

**How Useful are Urban Trees?
The Lessons of the Manchester
Research Project**

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The Physical Benefits of Urban Trees

1. They sequester and store carbon
2. They intercept airborne particles, reducing pollution
3. They shade people and buildings
4. They cool the air by evapotranspiring
5. They intercept rain and allow infiltration, reducing surface flooding

These effects have been widely investigated with great success, leading to the UFORE and iTree models

The Problems with the Existing Estimates

1. Many are based on modelling, so their validity is not certain
2. Most give values for “typical” trees or areas of woodland

Therefore many important questions need to be answered by experiment

Questions Still to be Answered

1. Are trees better than other vegetation?
2. Which species of trees are best?
3. What size of tree is best?
4. What effect will cultivation have?

Our Approach

1. We carried out small-scale investigations
2. We collaborated with the voluntary sector, local government and the tree industry
3. We used existing tree plantings as natural experiments

1) Quantifying The Effect of Trees In Reducing Runoff

We built 9 experimental plots in South Manchester

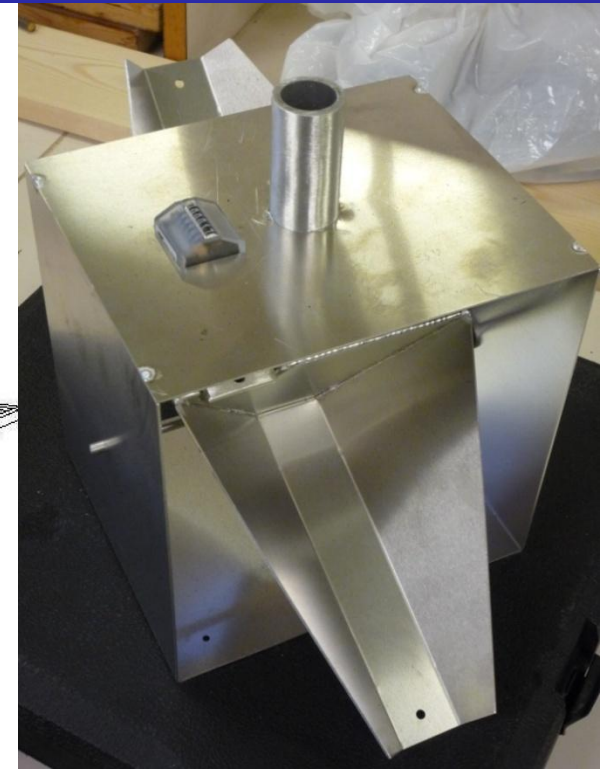
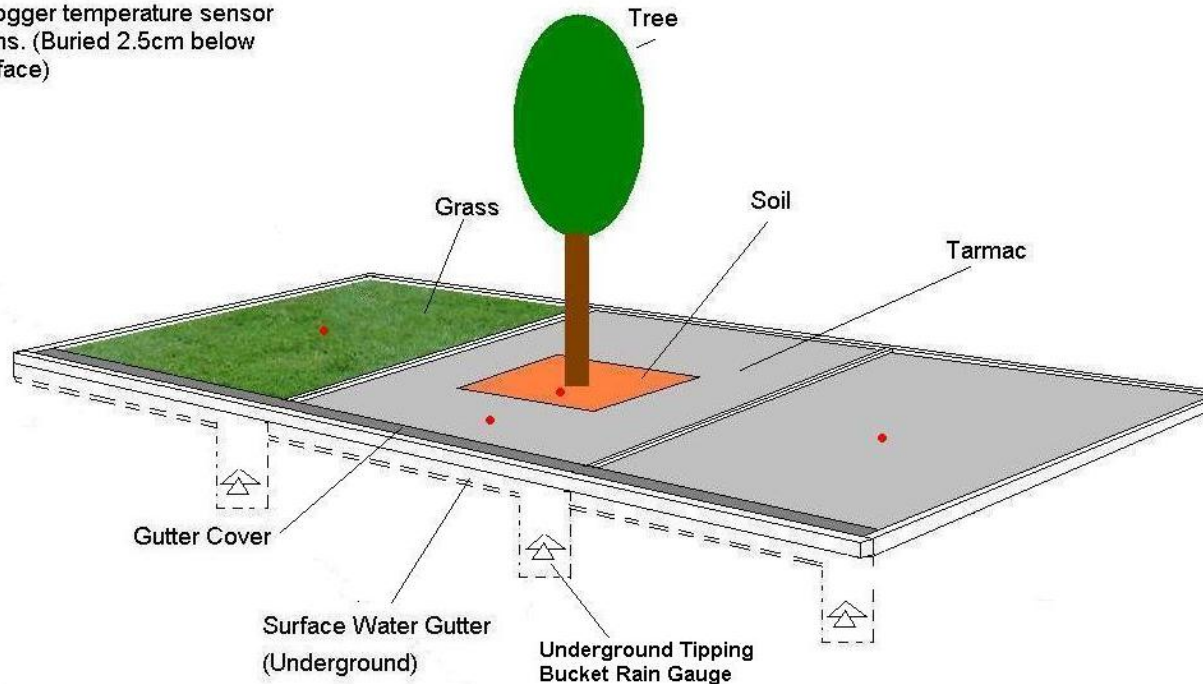


