

**Not all plants are the same:
the importance of plant choice to maximise the
environmental benefits in cities**

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Gardens

Advisory service

Publishing

Horticultural / Flower
Shows

Science 😊!!!

UK's oldest (est. 1804) and largest (500+ employed and 450k+ members) horticultural society aimed at demonstrating excellence in horticulture and promoting gardening in the UK and beyond





RHS Garden Wisley
and more



Sharing the best in Gardening

Chelsea Flower Show,
London





RHS Science Strategy themes 2014-2019

1: A Global Knowledge-bank on Gardening and Garden Plants

2: Plant Health in Gardens

3: Gardening in a Changing World

4: Plant Science for All: People, Plants, Planet



Sharing the best in Gardening

<https://www.rhs.org.uk/science>

Why cities?



- Almost **90%** of UK residents live in urban areas
- Cities are warmer AND more polluted than the surrounding countryside
- Cities can be more affected by (intense) rainfall due to a reduction in vegetated areas and an increase in impervious surfaces => higher risk of localised flooding



Why (worry about) urban domestic gardens and urban green spaces?

- **22.7 million** households (87% of homes) in the UK have access to a garden
- **20-25%** of every UK town/city's surface is occupied by domestic gardens

What we grow in our individual gardens and **how we manage** them can have a big **ENVIRONMENTAL IMPACT** collectively!



(Thompson et al., 2004; Davies et al., 2009; Cameron et al., 2012, Cameron and Blanusa, 2016)

What are the problems?



Cities are warmer than the surrounding countryside

- Urban areas trap heat + cool more slowly
- Energy release from buildings, industry, traffic *etc.* can also contribute to temperature increase

What are the problems?

- Rain water runoff
- Gaseous (NO_x , CO_2 , CO , SO_2 , ...) and particulate air pollution
- Noise ...



Plants!

Vegetation can help – but the extent of cover and choice of species are important!!

Maintenance ...



Cameron and Blanusa, 2016, Annals of Botany

<http://aob.oxfordjournals.org/content/early/2016/07/19/aob.mcw129.abstract>

Green roofs provide insulation and rainfall attenuation



Plants provide many simultaneous services.

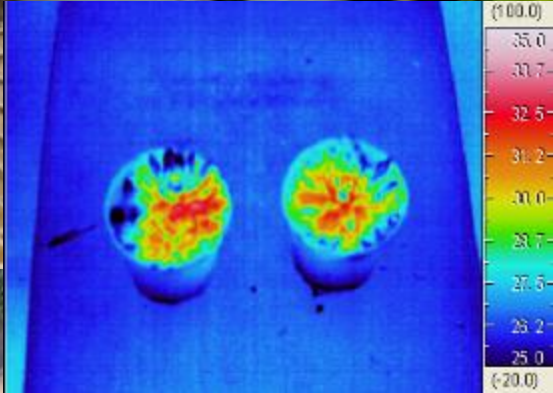
PLANTS DIFFER IN THE EXTENT OF SERVICES' PROVISION!

Green walls help provide insulation

- Air temperatures/building insulation
- Pollutant trapping
- Rainfall capture
- Carbon capture
- BVOCs emissions
- ...

Trees help with air cooling, pollutant trapping, carbon sequestration and rainfall attenuation





Plant traits which can be linked to enhanced services' delivery:



