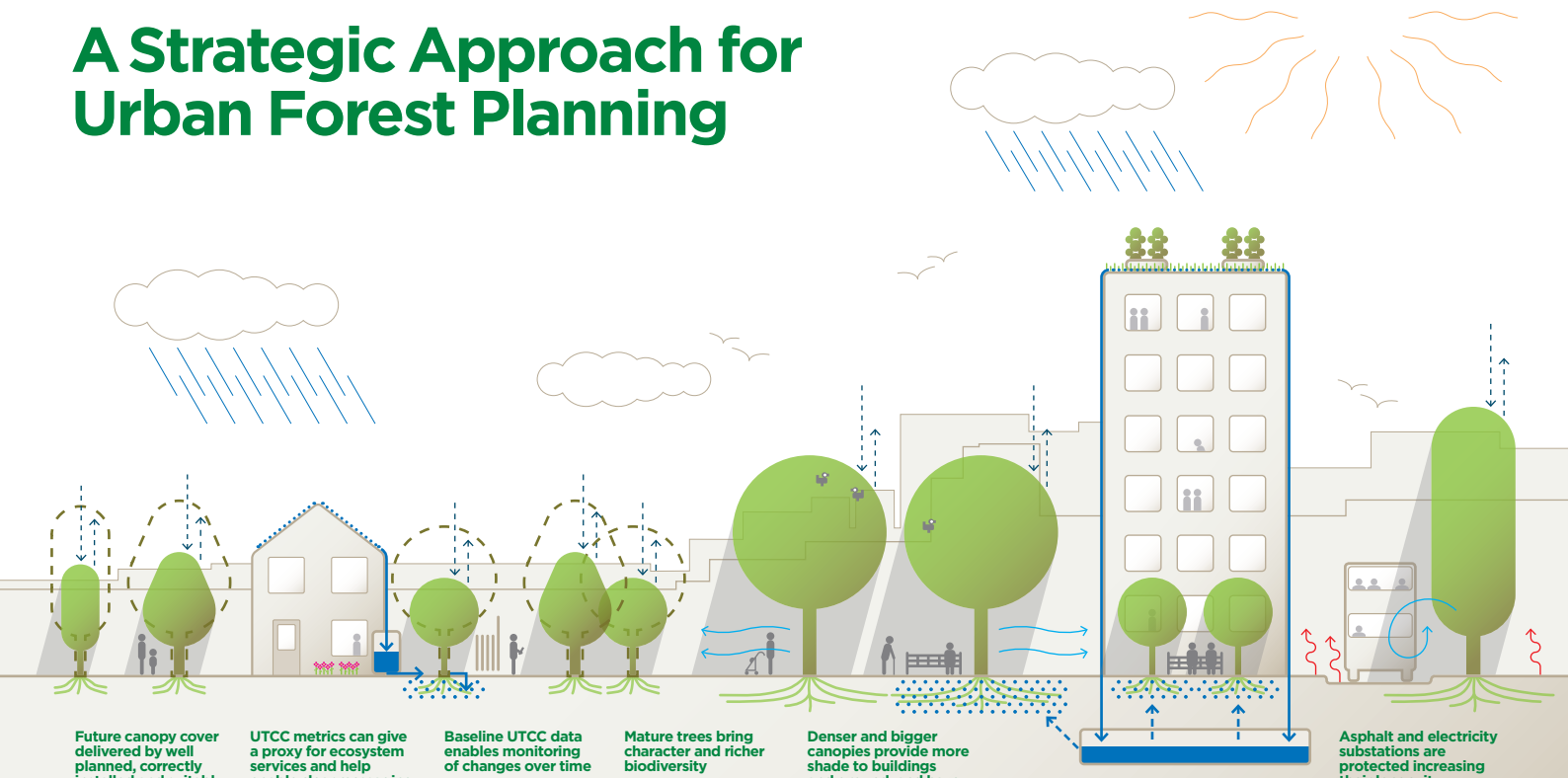
First Steps in Urban Tree Canopy Cover

A Strategic Approach for Urban Forest Planning



Future canopy cover delivered by well planned, correctly installed and suitably managed trees

UTCC metrics can give a proxy for ecosystem services and help enable clear messaging

Different UTCC calculation methodologies may provide differing values – choose one for consistency over time