Experimentally Measuring the Effects of Trees and Grass on Runoff

We designed the experimental plots to measure runoff.

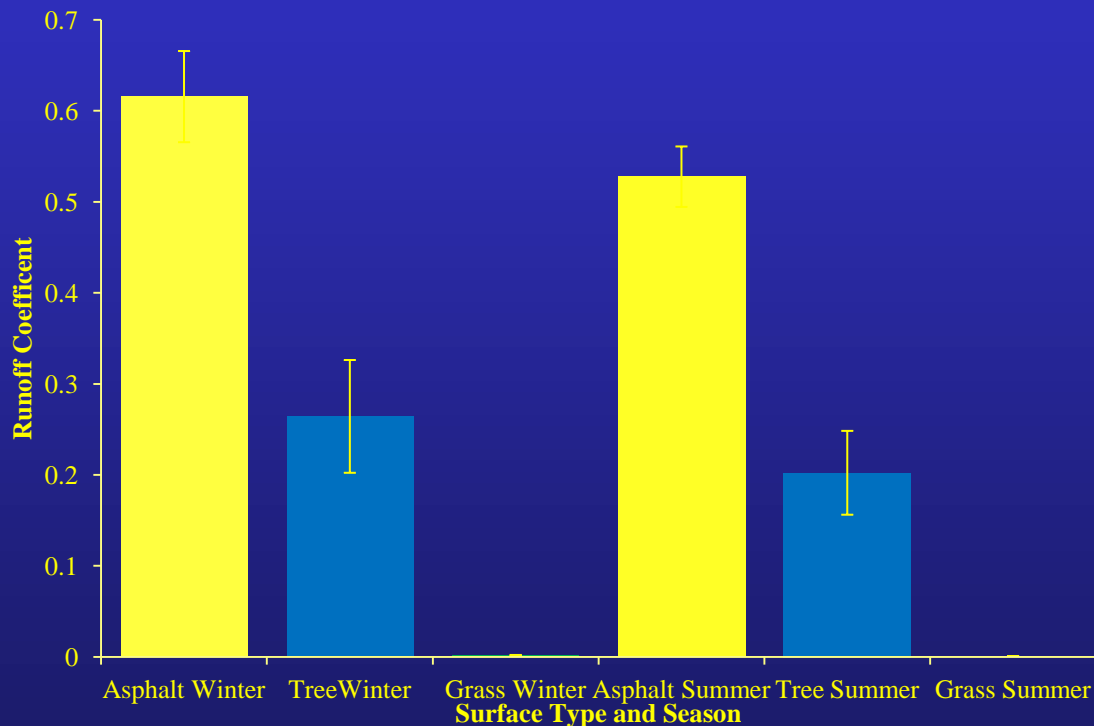
Tipping bucket gauge

- Data Logger temperature sensor positions. (Buried 2.5cm below the surface)



Results

- 1) Trees reduced runoff by 60% across the whole plot, despite covering only 35% of it (water infiltrated the hole).
- 2) Grass reduced runoff by 99%!