University of Reading

Cooling

Vaz Monteiro MM

High ETp rate

Light colour, presence of hairs

Large LA

Rainfall capture

Kemp S

High ETp rate

Presence of hairs and rough surfaces

Large LA

Pollutant trapping

Fantozzi F

Presence of hairs and rough surfaces

Large LA



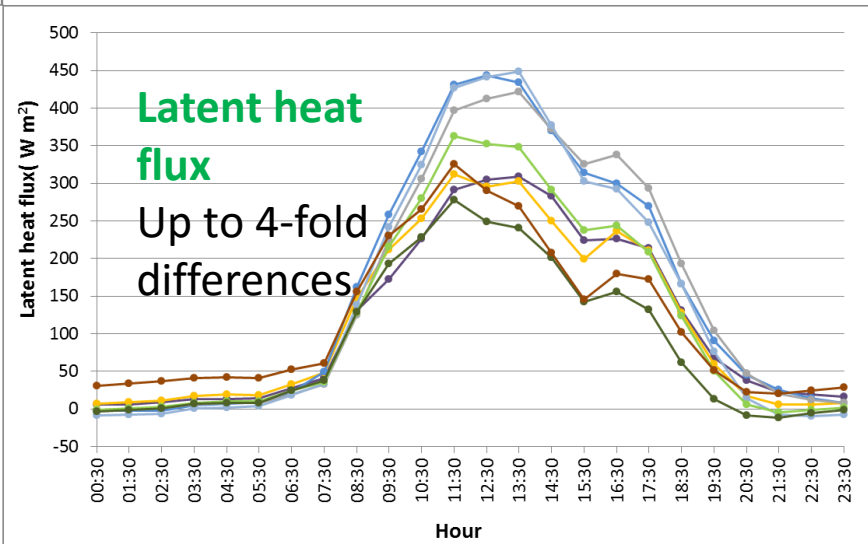
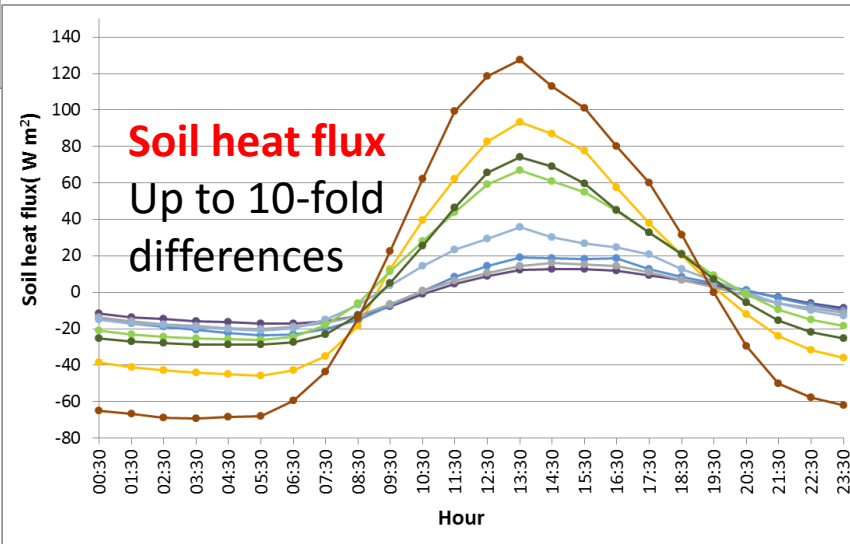
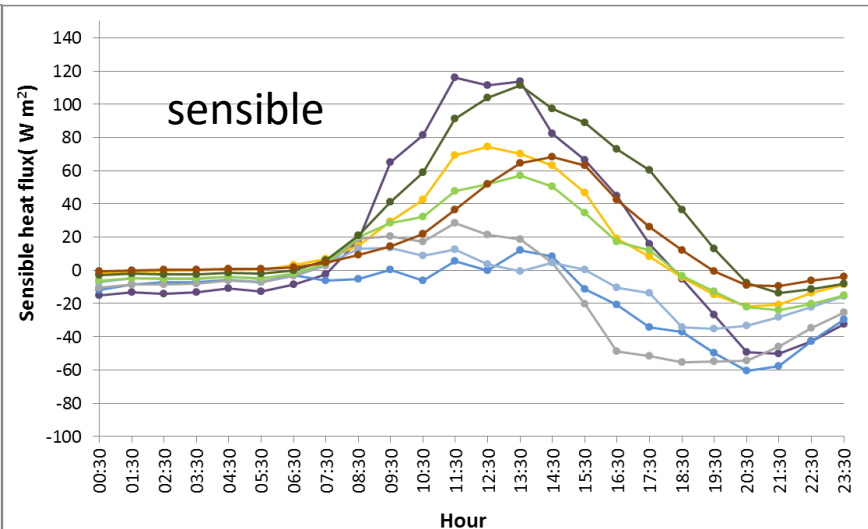
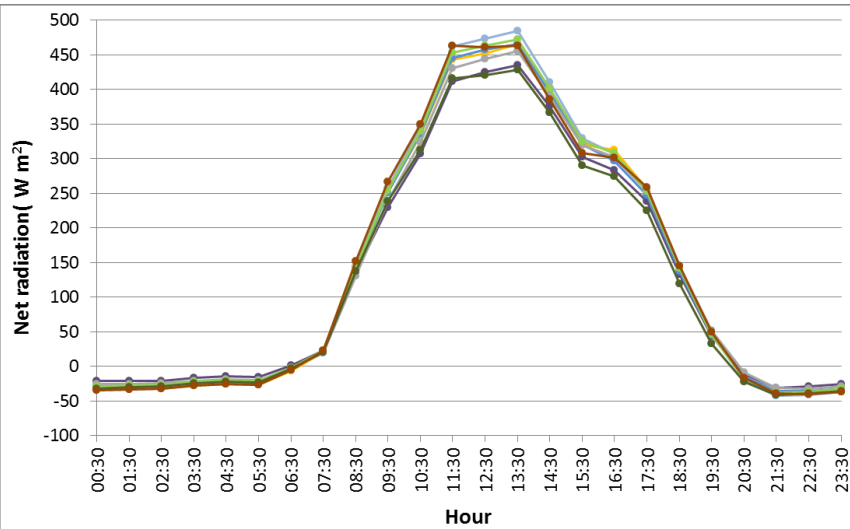
Vegetation and cooling

