

i-Tree, i-Tree Canopy Cover and The changing trends for tree species

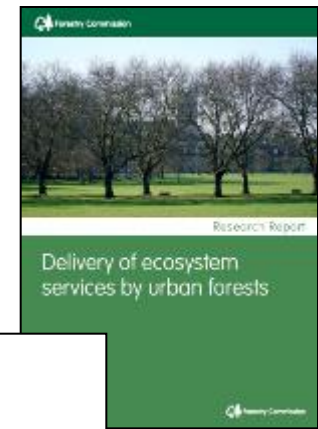
Dr Kieron J. Doick
Urban Forest Research Group
Forest Research



1. The 'Urban Forest'
2. i-Tree Canopy – urban tree cover and changing trends
3. i-Tree Eco, and tree species trends



Defined as... **All** the trees in the urban realm – in public and private spaces, along linear routes and waterways and in amenity areas. It contributes to green infra-structure and the wider urban ecosystem.



The relationship between GI and the Urban Forest

Green infrastructure typology*	Urban forest components			
	Single tree	Line of trees	Tree cluster	Woodland
Street trees and verges	Commonly related	Commonly related	Rarely related	Rarely related
Green roofs and walls	Rarely related	Rarely related	Rarely related	Rarely related
Amenity spaces	Commonly related	Rarely related	Commonly related	Commonly related
Derelict lands	Commonly related	Rarely related	Commonly related	Commonly related
Water management spaces	Rarely related	Rarely related	Rarely related	Rarely related
Parks and gardens	Commonly related	Commonly related	Commonly related	Commonly related
Land used for urban agriculture	Commonly related	Rarely related	Commonly related	Rarely related
Civic spaces	Commonly related	Rarely related	Rarely related	Rarely related
Institutional grounds	Commonly related	Rarely related	Rarely related	Rarely related
Outdoor sports facilities	Rarely related	Commonly related	Rarely related	Rarely related
Green corridors	Rarely related	Commonly related	Rarely related	Rarely related
Natural and semi-natural spaces	Rarely related	Rarely related	Commonly related	Commonly related
Agricultural land	Rarely related	Rarely related	Rarely related	Commonly related

Commonly related
 Sometimes related
 Rarely related

* Source: Burgess (2015)

Figure from 'Delivery of Ecosystem Services by Urban Forests' (Davies et al., 2017) (Search: bit.ly/fcrp026)

Table 2 Matrix of the relationship between ecosystem services and urban forest components.

Ecosystem service		Urban forest components			
		Single tree	Line of trees	Tree cluster	Woodland
Provisioning	Food provision				
	Fuel provision (woodfuel)				
	Wood provision				
Regulating	Carbon sequestration				
	Temperature regulation				
	Stormwater regulation				
	Air purification				
	Noise mitigation				
Cultural	Health				
	Nature and landscape connections				
	Social development and connections				
	Education and learning				
	Economy				
	Cultural significance				

Table 2 Matrix of the relationship between ecosystem services and urban forest components.

Ecosystem service		Urban forest components			
		Single tree	Line of trees	Tree cluster	Woodland
Diservice	Fruit and leaf fall				
	Animal excrement				
	Blocking of light, heat or views				
	Decrease in air quality				
	Allergenicity				
	Spread of pests and diseases				
	Spread of invasive species				
	Damage to infrastructure				
	Creation of fear				
	Tree and branch fall (especially during storms)				

Commonly delivered
 Sometimes delivered
 Rarely delivered



From '**Delivery of Ecosystem Services by Urban Forests**'
 (Davies et al., 2017) (Search: [bit.ly fcrp026](https://bit.ly/fcrp026))

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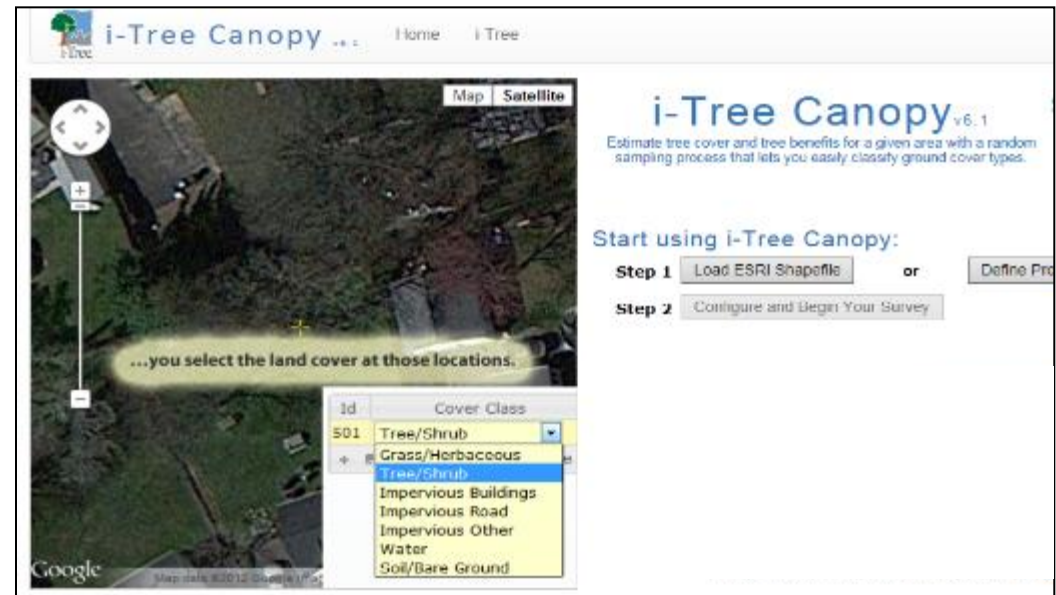
i-Tree Canopy – Citizen Science project to map Urban Canopy Cover for **every** urban ward

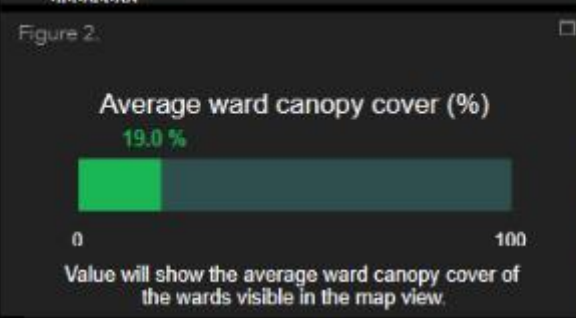
Visit <https://www.forestresearch.gov.uk/research/i-tree-eco/urbancanopycover/>

