Urban Ecosystem Services: Aboveground Vegetation Carbon Storage on Brayford Pool Campus

Introduction

Vegetation, in particular trees, are widely adopted in climate mitigation plans [1] as they sequester (absorb and store) carbon from the atmosphere.

As the climate crisis unfolds and urban areas expand [2], vegetation is increasingly likely to be utilised for sustainable management in cities.

However, a lack of high spatial resolution vegetation data is still a barrier to effective urban planning and carbon accounting [3].

Aims

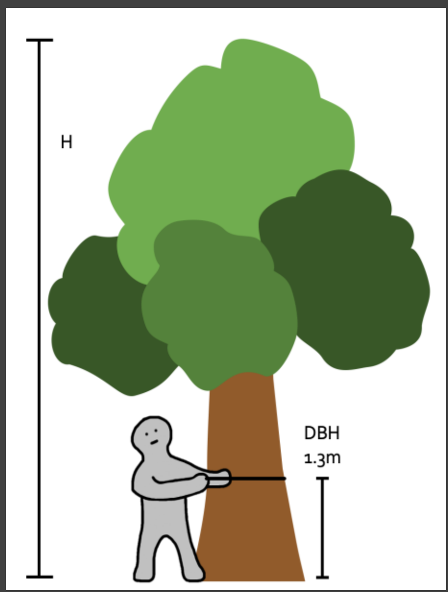
To develop a baseline dataset of aboveground vegetation carbon stocks for the University of Lincoln's Brayford Pool campus to help inform future environmental management.

This will include a georeferenced inventory of open-growing trees; areas of shrub, hedges, and herbaceous growth; and estimates of the carbon stored within them.

Methods

24 hectares spanning the Brayford Pool campus and Lincoln Science and Innovation Park were surveyed.

Fig 1. Size measurements taken for each tree. Diameter tapes and a laser hypsometer were used.



Tree census

The species of each tree was identified. Diameter (DBH) and height (H) were measured (Fig. 1).

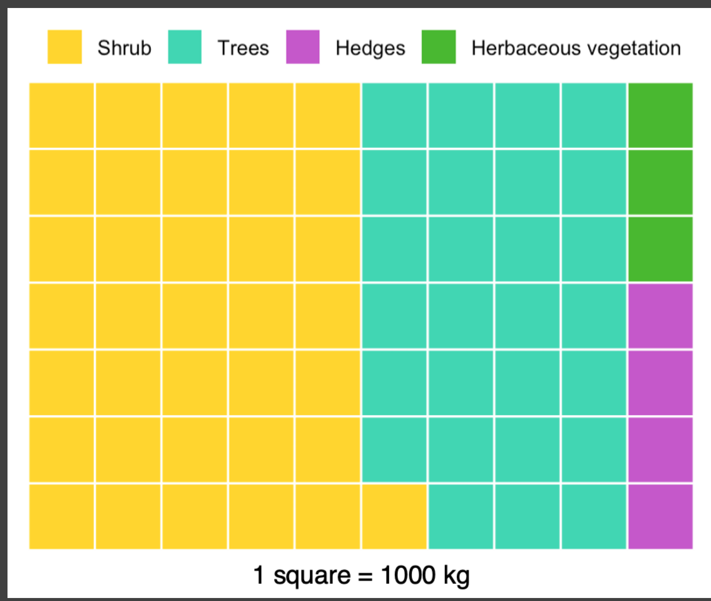
Allometric equations (which link the size of a tree to its mass) were used to convert DBH and H into dry biomass.

Biomass was converted to carbon (C) content using conversion factors of 0.42 for conifers and 0.48 for broadleaves [4].

Shrubs, hedges and herbaceous vegetation

Areas of non-tree vegetation were measured in Google Earth and converted to C content using carbon densities from the literature [4, 5, 6].

Results



The amount of carbon stored in aboveground vegetation on campus was estimated to be **73100 kg** (± 1860 kg) (Fig. 2). This equates to a carbon density of 3.04 ± 0.08 Mg ha^{-1} (1 Mg = 1 metric tonne and 1 ha ≈ 2.5 acres).