- Shading by a (large) canopy
- Reflection of incoming energy
- **Providing latent heat loss *via* evapo-transpiration**



Impact of leaf colour and structure on energy balance





● Purple Heuchera ● Yellow Heuchera
● Stachys ● Sedum

● Salvia 2012 ● Savia 2013
● Sempervivum ● Dark substrate

Vegetation and precipitation

- Retaining water droplets on canopy

Reduced pressure on urban drainage system



- Restoring soil's water holding capacity *via* evapo-transpiration

(BLUE-GREEN infrastructure)



Plant function / canopy size and rainfall capture



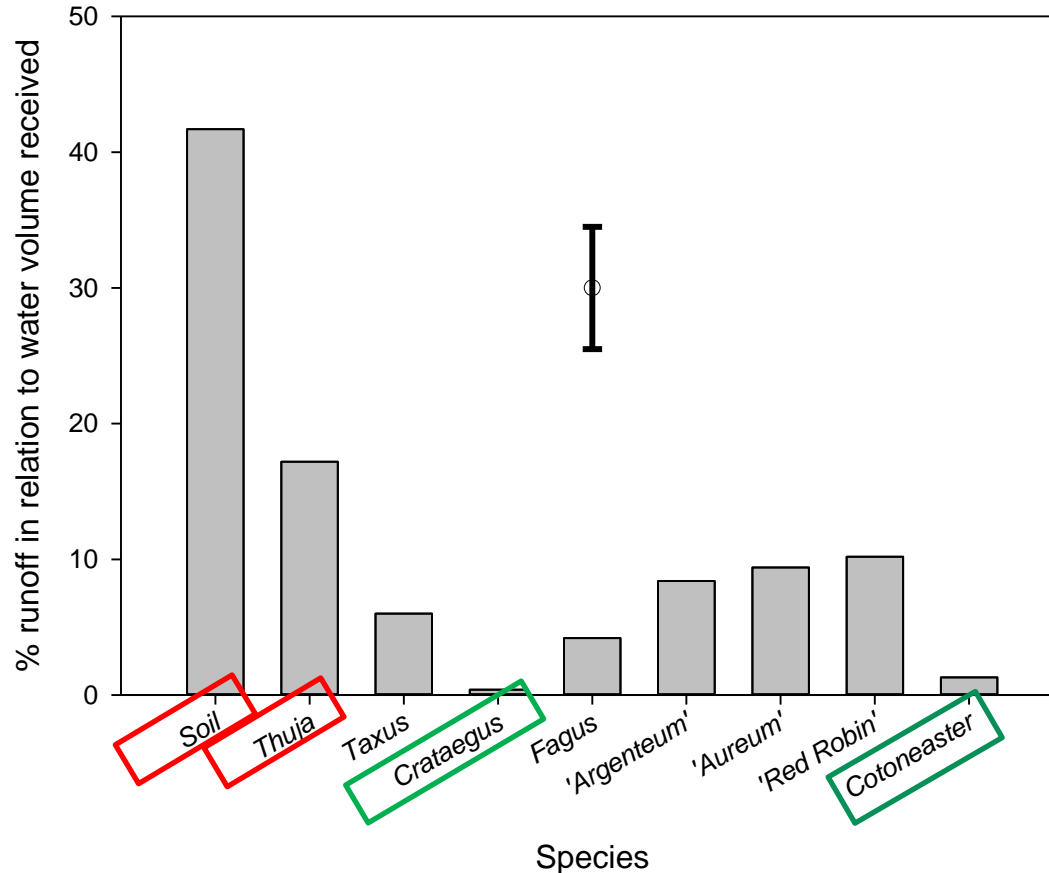
evergreen



deciduous



Mean runoff (and associated LSD) after the application of simulated rainfall, after 3 days of dry 'weather' in summer conditions



*canopies received about 1.1 L of rainfall per m² of ground area they cover
⇒ larger canopies collect and funnel more rainfall*