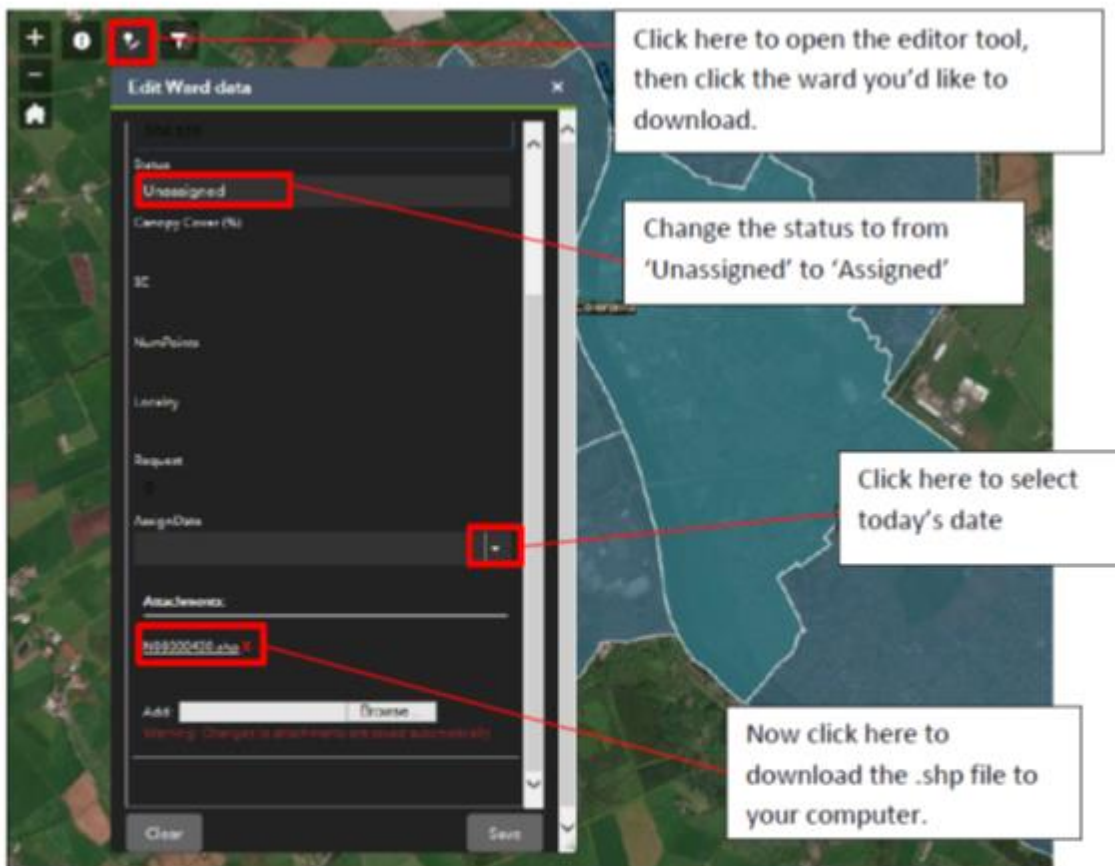
for our step-by-step guide and to learn about the project objectives

- 5,091 urban wards
- GB and Northern Ireland

<https://bit.ly/2PT8Mlo>






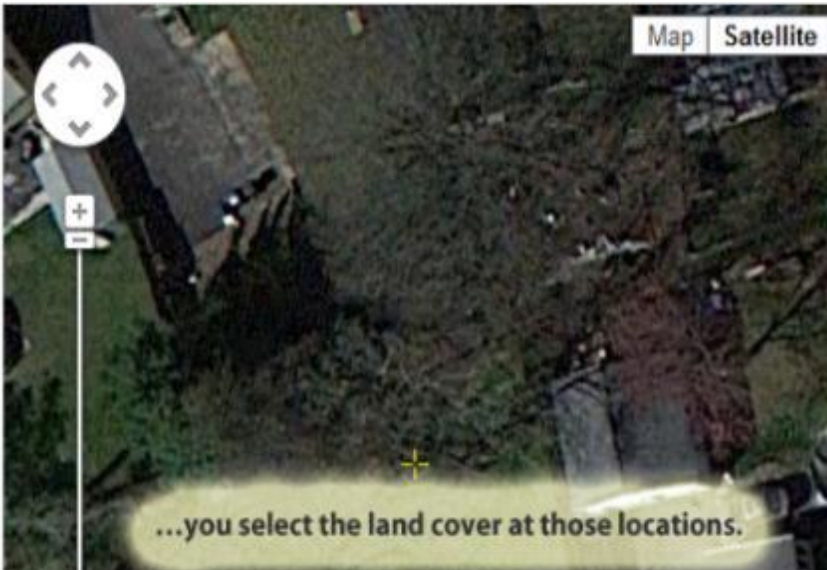


iii) Go to <https://canopy.itreetools.org/> and click the button 'load ESRI Shapefile'. Upload the .shp file you have just downloaded.

iv) Once uploaded the page will refresh and you should now see your boundary outlined in red on a Google map, to the left-hand side of the screen. [Proceed to Step 2.](#)

B. Contact us to get the official ward boundaries. We'll email you a file (an ESRI GIS shape-file)


i-Tree Canopy v6.1
Home i-Tree



Id	Cover Class
501	Tree/Shrub
+	Grass/Herbaceous
	Tree/Shrub
	Impervious Buildings
	Impervious Road
	Impervious Other
	Water
	Soil/Bare Ground

i-Tree Canopy v6.1

Estimate tree cover and tree benefits for a given area with a random sampling process that lets you easily classify ground cover types.