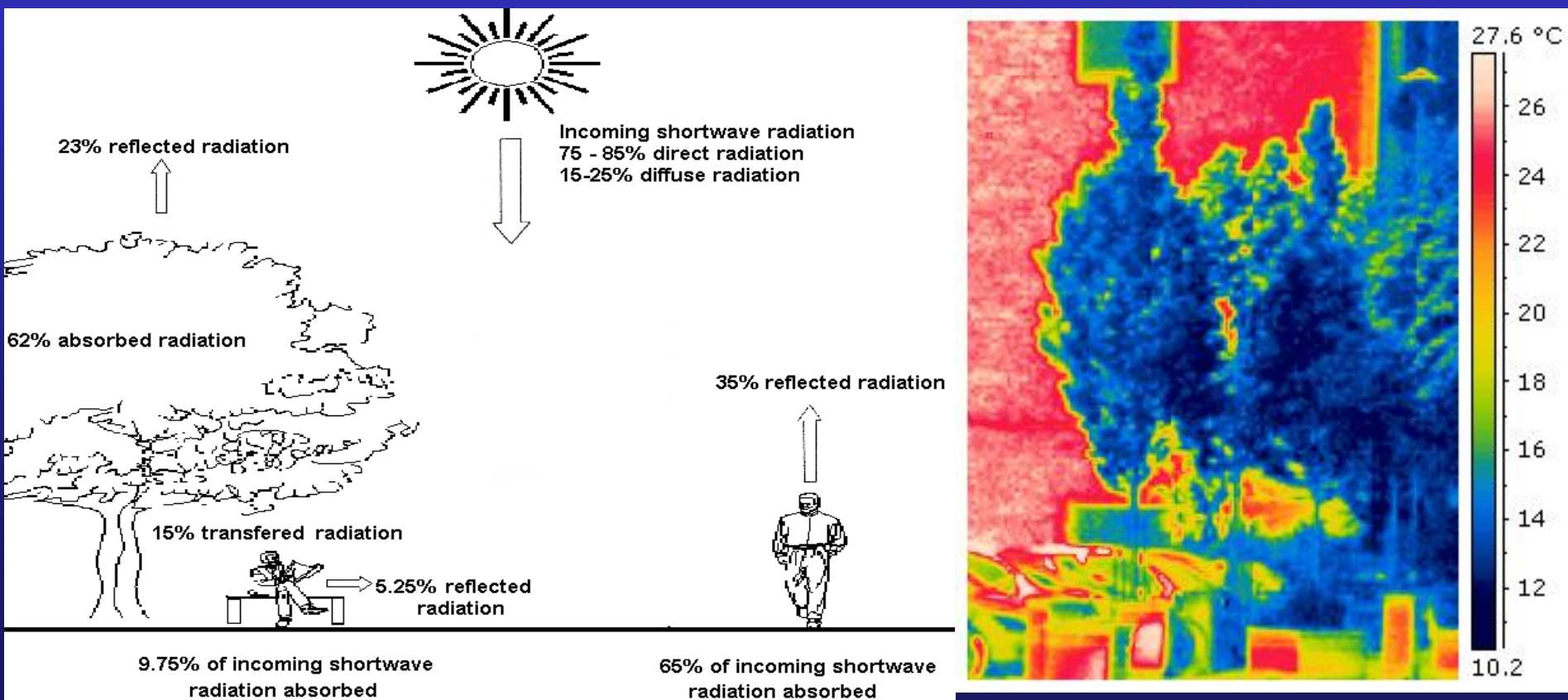


The planting method is clearly very important and far more research is needed to investigate the optimum methods.

2) Quantifying the Local Cooling Effect of Trees

How warm we feel depends far more on the radiation we receive than on air temperature

