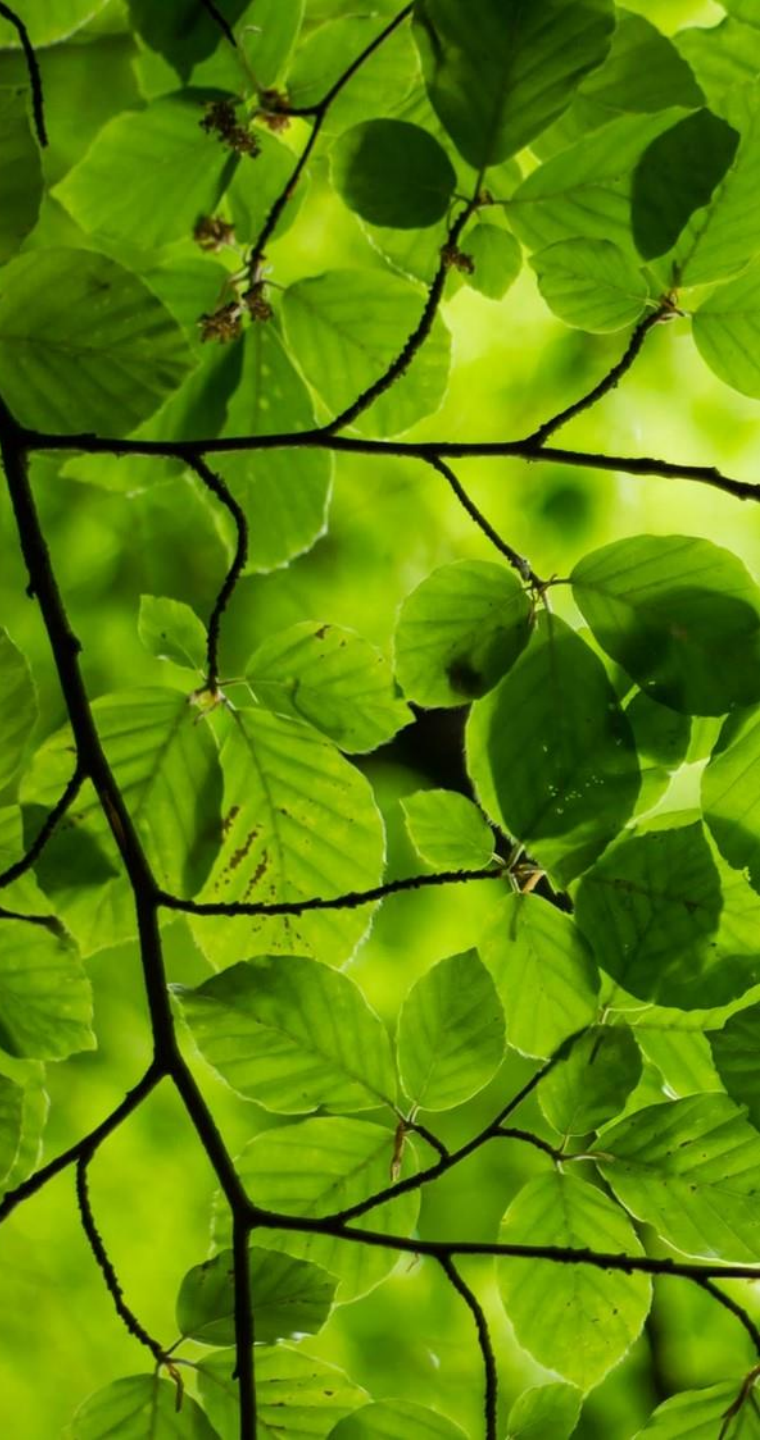
Hedges can cut exposure to particulate matter by more than 50%
(University of Surrey)

Protecting Playgrounds, Manchester

Protecting children from air pollution by planting hedgerows around schools



Source: https://cleanairgm.com/news/protect-playgrounds/



deposition

- Greenery can potentially protect against air pollution by enhancing the deposition rates of pollutants
- Pollutants deposit more efficiently on vegetation than on smoother artificial surfaces
- Highly dependent on the available surface area and the aerodynamic roughness of the surface

Image: @modernafflatusphotography, Unsplash

Which are the

BEST TREE SPECIES

to reduce air pollution?