Fig 2. Aboveground carbon stock by vegetation type:

Shrub - 51 ± 0.5%
Trees - 38 ± 0.6%
Hedges - 6.3 ± 0.1%
Herbaceous - 5.3 ± 0.1%

Trees

501 trees representing **26 species** were recorded. The most common species were silver birch (*Betula pendula*, 96) and ash (*Fraxinus excelsior*, 76).

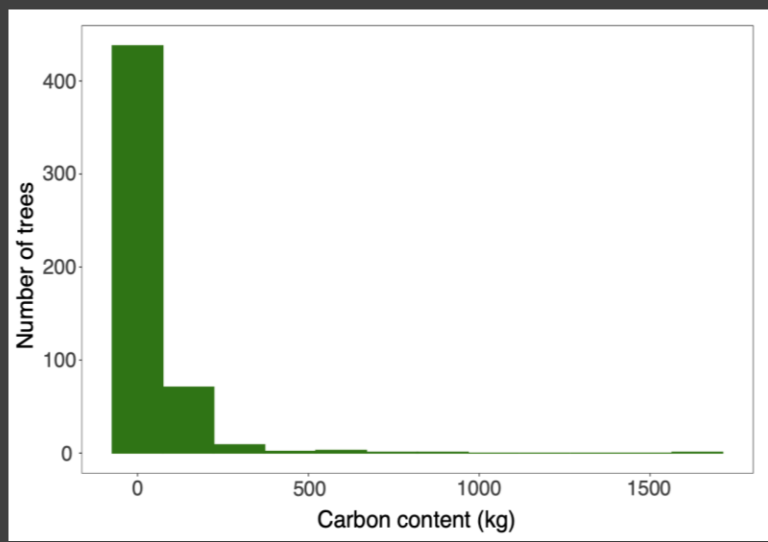


Fig 3. Histogram of carbon content per stem (526 stems in total). Trees tended to be small - mean DBH was 16.5 cm and mean H was 8.6 m

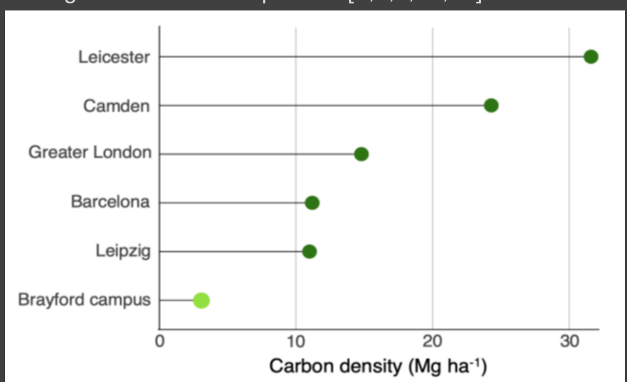
Shrubs, hedges and herbaceous vegetation

Hedges are the most carbon-dense but their current extent is lowest. Common species were hazel (*Corylus avellana*), and goat willow (*Salix caprea*) in shrubs, and privet (*Ligustrum spp*) in hedges.

Fig 4. Non-tree vegetation percentage covers across campus and their carbon densities [4,5,6].

Discussion

Fig.5 Vegetation carbon densities from similar studies at larger scales for comparison [4,8,9,10,11].



Compared to other regions (Fig. 5), the lower carbon density on campus could be due to a lack of large parks and urban forests present in many of the other areas, and the relatively recent history of the campus, contributing to a higher ratio of smaller and younger trees (Fig. 3).

Half of the carbon stock was found in areas of shrub (Fig. 2). The dense growth of woody vegetation constitute substantial a carbon store that is often overlooked, especially in comparison to trees [7].

Hedges are the most space-efficient carbon stores among non-tree vegetation, but they currently cover the smallest area (Fig. 4), so carbon sequestration on campus could be enhanced by establishing more hedges, with consideration of the emission generated during their establishment and maintenance.

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Acknowledgements

This project has come to fruition with the support of Rebecca Forster and Jack Hughes from the Estates Department; Simon Chappell from Four Oak Landscapes; and Emma and Jack. Their help is sincerely appreciated.

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