Crataegus and Cotoneaster excelling

Vegetation and particle pollutant capture

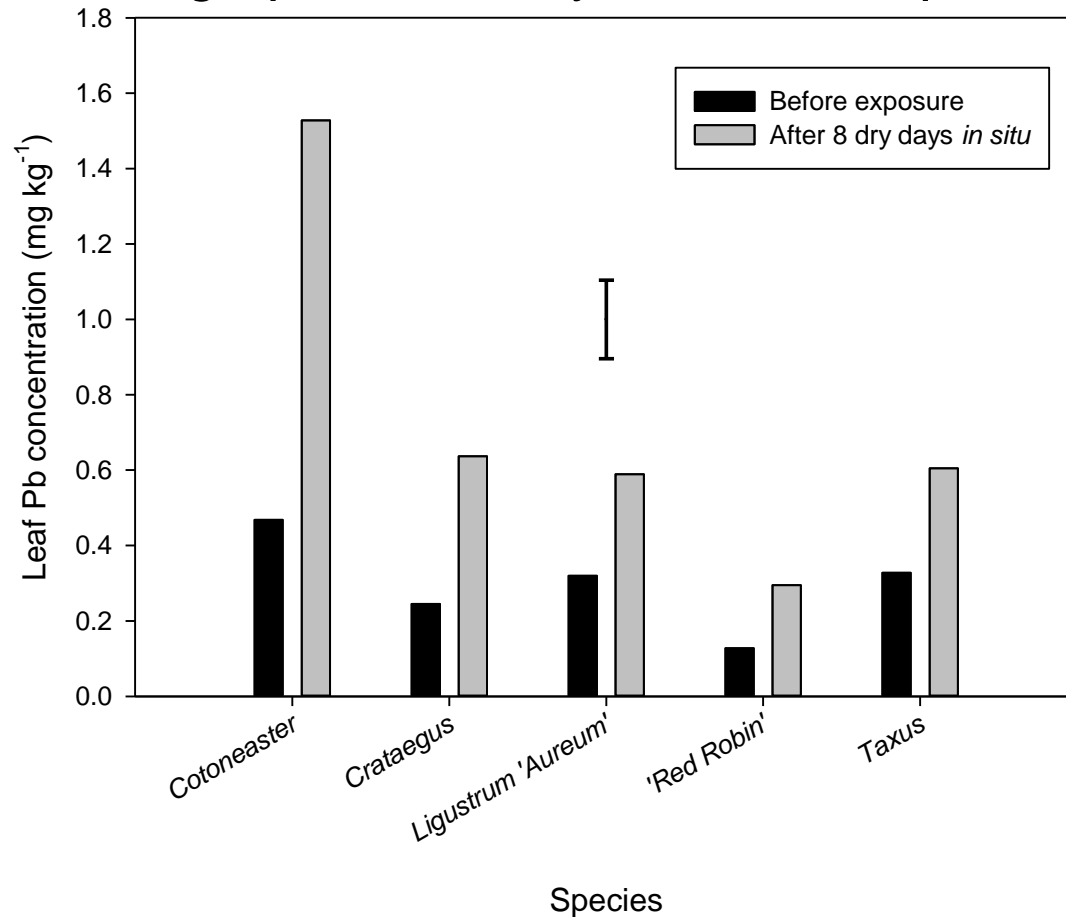
- Deposition
- Dispersion