filtering activity of trees depends mainly on the

canopy size

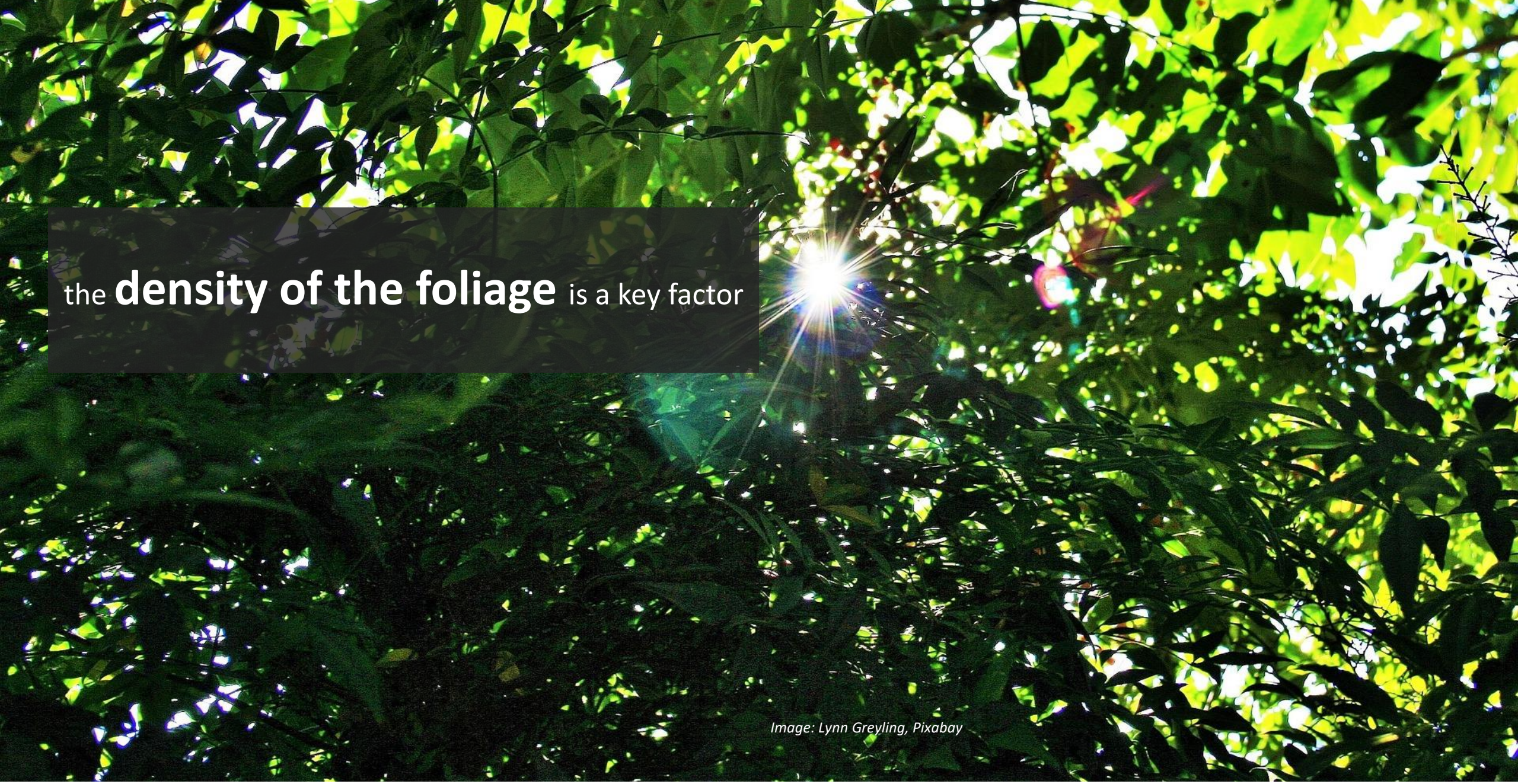
Small Trees
1-4m canopy diameter
3-7.5m²* planting area
e.g. Malus 'John Downie'
Amelanchier lamarckii
'Robin Hill'

Medium Trees
4-7m canopy diameter
7.5-23m²* planting area
e.g. Prunus 'Pandora'
Betula pendula
Alnus cordata

LargeTrees
7-25+m canopy diameter
23-300m²* planting area
e.g. Quercus robur
Platanus x hispanica
Tilia platyphyllos

* This area calculation assumes that a 1m depth of soil is available, if there is less depth then a larger area is required.

Source: Anna French Associates Ltd



the **density of the foliage** is a key factor

Image: Lynn Greyling, Pixabay

shape of the crown

Source: Organically Green Blog

shape of the crown

a **spherical crown** is more effective
than one with a pyramid shape

foliage longevity is a key aspect

Image: Yoksel Zok, Unsplash

leaf size

species with **smaller leaves** tend to be more effective in filtering pollutants