Baseline UTCC data enables monitoring of changes over time

UTCC data can be integrated with other datasets eg socioeconomic indices, flood risk

Mature trees bring character and richer biodiversity

Denser and bigger canopies provide more shade to buildings and ground, and have greater potential for rainwater attenuation and local cooling by evapotranspiration

Asphalt and electricity substations are protected increasing their longevity

Key

- Emitted thermal (longwave) radiation
- Evapotranspiration
- Air flow
- Movement of cooler air
- Shading
- UTCC Urban Tree Canopy Cover

Trees & Design Action Group

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CARMINE co-create climate resilience

References

1 Terms highlighted in *green italics* are defined in the **Glossary**.

2 Dasgupta, P. (2021) Link

3 Gore, T. et al (2013) Link

4 Pataki, D.E. (2021) Link

5 *First Steps in Urban Water* Link

6 *First Steps in Urban Heat* Link

7 Urban forests and the SDGs Link

8 Konijnendijk, C.C. (2023) Link

9 Doick, K.J. (2021) Link

10 For England: Link
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For Scotland: Link
For Wales: Link

11 England Tree Action Plan Link

12 *First Steps in Valuing Green Infrastructure* Link

13 Climate change mitigation Link

14 Climate change adaptation Link

15 Gill, S. et al (2007) Link

16 Levelling Up Link

17 Biodiversity Net Gain Link

18 *Trees, Planning and Development: A Guide for Delivery – Section Two* Link

19 Walters, M. and Sinnett D. (2021) Link

20 National Forest Inventory Link

21 Trees Outside Woodlands Link

22 Tree inventory vs tree canopy assessment – What's the difference? Link

23 *Trees, Planning and Development: A Guide for Delivery – Section One* Link

24 Tan, et al (2022) Link

25 Alvey, A. (2006) Link

Trees provide a range of benefits for urban society including biodiversity enhancement[2], promoting better health and wellbeing[3,4], and increasing urban resilience to extreme weather such as heavy rainfall[5] and hot summer temperatures[6,7]. Quantifying how much of a given area is covered by trees, when viewed from above, ie the tree *canopy cover*[1], provides a proxy for these current benefits[8] and projections can be made for future benefits. Generally, the larger a tree *canopy*, the greater the *ecosystem services* provided by the tree[9]. *Urban Tree Canopy Cover (UTCC)* is expressed as a percentage of the total area or in m², ha or km² (Fig. 1).

In recent years, UTCC values and targets have become increasingly embedded in both planning policies[10] and strategies[11] in relation to the built environment[12]. Policy drivers for increasing UTCC include Net Zero[13], Climate Adaptation[14,15], National Planning Policy Framework (NPPF), Levelling Up[16], local planning requirements and *Biodiversity Net Gain* (*BNG*)[17].

This guide summarises how canopy cover can be determined at different scales using methodologies that look down from above. It is designed for built environment practitioners to inform strategy and monitor change over time[18]. In contrast, UTCC assessments for new development sites are carried out from ground level, using *BS 5837* tree survey methods.

Using a *canopy cover metric* in isolation to inform strategy and development designs carries risks[19] (Fig. 2) as it is also crucial to understand the existing tree stock (*tree inventory*) and its management from the outset[20,21,22]. Understanding and protecting existing trees should be prioritised above removal and replanting[10], and new planting should only take place if there is an aftercare and maintenance plan that will lead to successful tree establishment[23]. Understanding what space is available is important. Setting strategic targets without knowing if the local delivery is practical could lead to pressures to plant trees which have little chance of reaching maturity (*greenwasting*). Planting with a focus on tree numbers or increasing UTCC without due thought given to tree species, design, climate change and long-term maintenance is unlikely to deliver UTCC aspirations and benefits. Landscape layers, including a tree canopy layer, is the key to increasing biodiversity, however research directly linking canopy cover with biodiversity is limited[24,25].

Projecting future canopy growth is complex. At small scales, growth predictions can be made using specialist knowledge of the tree and the site conditions. At larger scales, modelling or allometric scaling can provide generalised predictions on growth. However, such projections are inherently uncertain given trees are living things that grow in response to their planting conditions, surroundings, and maintenance[26]. Modelling output should not be assumed to be exact and empirically correct. Different UTCC calculation methodologies (Table 1) may provide differing values, however using the same methodology maintains consistency so comparisons over time can be made.