Removal of particles from the air by increasing the area onto which they can be deposited

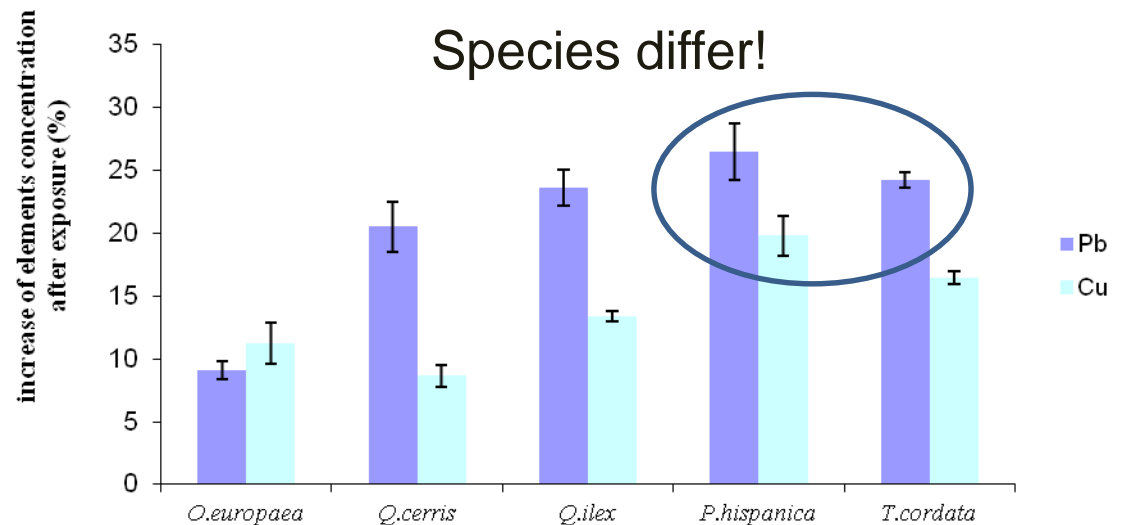
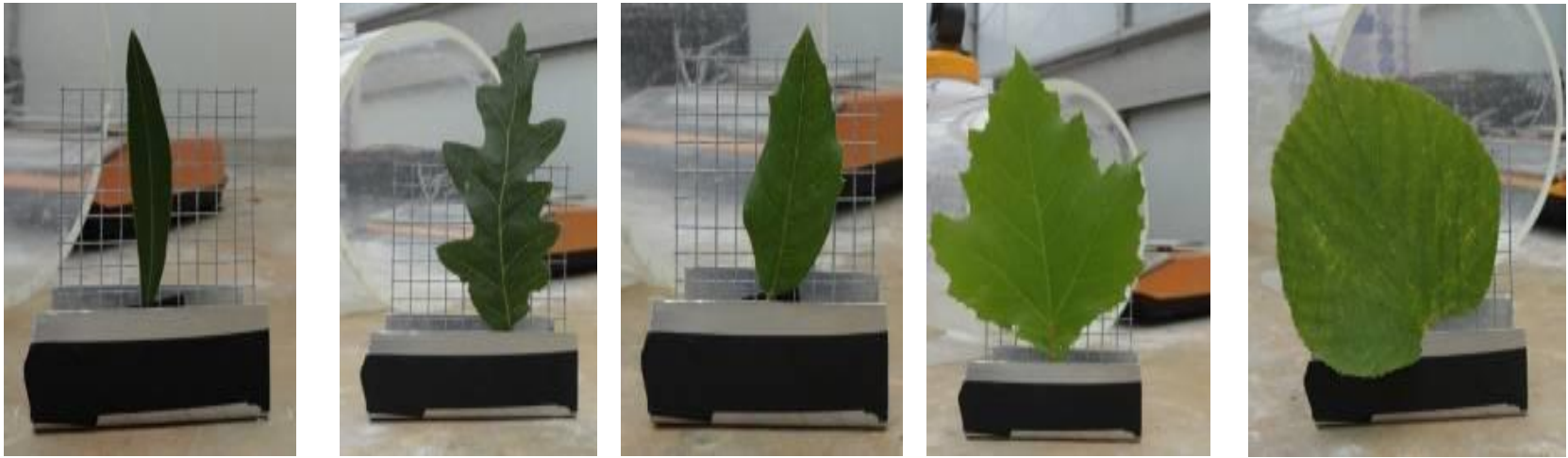