Start using i-Tree Canopy:

Step 1 Load ESRI Shapefile or Define Pro

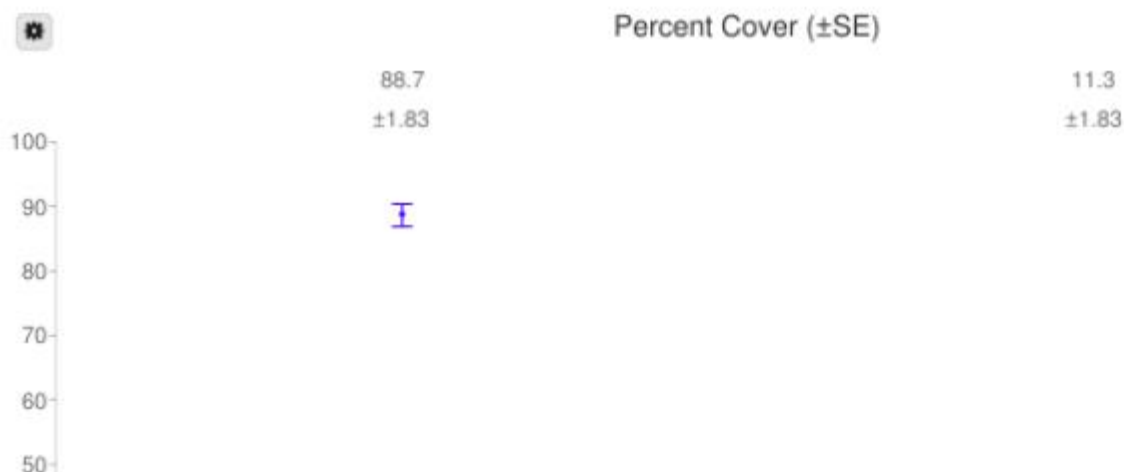
Step 2 Configure and Begin Your Survey



i-Tree Canopy v6.1

Cover Assessment and Tree Benefits Report

Estimated using random sampling statistics on 10/10/18



Cover Class	Description	Abbr.	Points	% Cover
Non-Tree	All other surfaces	NT	266	88.7 ±1.83
Tree		T	34	11.3 ±1.83

Tree Benefit Estimates

Abbr.	Benefit Description	Value (GBP)	±SE	Amount	±SE
CO	Carbon Monoxide removed annually	£1.96	±0.32	60.99 lb	±9.85
NO2	Nitrogen Dioxide removed annually	£3.38	±0.55	332.58 lb	±53.71
O3	Ozone removed annually	£176.10	±28.44	1.66 T	±0.27
PM2.5	Particulate Matter less than 2.5 microns removed annually	£364.04	±58.79	160.95 lb	±25.99
SO2	Sulfur Dioxide removed annually	£0.59	±0.10	209.58 lb	±33.85
PM10*	Particulate Matter greater than 2.5 microns and less than 10 microns removed annually	£127.85	±20.65	1,109.51 lb	±179.17
CO2seq	Carbon Dioxide sequestered annually in trees	£9,031.81	±1,458.53	337.22 T	±54.46
CO2stor	Carbon Dioxide stored in trees (Note: this benefit is not an annual rate)	£227,720.08	±36,774.10	8,502.45 T	±1,373.05




i-Tree Canopy – Citizen Science project to map at 'ward' level across GB and Northern Ireland

Results so far:

- 5,091 urban wards
- 914 completed (17.95%)
- Average canopy cover: 16.8%
- Range 2-52%



step-by-step guide:

<https://www.forestresearch.gov.uk/research/i-tree-eco/urbancanopycover/>

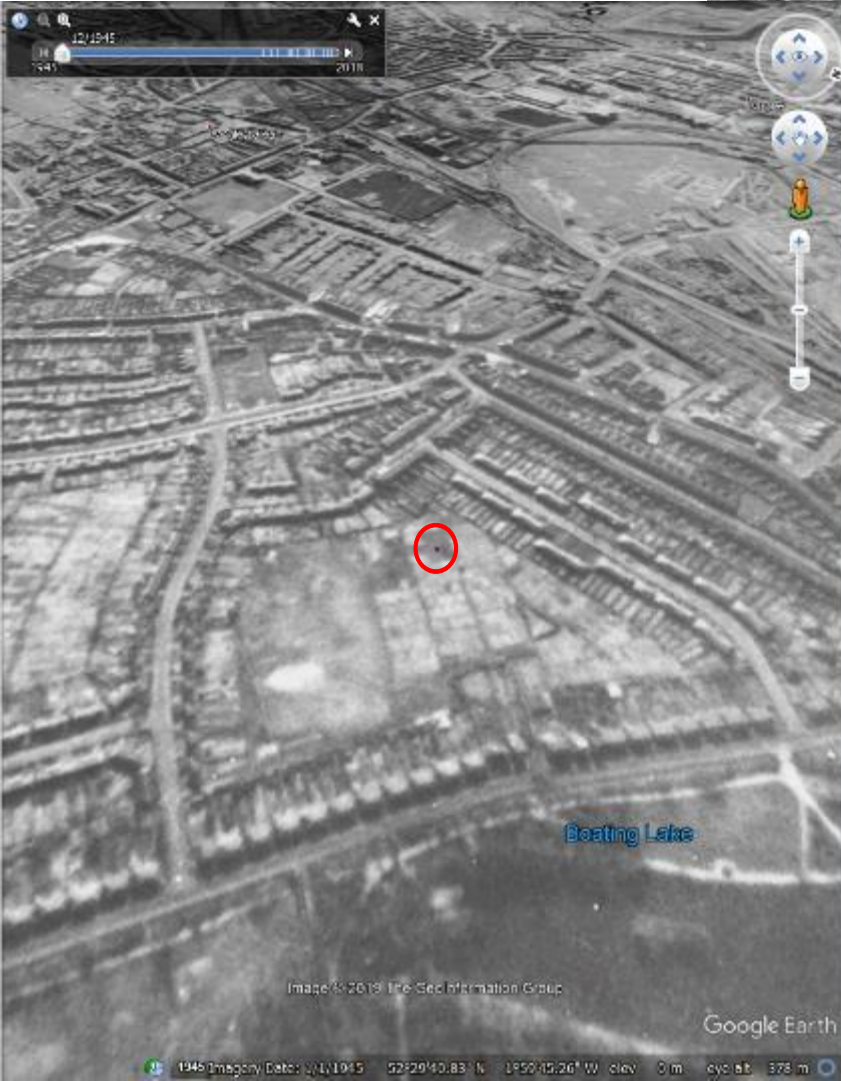
Interactive web map: <https://bit.ly/2PT8Mlo>

What do we know about changes (trends) in Urban Tree Cover?