Fig. 1 **Example UTCC map**

Areas in a darker shade of green have a more significant percentage of canopy cover, and additional data layers can be incorporated to identify areas of lower *tree equity*[27]
Image: TreePlotter CANOPY

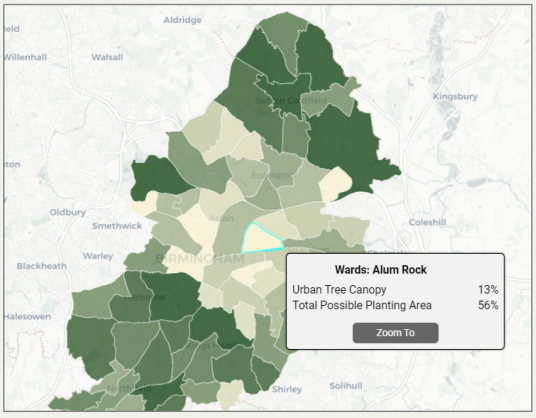
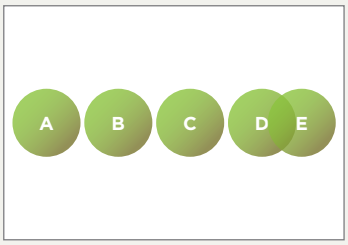


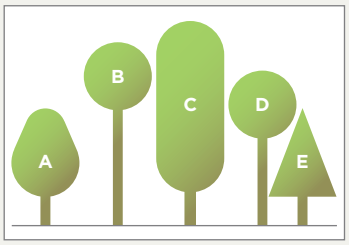
Fig. 2 **Limitations of viewing trees from above rather than from the ground**

Not all trees are equal[28] – some trees with the same crown footprint provide more ecosystem services than others. Two-dimensional aerial imagery provides information on crown spread, but detail such as crown depth, health, and density, is not captured. Despite this limitation, a canopy cover metric is still a useful indicator of the scale of ecosystem services delivery[29,30].

Trees from above
The overlapping crowns of D and E create a combined footprint, thus avoiding area double-counting



Trees in elevation
Trees with the same sized crown spread can have different profiles when viewed from the ground, but this does not prevent their footprints being a useful urban tree management metric



With understanding of the limitations, canopy cover projections can and should be used as broad guidance to support short- and long-term decisions. The key steps to calculating and using UTCC assessments at different scales are outlined in Box 1.

Key considerations include: data resolution, accuracy, seasonality and timing of images, size of area to be measured, plus the frequency of image updating and data availability. Quality assurance of spatial datasets is important. For example, trees on car parks can be overlooked, infrastructure can sometimes be miscategorised as tree canopy, or other false positives can occur such as the shadow of a tree appearing as an extension of its *crown*.

Top-down UTCC assessment results can be considered locally, leading to identification of areas that might benefit from: further site-level assessment for ground truthing; a more detailed tree inventory; and, development of plans for managing, protecting and planting trees.

Box 1 **Key Steps in using a UTCC metric**[31]

Step 1: Plan
Set clear goals and strategies and key audiences and plan report dissemination ahead. Understand why you need and how you will use a canopy cover metric. UTCC metrics can be used to monitor change over time and space, to support tree population resilience planning or climate adaptation to prioritise areas for increasing canopy cover to deliver tree equity[27].

Step 2: Assess
Complete data collection/purchase data/use open access data (Table 1), ensuring assessment approach supports the decision making context and future comparative assessments. For example, if you want to monitor changes over time at *LSOA* level, be mindful that for each UTCC assessment you will need to do the same data collection again/purchase the data again (if available) and make sure the date is from an 'in leaf' time series.

Step 3: Analyse
Integrate data with stakeholder input and other datasets to determine local, neighbourhood, and city wide canopy cover goals.

Step 4: Project
Model future canopy cover if appropriate to set interim UTCC goals.

Step 5: Implement
Share information to help inform policy and planning. Clear messaging using UTCC metrics can improve communication and public engagement[32] and can provide evidence to lever funding for urban forests and maintain funding support during local council budget cuts.

Step 6: Monitor and evaluate
Track progress towards goals set at Step 1 and Step 4.