features of leaf surface

rough, **hairy** surfaces, **sticky** leaves
have better filtration potential

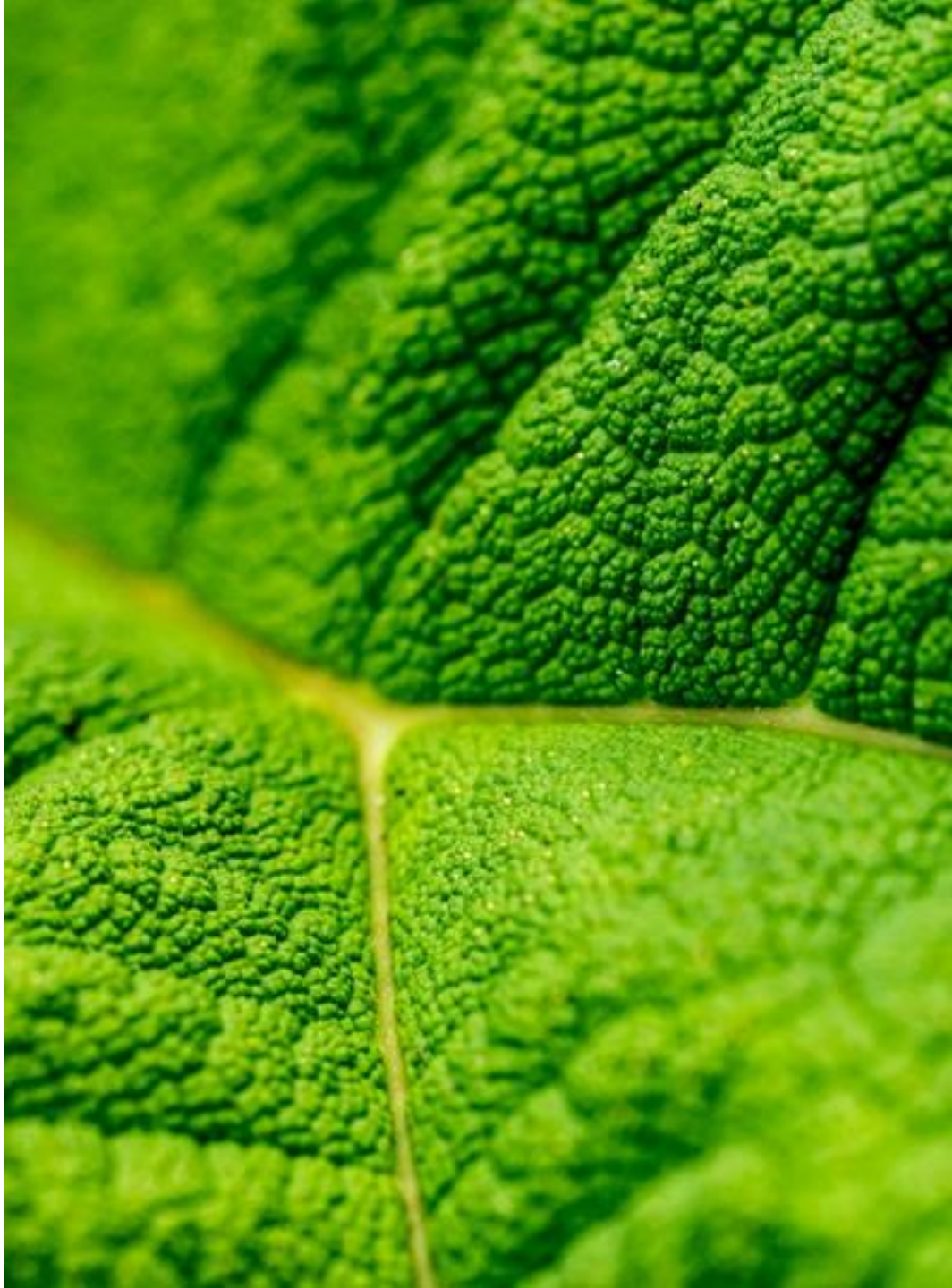


Image: Stefan Steinbauer, Unsplash

COMPOSITION and STRUCTURE

of the vegetation

complex, well-functioning urban ecosystems

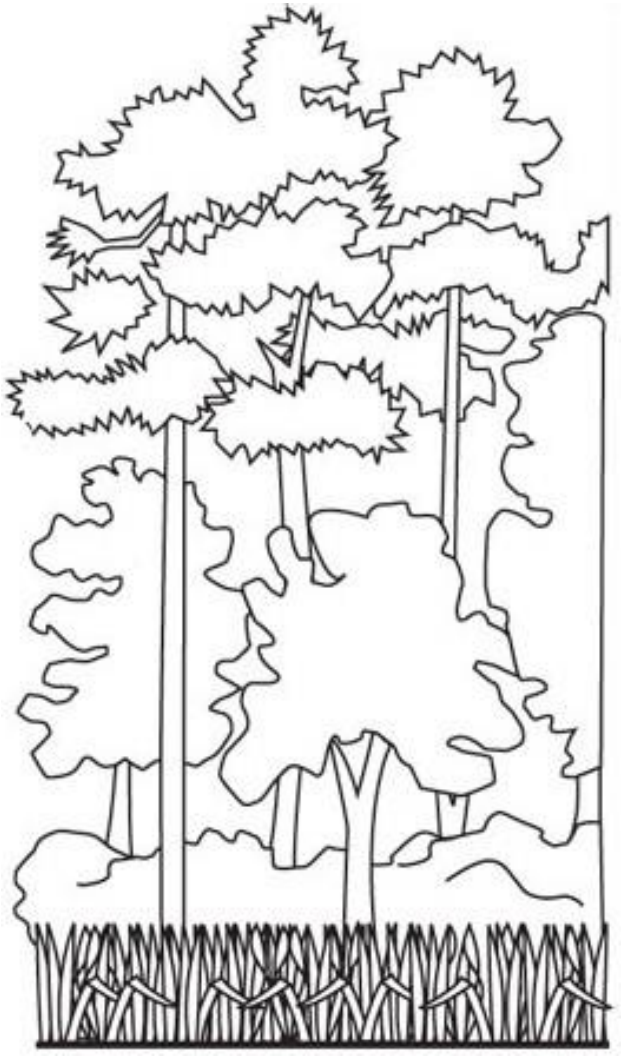
- focus on environmental conditions
- plants to be adapted to topographical, soil and climatic conditions
- plant diversity

Image: Gábor Adonyi, Unsplash

vertical layering of forests

Multi-level tree cover:

multiple floors with trees complemented by shrub floors



Source: University of Missouri

sensitivity of the proposed greenery to the **air pollution**

species with increased tolerance to air pollution

Image: Mike Marrah, Unsplash

Database of viable tree species for air pollution mitigation

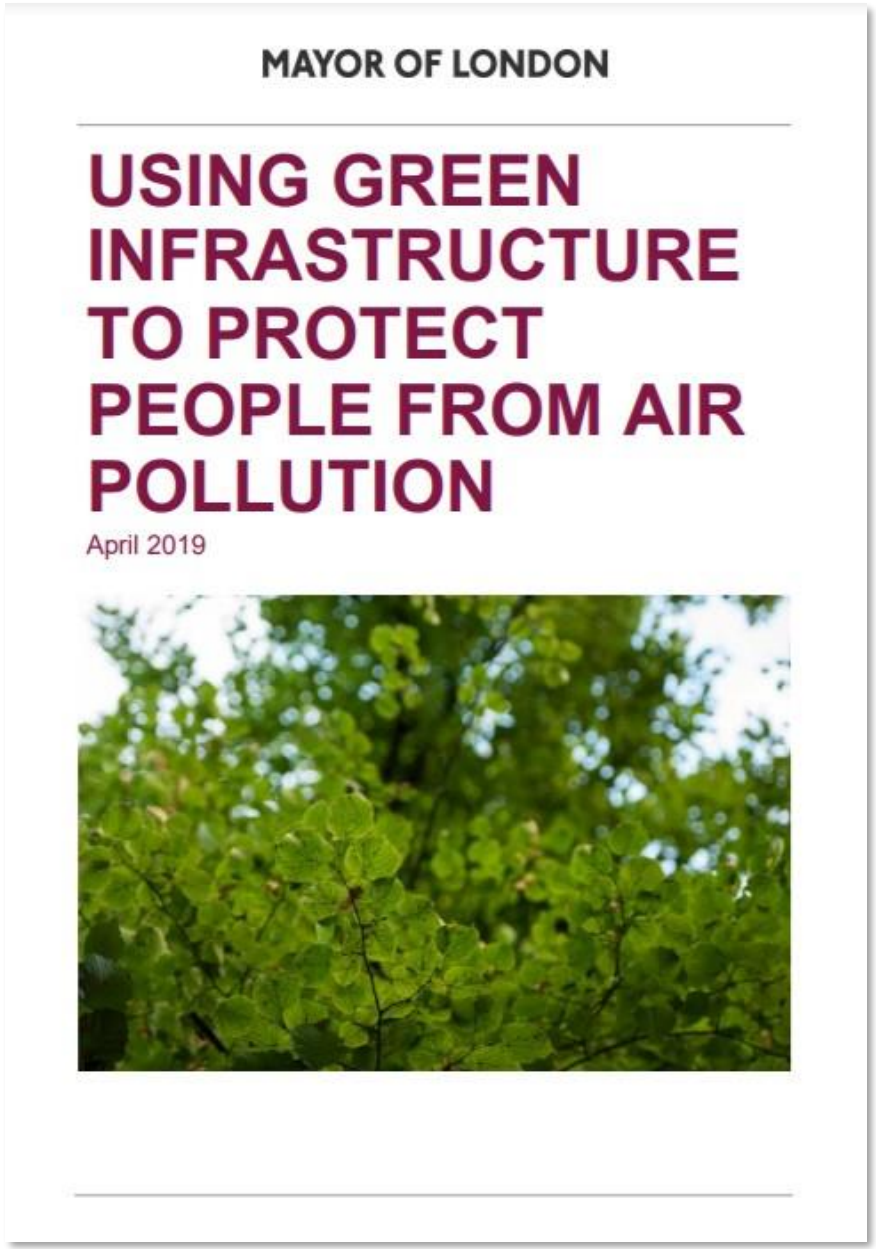
Source: npj Climate and Atmospheric Science, Designing vegetation barriers for urban air pollution abatement: a practical review for appropriate plant species selection