Mean leaf Pb concentration (and associated LSD), hedge plants, 8 day roadside exposure, Summer 2016



- 3-fold increase in concentration in *Cotoneaster*, almost 3-fold in *Crataegus*
- 2-fold increase in *Ligustrum* and *Taxus*
- < 2-fold increase in Red Robin

Leaf morphology and particle pollution capture



Main messages from 'green infrastructure ecosystem services' research to date:

NOT ALL PLANTS ARE THE SAME!

Larger and more active plants with more complex structure usually provide more environmental benefits

When possible, plant choices for our green spaces should not only be based on the survival, but also on the ability of plants to provide environmental benefits



What does this mean for practice?

- Planners, architects, builders

'anything, everything, a tree'

(L. Hunt 😊)

- Landscapers, horticultural specialists

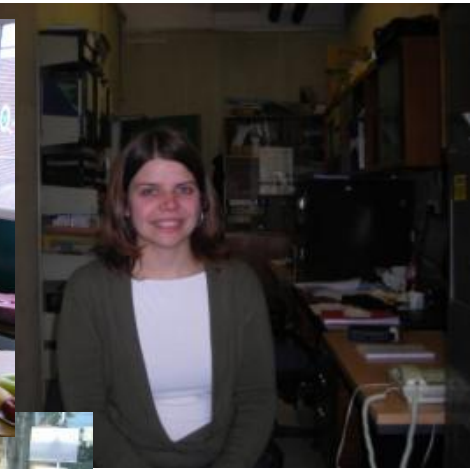
Consider environmental impact of the plants, and which plant traits would be useful to improve the delivery of environmental benefits (cooling, noise, pollutant trapping, rainwater capture...)

Perennial, physiologically active plants, with high ETp (strong 'pumps'), light, rough/hairy foliage, evergreen...



Thanks 😊

*Dr Madalena Vaz Monteiro,
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Dr Anne Verhoef
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Paul Mealey, Leigh Hunt
Val Jasper, Mike Dawes, Matthew Richardson
Kevin Hobbs/Hilliers*



Funding:



Differences in plant structure and function lead to differences in the delivery of a number of ecosystem services

Cooling, pollutant trapping, rainfall capture

• Blanusa T, Vaz Monteiro MM, Kemp S, Cameron RWF (2016) Planting choices for retrofitted green roofs to increase the delivery of ecosystem services, In: Green roof retrofit: Building urban resilience (Eds. S. Wilkinson, T. Dixon), Wiley, Oxford

Cooling

• Vaz Monteiro MM, Blanusa T, Verhoef A, Hadley P, Cameron RWF (2016) Relative importance of transpiration rate and leaf morphological traits for the regulation of leaf temperature. *Australian Journal of Botany*, 64, 32-44

• Blanusa T et al. (2013) Alternatives to Sedum on green roofs: Can broad leaf perennial plants offer better 'cooling service'? *Building and Environment*, 59, 99-106

Pollutant trapping

• Blanusa T, Fantozzi F, Monaci F, Bargagli R (2015) Leaf trapping and retention of particles by holm oak and other common tree species in Mediterranean urban environments. *Urban Forestry & Urban Greening* 14, 1095-1101