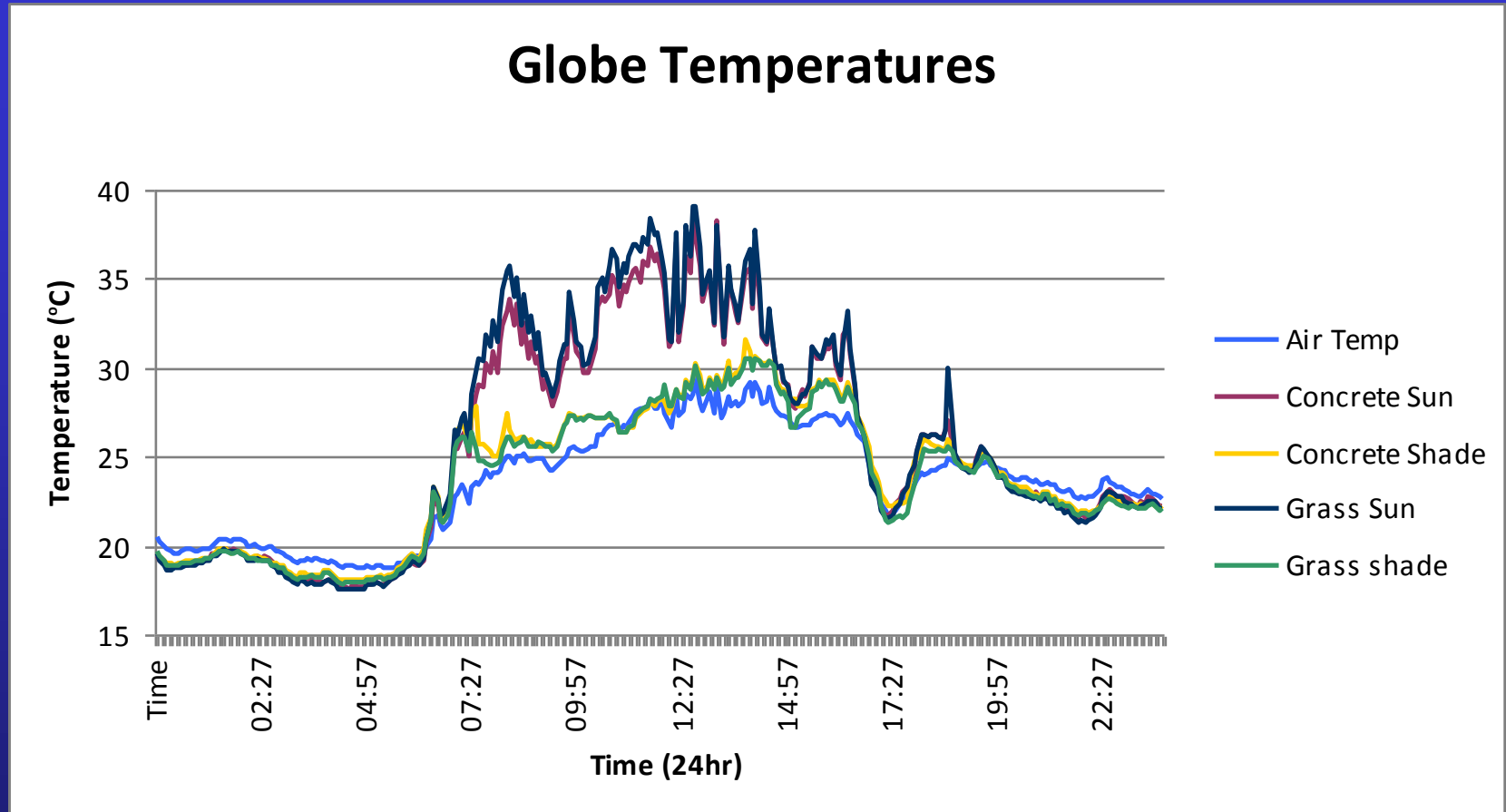
Trees act like cool parasols, providing shade to people and so directly cooling them.



We used globe thermometers to measure the radiant temperature (how hot you actually feel) in sun and tree shade.