https://www.nature.com/articles/s41612-020-0115-3#citeas

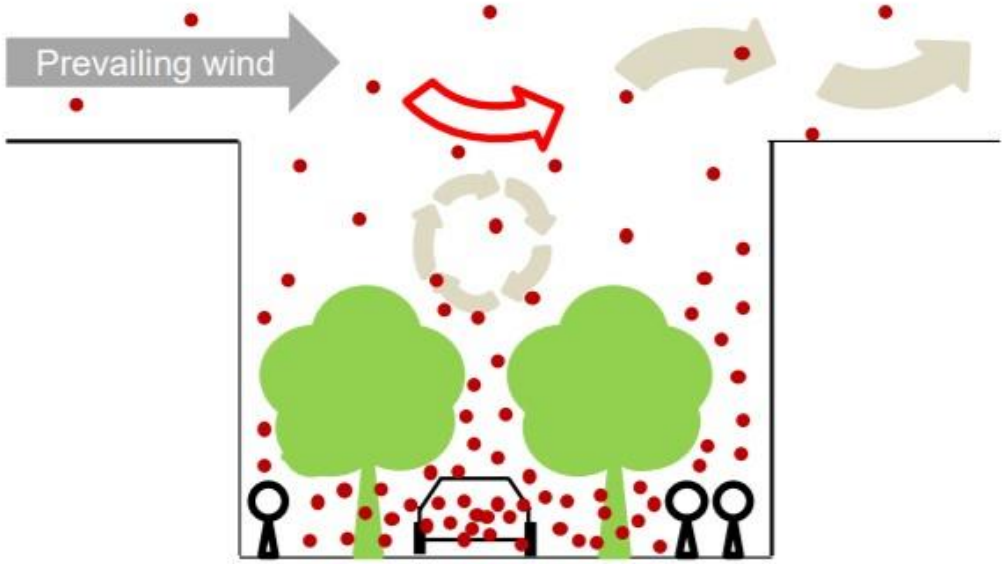
Plant species	Morphology		Successional status	Tolerances		Emissions	
	Mature size	Canopy density		Drought	Salt	bVOCs	Pollen
Acer buergerianum	Large	Dense	–	Moderately tolerant	Yes	Low	Moderate
Acer campestre	Medium	Dense	Early	Moderately tolerant	Yes	Low	Moderate
Acer platanoides	Large	Dense	Late	Moderately tolerant	No	Low	High
Acer pseudoplatanus	Large	Dense	Late	Moderately sensitive	No	Low	High
Acer rubrum	Large	Moderate	Late	Moderately tolerant	Yes	Low	High (var.)
Acer tataricum	Medium	Moderate	Late	Tolerant	Yes	Low	Moderate
Acer tataricum subsp. *ginnala*	Small	Dense	Late	Moderately tolerant	Yes	Low	Moderate
Ailanthus altissima	Massive	Moderate	–	Tolerant	Yes	Low	Moderate (var.)
Alnus glutinosa	Large	Open	Early	Moderately sensitive	Yes	Low	High
Alnus incana	Large	Open	Early	Moderately sensitive	Yes	Low	High
Alnus × *spaethii*	Large	Moderate	Early	Moderately sensitive	Yes	Low	High
Amelanchier arborea	Medium	Moderate	–	Moderately sensitive	Yes	Low	Low
Celtis australis	Large	Moderate	Early	Tolerant	Yes	Low	Moderate
Celtis occidentalis	Large	Moderate	Early	Moderately tolerant	No	Low	Moderate
Crataegus monogyna	Small	Dense	Early	Tolerant	Yes	Low	Low
Elaeagnus angustifolia	Medium	Moderate	Early	Tolerant	Yes	Low	High
Eucommia ulmoides	Large	Moderate	–	Tolerant	Yes	Low	High (var.)
Ginkgo biloba	Large	Moderate	–	Tolerant	Yes	High	Moderate (var.)