- Mini project

(2 Scottish, 2 Welsh, 6 English cities)

- Decadal trend analysis,
from the 1940's



Birmingham, 1945

www.britainfromabove.org.uk



1999



2001



2003



2007



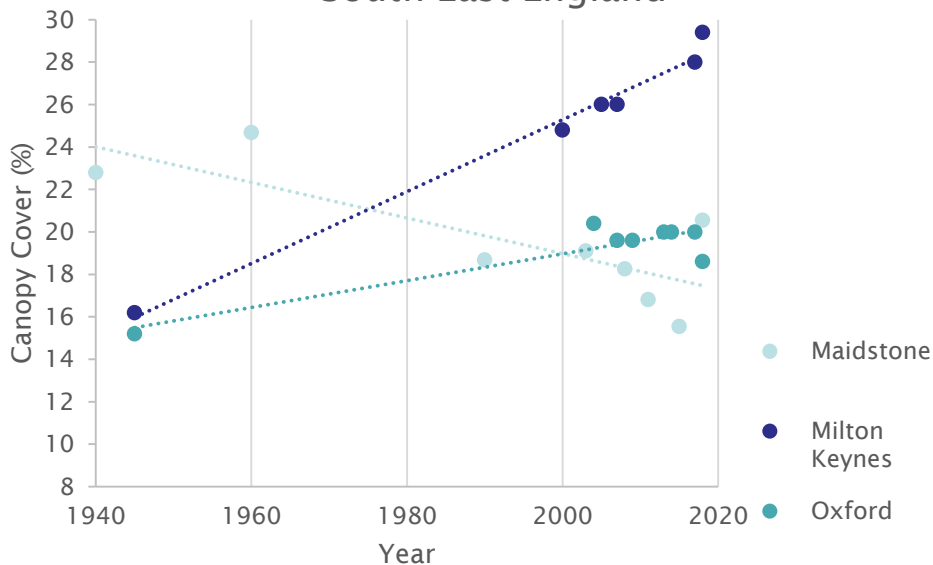
2013



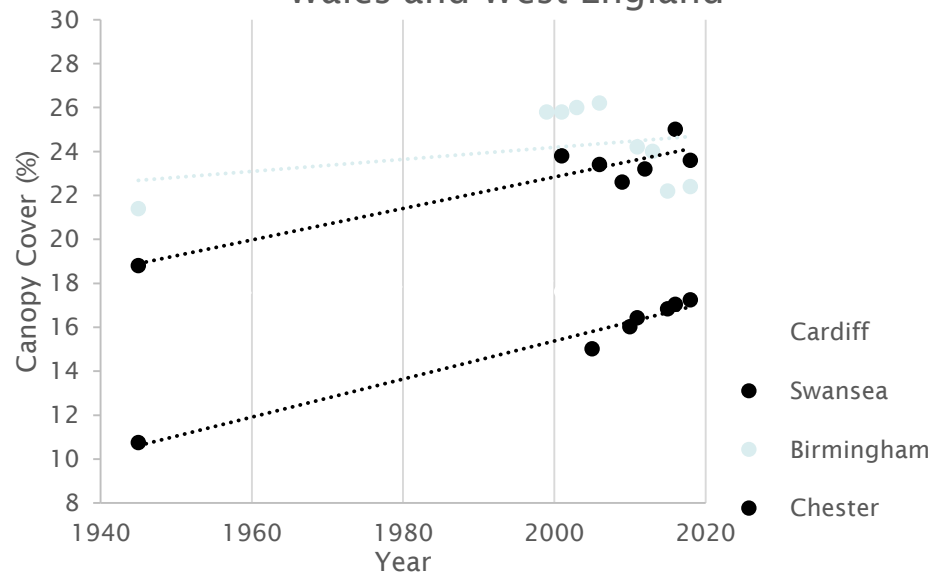
2018

Birmingham

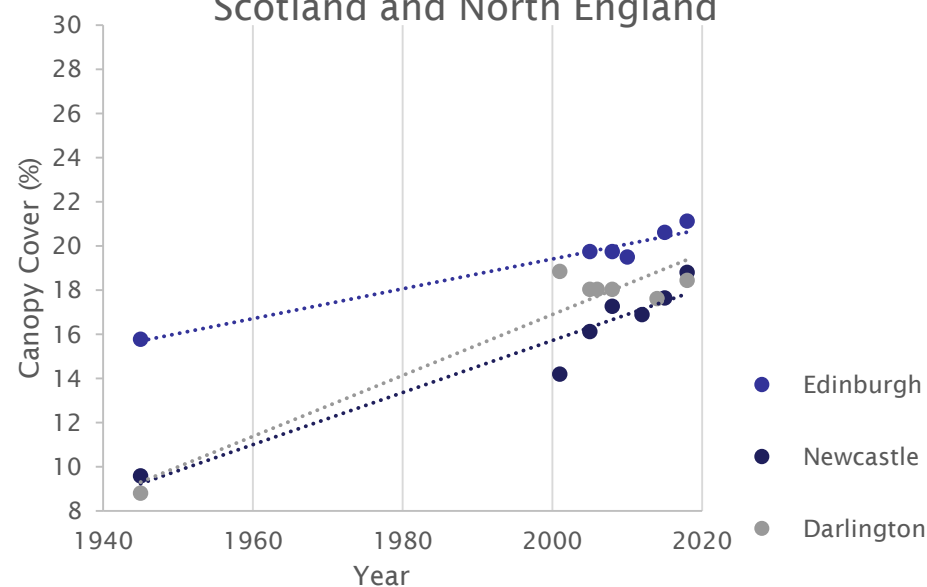
South East England



Wales and West England

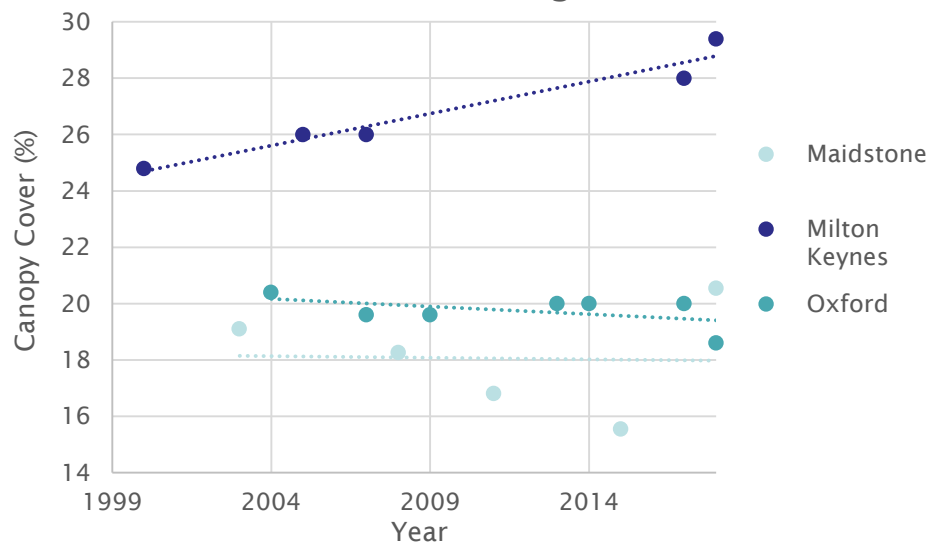


Scotland and North England

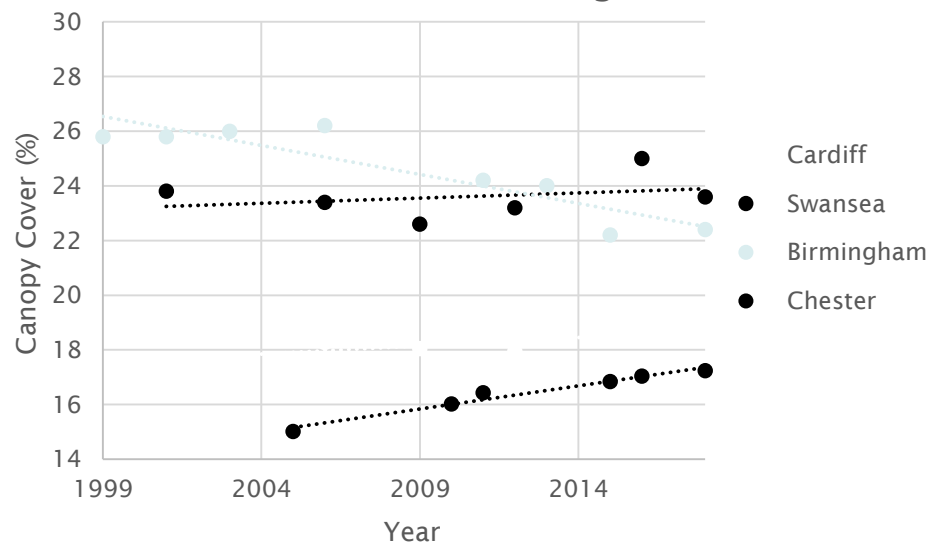


- 7 urban areas show increase, 4 statistically significant ($p > 0.05$, 95%CI)
- 2 urban areas (Cardiff and Birmingham) little to no change
- 1 urban area (Maidstone) shows statistical decline

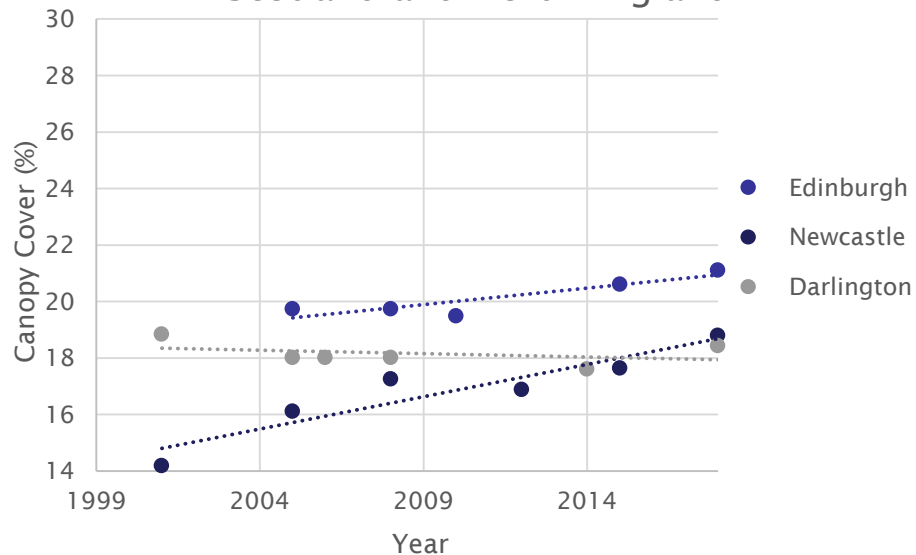
South East England



Wales and West England



Scotland and North England



- 5 urban areas show increase
- 3 urban areas show little to no change
- 2 urban areas show decline

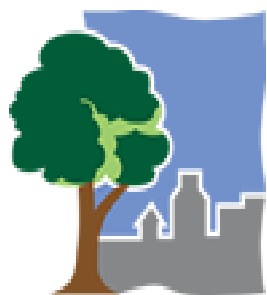
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i-Tree: a suite of tools

- Eco, Canopy, [Hydro]

www.itreetools.org



i-Tree

By the USDA
Forest Service
and Davey

Urban Trees

'Public good'

Quantification and valuation

= Decision making

Ecosystem services (aka Public good)

Provisioning	Regulating	Supporting	Cultural
	Climate regulation Flood regulation Air pollution removal		[CAVAT]