Results: Permanent Tree Shade



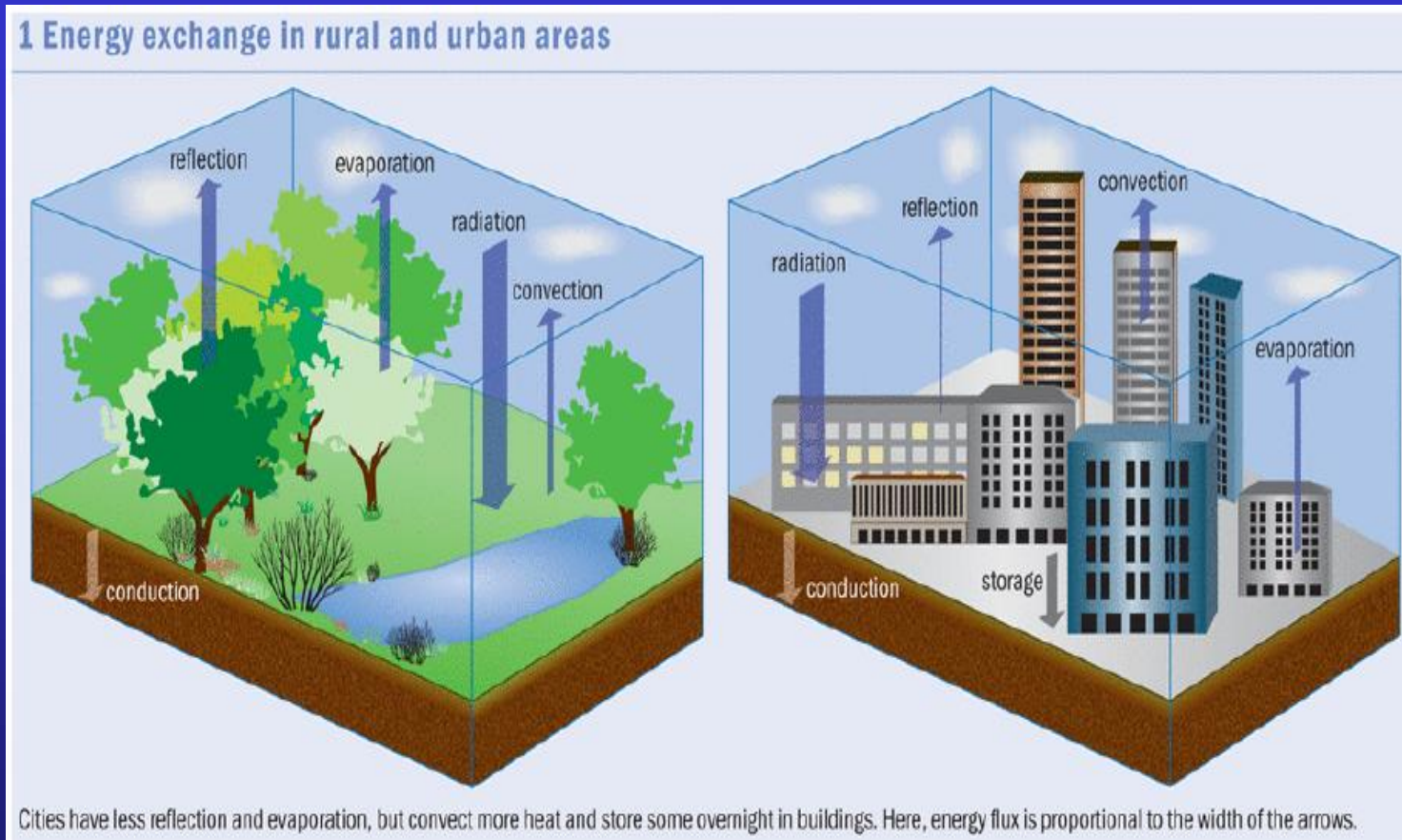
Permanent Tree shading reduced globe temperatures on hot sunny days by 5-7°C

Small street trees reduced globe temperatures by 4-5°C

This explains the distribution of park-goers



3) Quantifying the regional Cooling Effect of Trees



Trees cool their leaves and the air by evapotranspiring, so cooling can be quantified by measuring water loss from trees