GREENING URBAN ROADS

for better air quality



https://www.london.gov.uk/sites/default/files/green_infrastruture_air_pollution_may_19.pdf

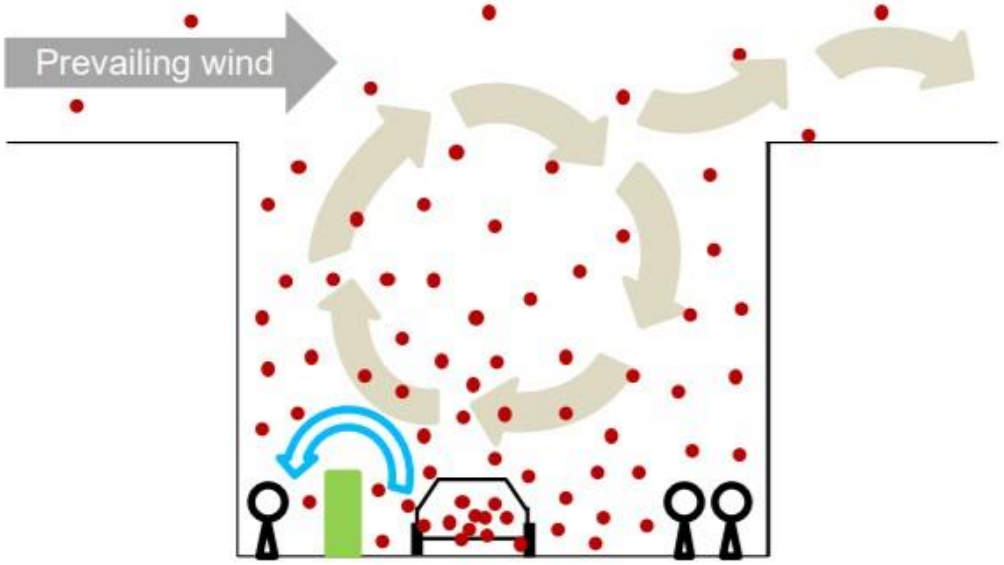


Street canyons

Air at street level is more polluted than above the buildings

Source: Using Green Infrastructure To Protect People From Air Pollution. Mayor of London, 2019

Street canyons



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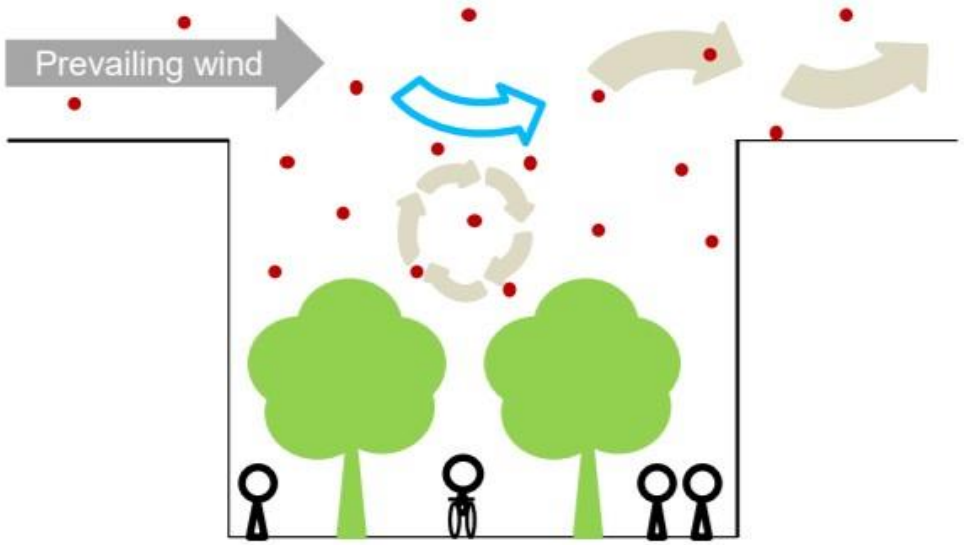


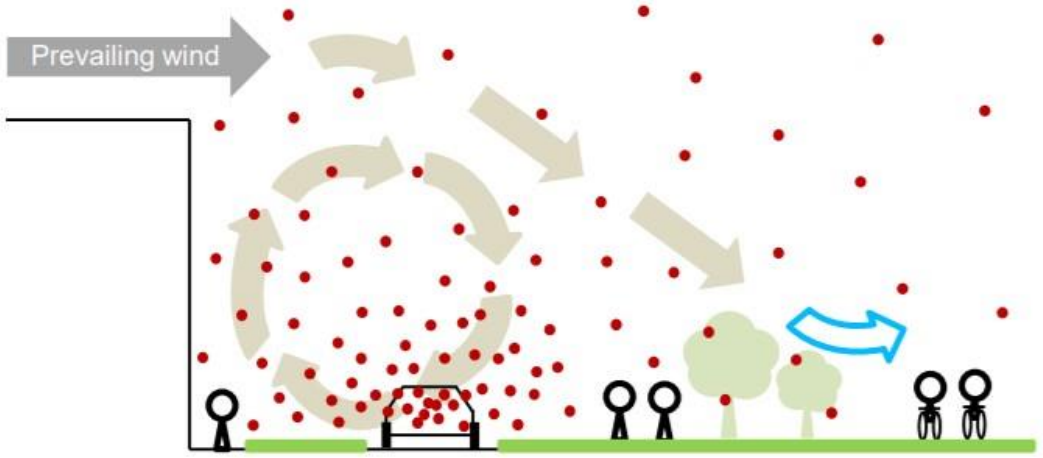
Street canyons

Air above the buildings is more polluted than at street level

Source: Using Green Infrastructure To Protect People From Air Pollution. Mayor of London, 2019