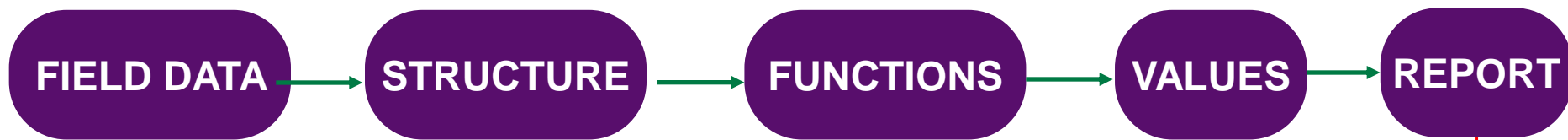
i-Tree: tools for urban forest management

Who is using i-Tree?

- ✓ Local authorities
- ✓ Community groups, charities, tree wardens
- ✓ Developers
- ✓ Government bodies
- ✓ Highways
- ✓ Universities

~ 30 GB studies now





- Sample plot inventory
- Land use
 - Tree cover
 - Impervious cover
 - Plantable space
 - Etc, etc

- Number of trees
- Species comp.
- Age/Size structure
- Leaf area
- Leaf and tree biomass

- Carbon storage & sequestration
- Air pollution removal
- Stormwater attenuation

- Visual amenity
- Habitat provision
- Building energy use

£
as annual benefit
as amenity value
&
as a total



= policy

= understanding

= Budgets
= Funding
= Return on Investment

Findings: state of Tawe Catchment's trees (in 2014)

Number of trees: 530,000	Equal to an average of 76 trees per hectare, above existing estimates for other areas in the UK.
Tree cover: 16%	Higher than most other studied areas. Most trees were found in most often in parks, residential land, and on vacant land.
Low proportion of large trees	Lower than the recommended 10% value, and lower than other areas studied in the UK.
Number of species: 88	Includes both tree and shrub species. The most common species were Common alder, goat willow and downy birch.