Measuring water loss from trees

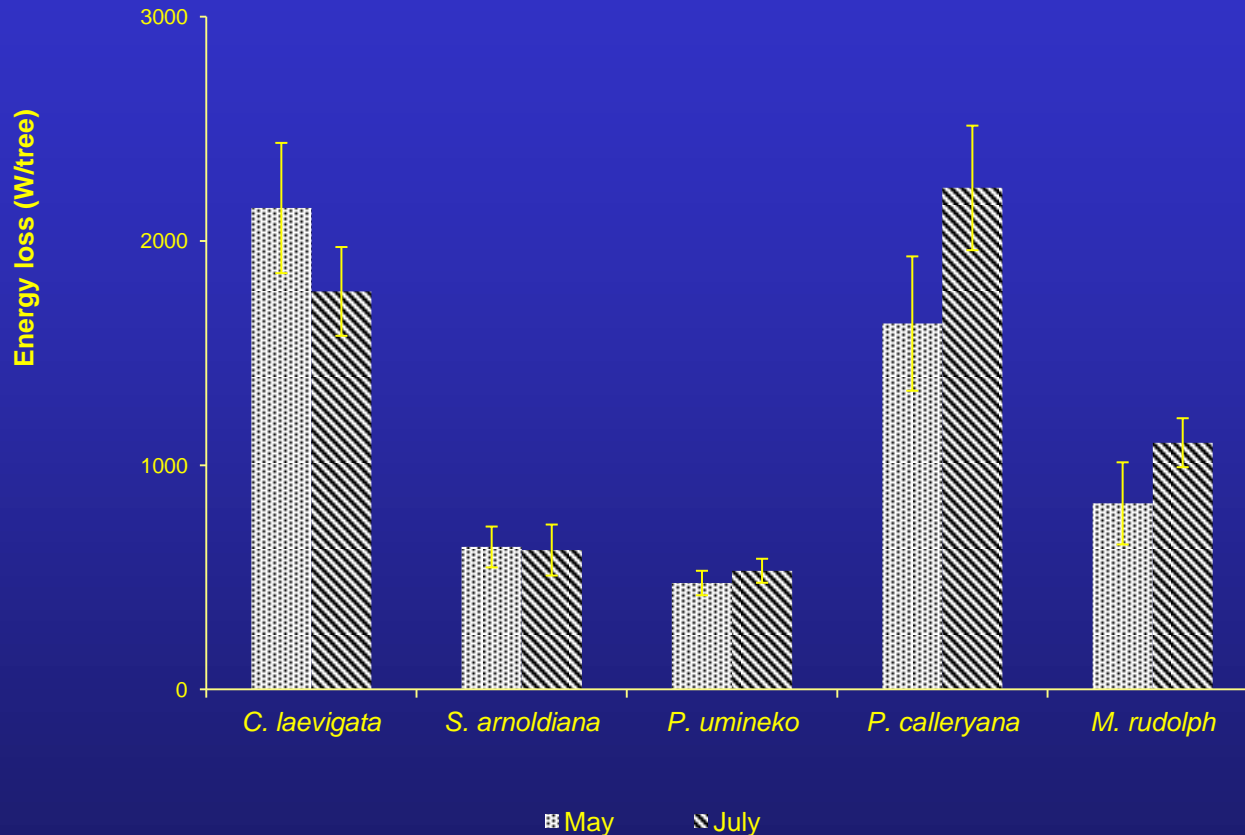
We investigated water loss using sap flow meters and porometers



We investigated the effect of species and of cultivation conditions on street trees

Water loss from Actual trees

1) Water loss (and hence cooling) depends on tree species



Cooling differs by a factor of 4! Trees with higher leaf area index performed better.

Effect of Growing Conditions on the Cooling Benefits of the street tree *Pyrus calleryana* Chanticleer