Table 1 **Resources**

Quality assured · Open access · Historical data · Copyright applies · Accuracy reported · Precision reported

	Resource	Detail
Data collection tools/data sets available	**National Tree Map™ (NTM™)** **Bluesky International Ltd**	Data entirely derived from photogrammetric datasets captured using fixed wing aircraft. It can be provided in a variety of formats for both non-GIS (Geographic Information System) and GIS users. Across England, Scotland and Wales, location, height and canopy/crown extents for all trees 3m and above in height is provided. Historical data can be requested. Data is updated every two years.
	i-Tree Canopy Tool **i-Tree**	A tool for calculating UTCC of defined areas, large and small, through user interpretation of aerial photographs from Google Maps aerial photography using point sampling. Data can be collected and processed very quickly with minimal training. As the date of the aerial photography is not known it is difficult to make comparisons over years.
	Trees Outside Woodland **Forest Research/Defra**	Designed to provide accurate information about the size, distribution, composition and condition of trees outside woodland. Data used is from the National Tree Map™, the National Forest Inventory programme of field surveys and hand mapping of non-woodland tree cover, for calibrating and correcting areas.
	Lidar derived Vegetation Object Model (VOM) **Environment Agency**	In this raster product each pixel represents the height of top of canopy above ground, for all classified vegetation objects above a threshold of 2.5 metres. Data is produced by complex GIS modelling of the Environment Agency national LIDAR programme, is fully automated and collected during the winter season with repeat coverage at least every five years. A 3D webmap including the VOM has been produced (60% of England covered).
UTCC processed data	**Friends of the Earth Tree Mapping** **Tera Sulis**	Identifies existing tree cover and aims to draw up an 'opportunity map' of areas that may be suitable for creating woodlands. UTCC percentage is available for local authorities in England and neighbourhoods within. Data source: Environment Agency data, newly available laser LiDAR imaging of England and national datasets from Defra.
	Google Environmental Insights Explorer (EIE) Tree Canopy	Builds on high resolution aerial imagery fed into a deep learning semantic segmentation model trained using a human-labelled Urban Tree Cover Webmap version of same type of aerial data. UK city-level data is available on the website, applications can be made to get access to more data for a city or region.
	Urban Tree Canopy Webmap **i-Tree**	UTCC percentages for all urban *wards* in the UK have been calculated based on 2018-2022 aerial images – UK Ward Canopy Cover. Percentage canopy cover is listed as 'percancov' and 'numpts' refers to the number of points.
	Tree Equity Mapping **The Woodland Trust, American Forests and Centre for Sustainable Health Care**	A map-based application created to help address disparities in urban tree distribution by identifying the areas in greatest need of people-focused investment in trees. Data source is Google EIE. This resource covers the UK (city and *LSOA* level) but some areas are not mapped [2024].
	TreePlotter CANOPY **PlanIT Geo/Goetre Villa**	Enables users to assess, visualize, and share tree canopy data, set measurable goals, and plan planting efforts. Combines multiple layers, indices of multiple deprivation, TreeEquity, 3-30-300, air pollution, flooding, and heat island.
	TreeKeeper® **Davey Resource Group/** **Treeco$_2$nomics**	A versatile software designed for observing, prioritising, and sharing tree canopy assessment data. It helps users define measurable canopy goals, prioritise planting efforts, project future canopy benefits, and budget planting costs. Users can review canopy data, explore changes, customise attributes, and identify planting opportunities. It supports strategy creation, community customisation, and stakeholder collaboration. Historical data can be added on request.

Table 1 – Definitions

Quality assured.
Standard methodology process followed to ensure standards are upheld; data inconsistencies and anomalies have been removed.

Accuracy reported.
Data is close to true value ie when it says there is a tree, there is a tree.

Precision reported.
The level of data consistency arising following repeated use of the same methodology.

26 Vaz Monteiro, et al (2016) Link

27 Tree Equity Link

28 Francis J. et al (2023) Link

29 Hand, K. and Doick, K.J. (2021) Link

30 *Tree Species Selection for Green Infrastructure: A Guide for Specifiers* Link

31 Urban Tree Canopy Assessment Link

32 Sales, K. et al (2023) Link

Glossary

Biodiversity Net Gain.
An approach to development – habitats for wildlife are left in a measurably better state than they were before development.

BS 5837.
British Standard 5837:2012 Trees in Relation to Design, Demolition and Construction.

Canopy.
The collective branches and foliage of trees that make up the tree's crown.

Canopy cover.
Two-dimensional representation of the area covered by the branches and foliage of a tree(s).