Findings: ecosystem services provided by Tawe Catchment trees

Stormwater mitigation	252 million litres of water intercepted annually	Worth £333,900 annually in avoided sewerage charges
Air pollution removal	136 tonnes of airborne pollutants removed annually	£715,500 annually in avoided damage to health, buildings & crops
Carbon sequestration	3,000 tonnes of atmospheric carbon removed annually	£671,000 annually for climate change mitigation
Carbon stored	102,000 tonnes of carbon stored in current stock of trees	£23.1 million for climate change mitigation



Ecosystem services delivery by large stature urban trees



Rese



Ecosystem services delivery by small and medium stature urban trees



Research Note

Understanding the role of urban tree management on ecosystem services

Kathryn L. Hand and Kieron J. Doick

June 2019

Urban forests provide ecosystem services that contribute to human health, livability and sustainability. The management of trees influences the delivery of these ecosystem services and thus helps determine the total benefit provided by an urban forest. This Research Note summarises two Research Reports that assessed the delivery of regulating ecosystem services by 38 tree species common to the urban environment in the UK. The importance of characteristics such as tree size, stature and condition on ecosystem services delivery are examined, and how these vary across different regions. Using academic, industry, central and local government sources, the implications of management practices for trees are discussed, as well as the cumulative impact of the whole urban tree management system. The four key stages of urban tree management, delivery, maintenance and removal. The findings illustrate that management by urban forests through selection of the trees planted, how trees are cared for and how trees are removed. Healthy large trees are shown to provide the greatest benefits. The importance of urban tree management that values and maintains trees is highlighted, and how challenges can inhibit the proactive management of urban trees.

Forestry *An International Journal of Forest Research*



Institute of Chartered Foresters

An insight to the current state and sustainability of urban forests across Great Britain based on i-Tree Eco surveys

Madalena Vaz Monteiro*, Phillip Handley and Kieron J. Doick

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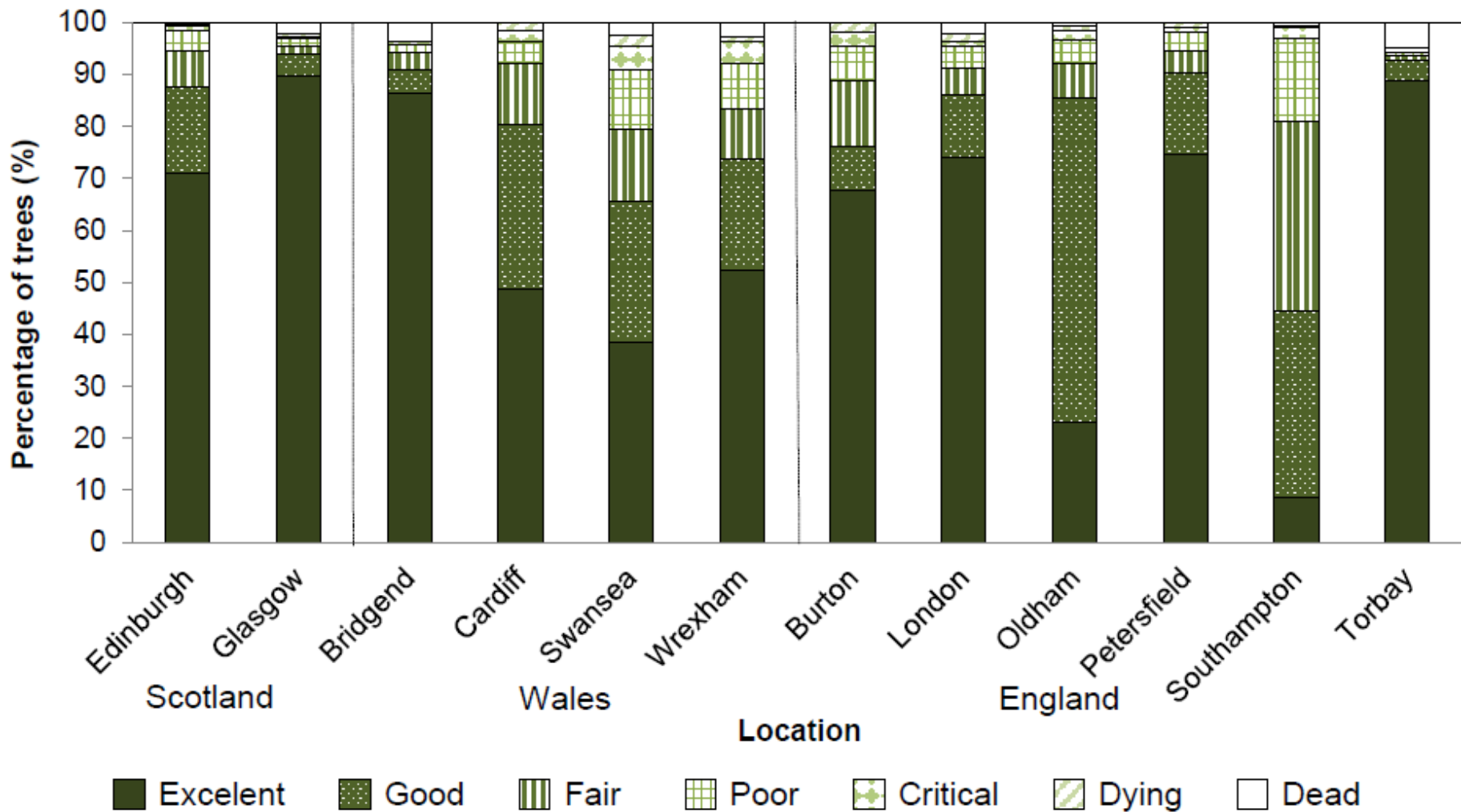