Experiment 1

We compared trees in three planting regimes

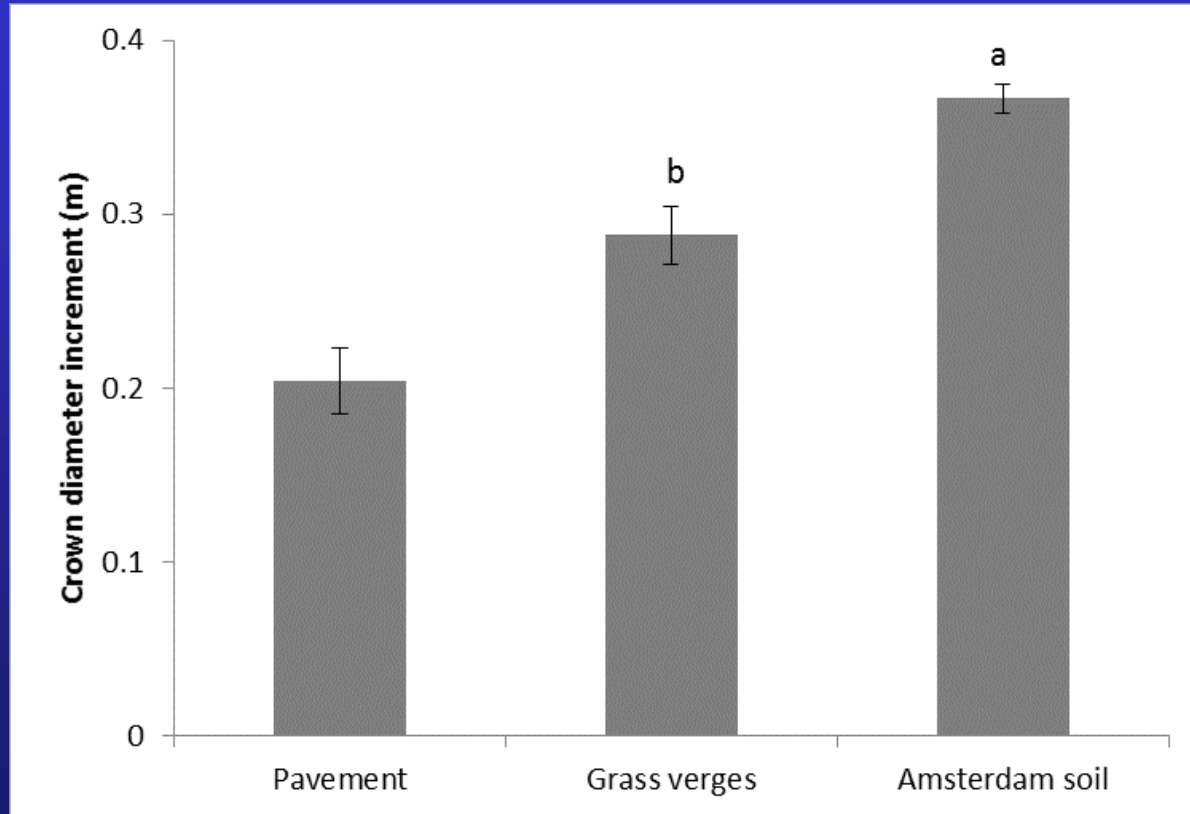
- 1) Conventional tree pits
- 2) Grass Verges
- 3) Pits containing Amsterdam soil



Results

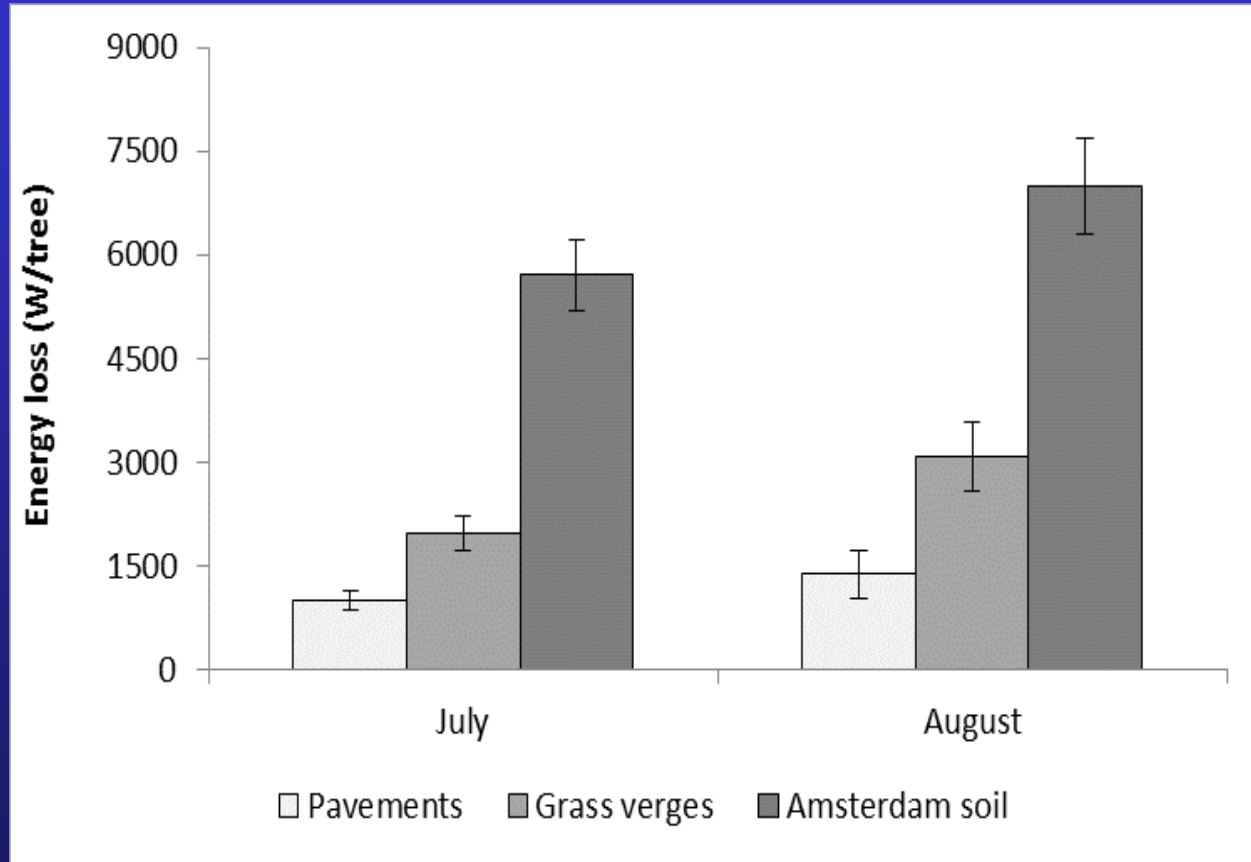
Trees planted in Amsterdam soil had twice the DBH growth