Canopy cover metric.
The measurements of canopy cover usually in m^2 or expressed as a percentage.

Crown.
All parts of a tree above the clear section of the stem.

Ecosystem services.
The direct and indirect contributions ecosystems provide for human wellbeing and quality of life.

Greenwasting.
Conscious/unconscious decision that wastes opportunities and resources to make a positive contribution to the environment.

LSOA.
Lower layer Super Output Area, contains between 1,000 and 3,000 residents with 400 to 1,200 households.

Tree Equity.
Equitable access to the benefits of trees.

Tree Inventory.
Trees in a defined area are assessed on a set of criteria and their location is plotted by personnel on the ground.

Urban Tree Canopy Cover (UTCC).
Total area of canopy within an identified urban area.

Ward.
A geographic subdivision of a local authority area.

Case study
Oxford, UK
Using UTCC assessments for an Urban Forest Strategy

Oxford City Council (OCC) used their UTCC assessments to inform their 2021 *Oxford Urban Forest Strategy* (*OUFS*). The OUFS sets out broad aims to '*Protect what we have, expand what we have, and to engage people in the process*'. OCC recognised that a coordinated approach was required between public, private, third sector and institutional stakeholders to meet its vision; and to maximise the myriad social, environmental and economic benefits of the urban forest. OCC responds to this challenge through three mechanisms: as a Local Planning Authority it controls works to protected trees and manages sustainable development through the planning policies in its adopted Local Plan; as a major landholder through its adopted Tree Management Policy for Oxford; and as a societal influencer through its adopted urban forest strategy (OUFS). The Council plans to use GIS to help set achievable canopy cover targets in the city in the future, and the strategy used the Oxfordshire Treescape mapping project to identify that priority should be given to increasing UTCC within areas of deprivation with lower UTCC and in Nature Recovery Network areas that have a lower UTCC.

Case study
Birmingham, UK
Using an UTCC assessment for an Urban Forest Master Plan

Birmingham City Council (BCC) has several canopy cover assessments, all of them with a different UTCC value, however, standardising the assessment process now means it is able to make comparisons over time. In 2021, BCC used their UTCC assessment to inform their Urban Forest Master Plan (UFMP), which is co-led by Birmingham TreePeople and BCC. The UFMP is a strategic plan that states the intentions for the green space and natural capital of the city. The plan defines the aspirations of the council, its urban forest managers, and key stakeholders. It takes a long-term approach with an action-based strategy and sets out measurable targets for strengthening the city's urban forest over the next 30 years. It has a strong focus on environmental justice and using trees and green infrastructure as a means of levelling up. Wards with the least canopy cover and elevated social deprivation indices are identifiable through layering the UTCC data with other socioeconomic data. Increasing UTCC in areas which already have a higher UTCC is not discouraged, but new tree establishment opportunities are guided towards the areas most in need. The UTCC data is available as open access, enabling local stakeholders to view the percentage tree canopy cover of their area and compare this to other *LSOAs* and Wards.

View of Birmingham's tree canopy cover

Case study
Clyde Climate Forest
Using an UTCC assessment to identify 'Target Neighbourhoods'

The Clyde Climate Forest (CCF) initiative was launched by the Glasgow City Region (GCR) Cabinet in June 2021 with a headline target of planting '18 million trees over the next decade'. One of the three objectives of the CCF is to provide an increase in tree canopy cover in 'Target Neighbourhoods'. In order to identify these neighbourhoods Forest Research undertook an aerial analysis of the canopy cover across the urban areas of the GCR, specifically to identify areas of low canopy cover. Then, using the Glasgow City Region Climate Vulnerability Map to identify flooding and urban heat islands, and the Scottish Index of Multiple Deprivation map, vulnerable postcodes were identified. These vulnerable postcodes were overlaid on the Forest Research urban canopy data to identify the 'Target Neighbourhoods' in the CCF area.

This data has helped the CCF team and local authorities to target resources, including funding and engagement with local schools and communities, thus ensuring that CCF effectively targets locations that will benefit the most from tree planting. There are 16 Target Neighbourhoods in the CCF area; at least one in each of the eight local authorities. In the first three years of the initiative CCF has worked with Local Authorities to plant over 10,000 trees in 12 of the Target Neighbourhoods. Next steps are to recruit Tree Wardens to help care for these trees.

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