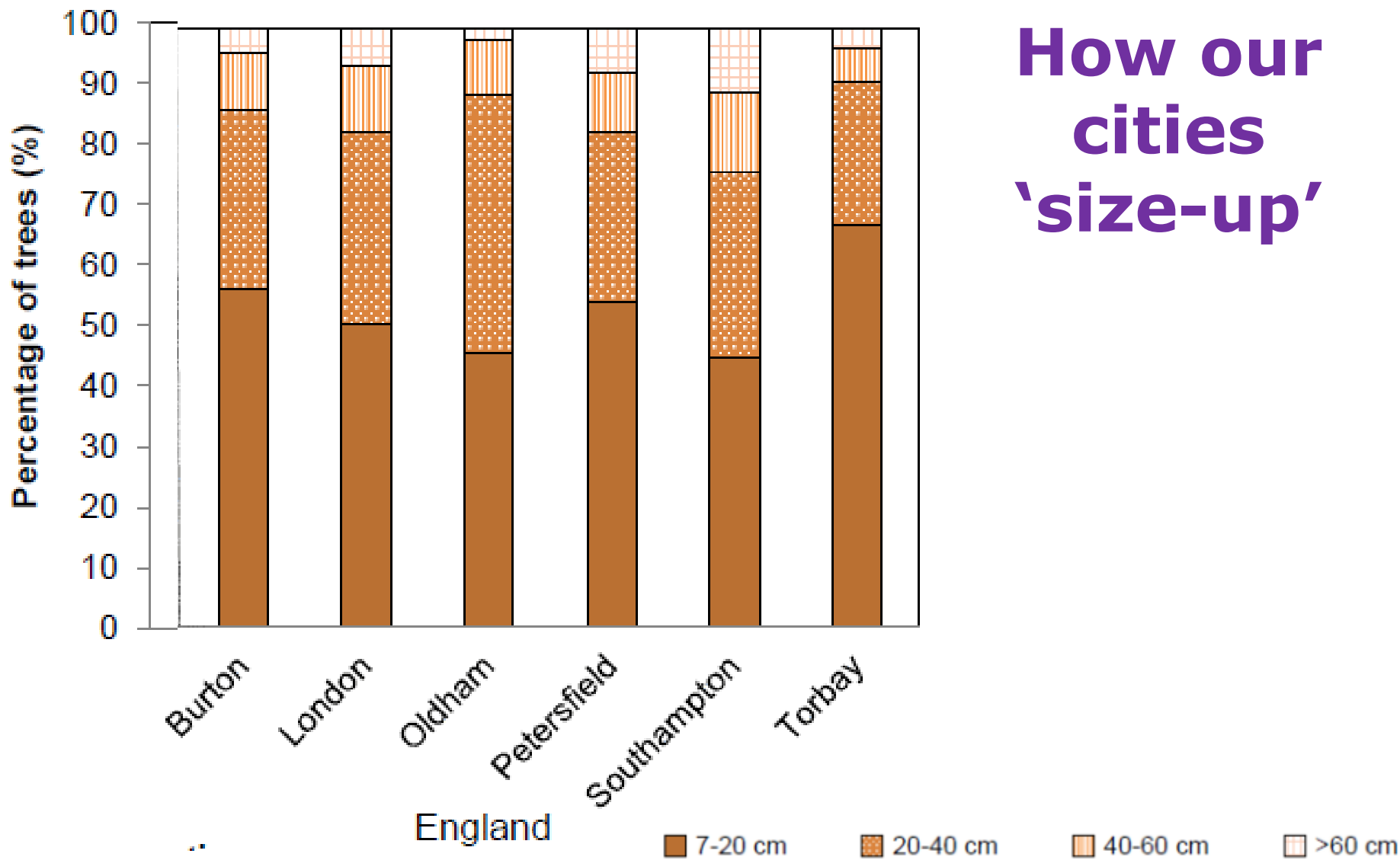
Region	City/Town	Number of trees and equivalent percentages of the total trees considered in each location			
		Conifers ¹	Native ²	Street trees	Public ³
England	Burton	14%	61%	6%	46%
	London	11%	36%	7%	30%
	Oldham	18%	63%	6%	41%
	Petersfield	18%	42%	8%	31%
	Southampton	9%	63%	3%	60%
	Torbay	21%	47%	0%	21%
	Total				

¹Palm trees are not presented.

²Trees only named to Genus are not presented.

³Trees growing in areas classified as "other" are not presented.





How our cities 'size-up'

Which trees deliver us the 'most' benefit?

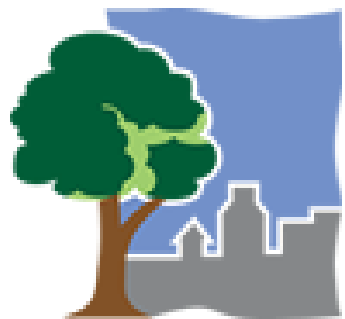
- Large stature
- Mature
- Healthy
- Well placed
- 'configuration' (urban forest component)

Table 1 Tree species ranked by their ecosystem services delivery as mature trees, in descending order.

Rank	Carbon storage per tree	Gross carbon sequestration per tree	Avoided run-off per tree	Pollution removal per tree
1	Oak spp.	Oak spp.	London plane	London plane
2	London plane	English elm	English elm	English elm
3	English yew	English yew	Oak spp.	Oak spp.
4	Beech	London plane	English yew	Wych elm
5	Sycamore	Beech	Wych elm	Beech
6	Ash	Sycamore	Beech	English yew
7	English elm	Holm oak	Lime spp.	Lime spp.
8	Holm oak	Ash	Sycamore	Sycamore
9	Wych elm	Wych elm	Norway maple	Norway maple
10	Norway maple	Silver birch	Ash	Ash
11	Lime spp.	Sweet cherry	Holm oak	Holm oak
12	Hornbeam	Lime spp.	Sweet cherry	Sweet cherry
13	Silver birch	Norway maple	Hornbeam	Hornbeam
14	Scots pine	Hornbeam	Silver birch	Scots pine
15	Sweet cherry	Scots pine	Scots pine	Silver birch
16	Lawson's cypress	Alder	Lawson's cypress	Lawson's cypress
17	Alder	Rowan	Field maple	Field maple
18	Downy birch	Field maple	Holly	Leyland cypress
19	Field maple	Lawson's cypress	Leyland cypress	Holly
20	Leyland cypress	Hawthorn	Bird cherry	Goat willow
21	Hawthorn	Downy birch	Goat willow	Bird cherry
22	Goat willow	Apple spp.	Rowan	Rowan
23	Apple spp.	Leyland cypress	Alder	Alder
24	Holly	Goat willow	Hawthorn	Hawthorn
25	Rowan	Holly	Hazel	Hazel
26	Hazel	Callery pear	Apple spp.	Apple spp.
27	Callery pear	Hazel	Downy birch	Downy birch
28	Bird cherry	Bird cherry	Callery pear	Callery pear
29	Elder	Plum spp.	Plum spp.	Plum spp.
30	Plum spp.	Elder	Elder	Elder