Open roads

benefits of green open space



Source: Using Green Infrastructure To Protect People From Air Pollution. Mayor of London, 2019

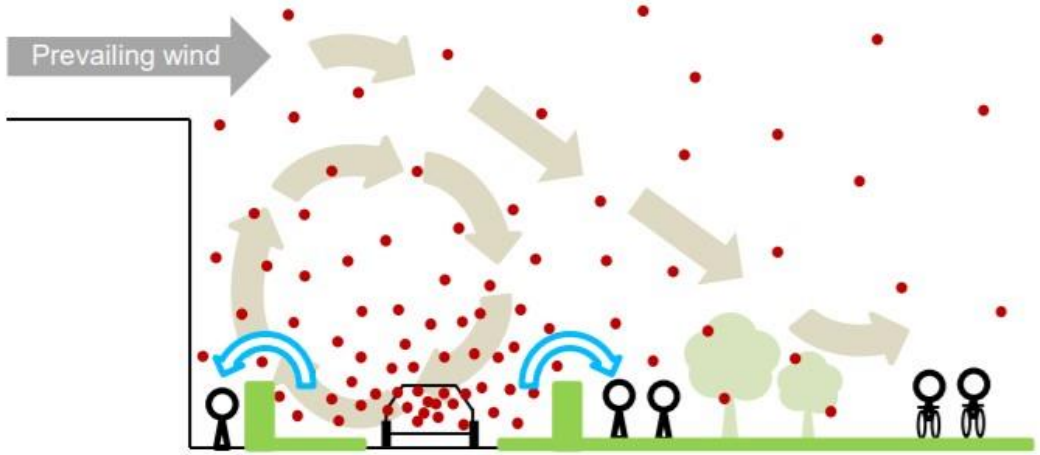
Open roads

Protecting people further from an open road

Source: Using Green Infrastructure To Protect People From Air Pollution. Mayor of London, 2019

Open roads

Protecting people next to an open road



Source: Using Green Infrastructure To Protect People From Air Pollution. Mayor of London, 2019

Street canyons			Open roads	
street canyons with **little or no traffic**	street canyons with **moderate or heavy traffic**		people to be protected **immediately at the roadside**	people to be protected **further away**
	wider canyons (height/width ratio > 2)	**narrower canyons** (height/width ratio < 2)		
A dense avenue of trees	**Addition of green open space** to one side	**A hedge or green wall** between vehicles and people	**A hedge or green wall** between vehicles and people	**A combination of hedge and dense line of trees**

Source: Greater London Authority (2019) 'Using Green Infrastructure To Protect People From Air Pollution'

DESIGNING FOR DEPOSITION

Height of vegetation is relevant

Filtering effect increases in the following order:

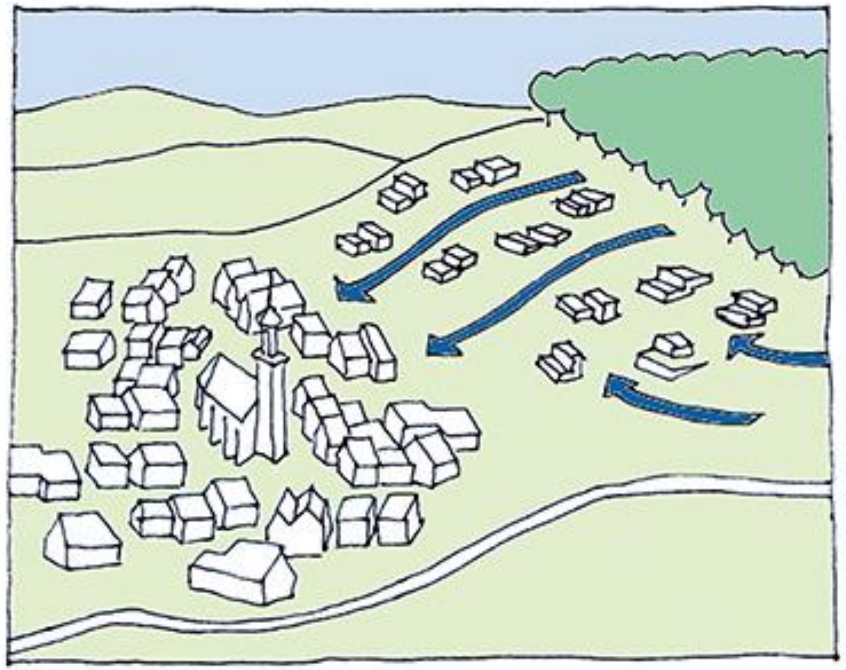
open water / bare soil < low grassland < high grassland < heath < shrubs < broad-leaved forest < pine forest