DBH
Increment
(cm yr⁻¹)



Growth Medium

Trees in Amsterdam Soil also had higher stomatal conductance, so provided 5 times the cooling per tree - around 7kW!



Maximum cooling can be over 600 Wm^{-2}

Experiment 2: We investigated the performance of young *Pyrus calleryana* trees growing in three common planting configurations



1) Conventional Pit

2) Pit with Urban Soil

3) Large Pit with Root Cells

Results



1) Conventional Pit



2) Pit with Urban Soil



3) Large Pit with Root Cells

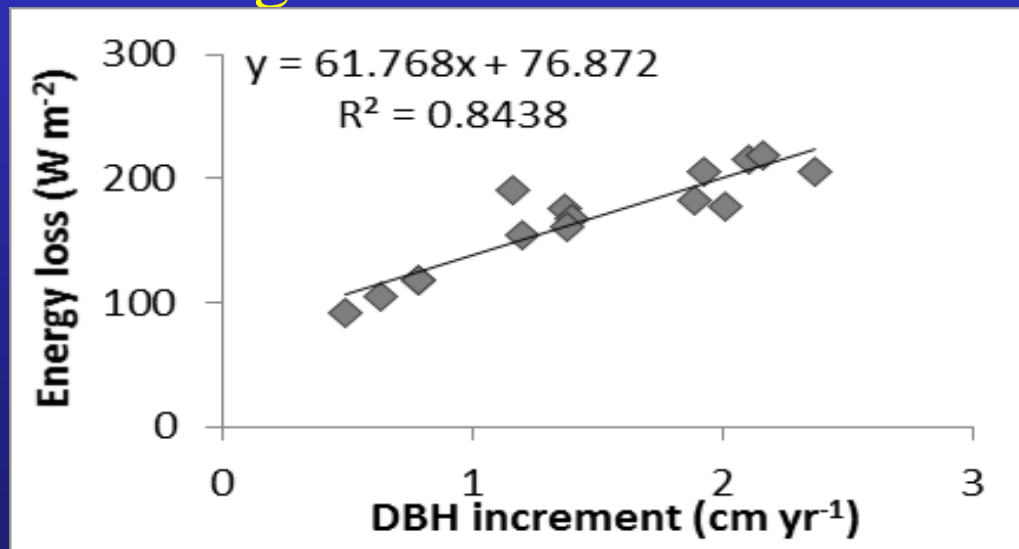
Trees in open pits grew twice as fast and produced four times the cooling!

Summary

- 1) Trees can provide large reductions in runoff, but their effectiveness depends on the planting regime.
- 2) Tree shade can reduce radiant temperatures by 5-7°C , improving human comfort.
- 3) Evapotranspiration from trees releases up to 60% of the incoming energy, providing effective regional cooling.
- 4) Cooling depends strongly on species: fast-growing trees with higher leaf area index perform far better than slow-growing ones.
- 5) Cooling depends even more strongly on growing conditions: street trees need access to uncompacted and well aerated soil to grow and perform well.

Take-Home Messages and Future Research

- 1) Collaboration between tree professionals and researchers can result in cheap, effective research.
- 2) It looks as if shading and cooling performance are directly linked to growth rate.



The next stage is to see if this link is universal, so we could estimate the effectiveness of trees just from their growth

Thanks to

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