Table 7. Sustainability rating for the urban forests, based on the trees surveyed (Good; Fair; or, Poor)

Region	City/Town	1. Canopy cover	2. Size diversity	3. Taxonomic diversity	4. Tree condition	5. Cold hardiness suitability	
						Current	In 2050s
Scotland	Edinburgh*	Good	Poor	Poor	Good	Good	Good
	Glasgow	Good	Poor	Poor	Good	Good	Good
Wales	Bridgend	Fair	Poor	Poor	Good	Good	Good
	Cardiff*	Good	Good	Poor	Good	Good	Good
	Swansea*	Good	Fair	Poor	Fair	Fair	Fair
	Wrexham	Good	Poor	Poor	Fair	Good	Good
England	Burton	Poor	Fair	Poor	Good	Good	Good
	London	Fair	Fair	Fair	Good	Good	Good
	Oldham	Fair	Poor	Poor	Good	Good	Good
	Petersfield	Good	Fair	Poor	Good	Good	Good
	Southampton*	Good	Good	Poor	Poor	Good	Fair
	Torbay*	Good	Poor	Poor	Good	Good	Good



i-Tree



Cyfoeth
Naturiol
Cymru
Natural
Resources
Wales



WOODLAND
TRUST



Forestry Commission



Trees & Design
Action Group



Arboricultural Association®
cares for trees



The Open
University

My thanks to:

- Davey Institute, especially to Scott Maco
- Forestry Commission
- Woodland Trust, for data
- My group at Forest Research
- Open University

Urban forests and Green Infrastructure

- Ecosystem Services delivered by urban forests
- i-Tree Eco
 - Involvement in 15 surveys
 - Developing new surveys
 - Exploring research impact
- Role of trees and greenspace in cooling urban environments - mapping cooling



RN37 "The role of urban trees & green spaces in mitigating urban heat islands" published in Jan

Figure 4. Current knowledge of design strategies that can lead to maximum greenspace and tree cooling.

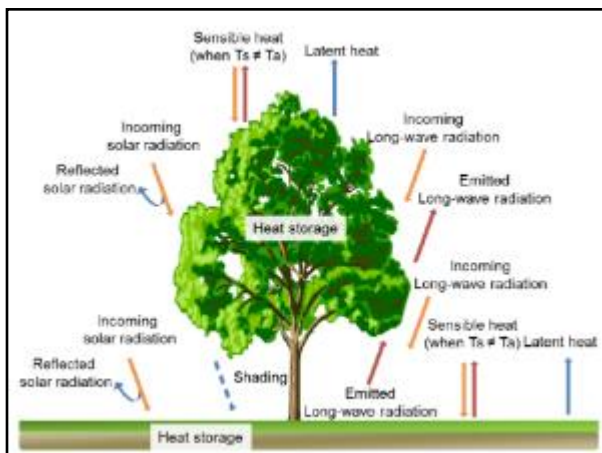
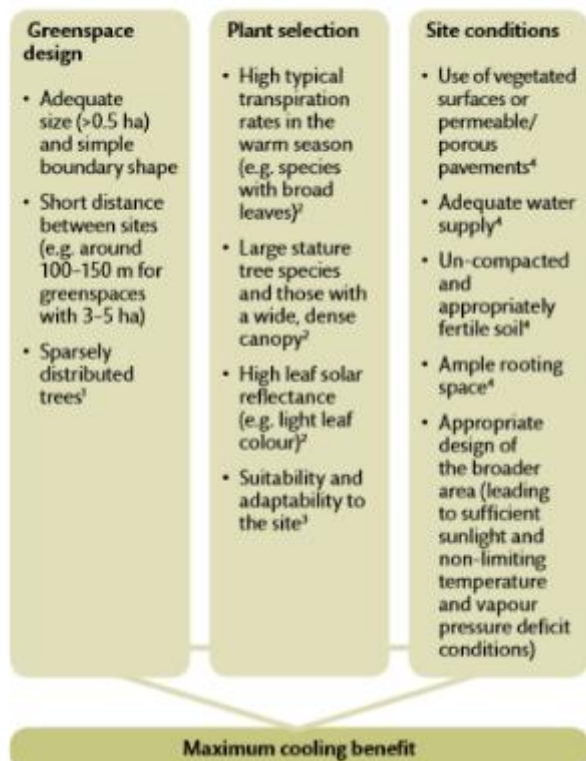
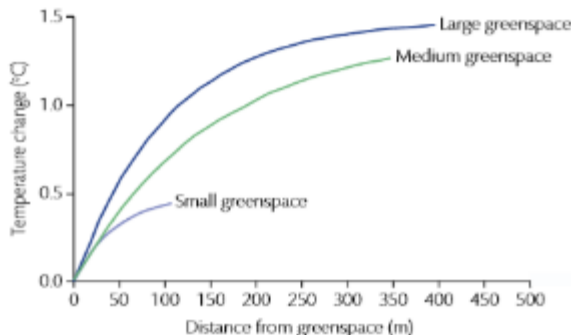


Figure 2. An example of estimated air temperature increase with increasing distance from greenspaces of different sizes (small: 2.5 ha; medium: 12 ha; large: 111 ha) during selected warm and calm nights up to a distance where the air temperature plateaued.



Influence of trees on Energy Cooling demand in cities, Published Sept. 2018

<https://doi.org/10.1016/j.ufug.2018.07.023>

- Evapotranspiration cooling quantified at a city scale
- Three UK case study urban forests; including Wrexham
- 14 – 27 kg water/hr/tree, contributing to cooling and humidification of air
- Pre-cooling air reduces A/C unit running costs, indicating service value of trees.
- more in-situ evapotranspiration required (species; locations)
- **1% -13% energy cost savings**



On-going research

- ***Role of street trees in cooling and thermal comfort***



- ***Growth rates of 'novel' street tree species***
- ~20 species
- ~2 London boroughs