Edge effect

transitions from low vegetation to forest
greatly affect deposition

Urban planning to support ventilation

- construction bans
- green ventilation corridors



Planning streets for better Air Quality:

REDUCE

exposure to air pollution where people spend time

Planning streets for better Air Quality:

INVITE

people to spend time where air quality is better

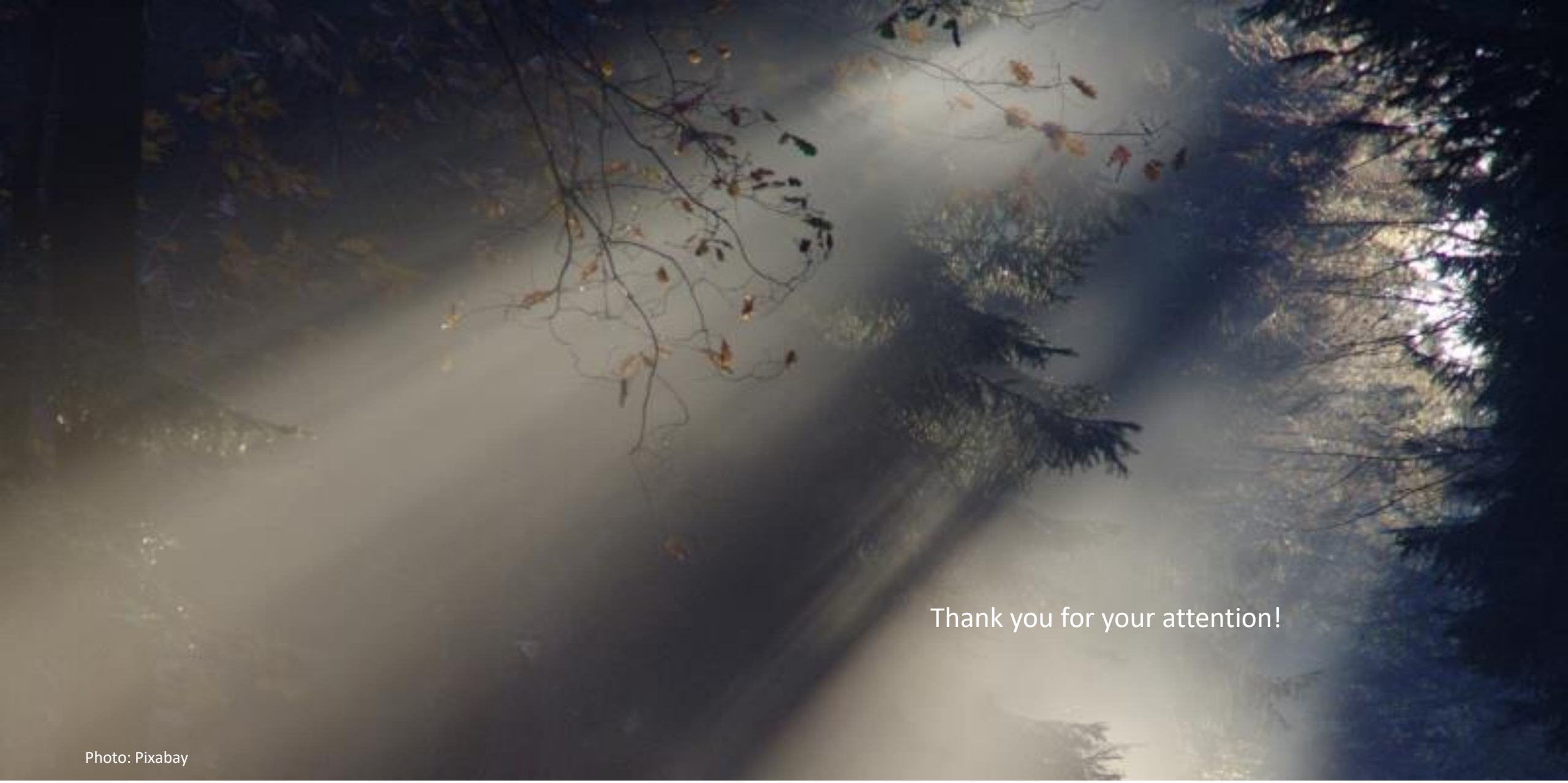


Photo: Pixabay

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