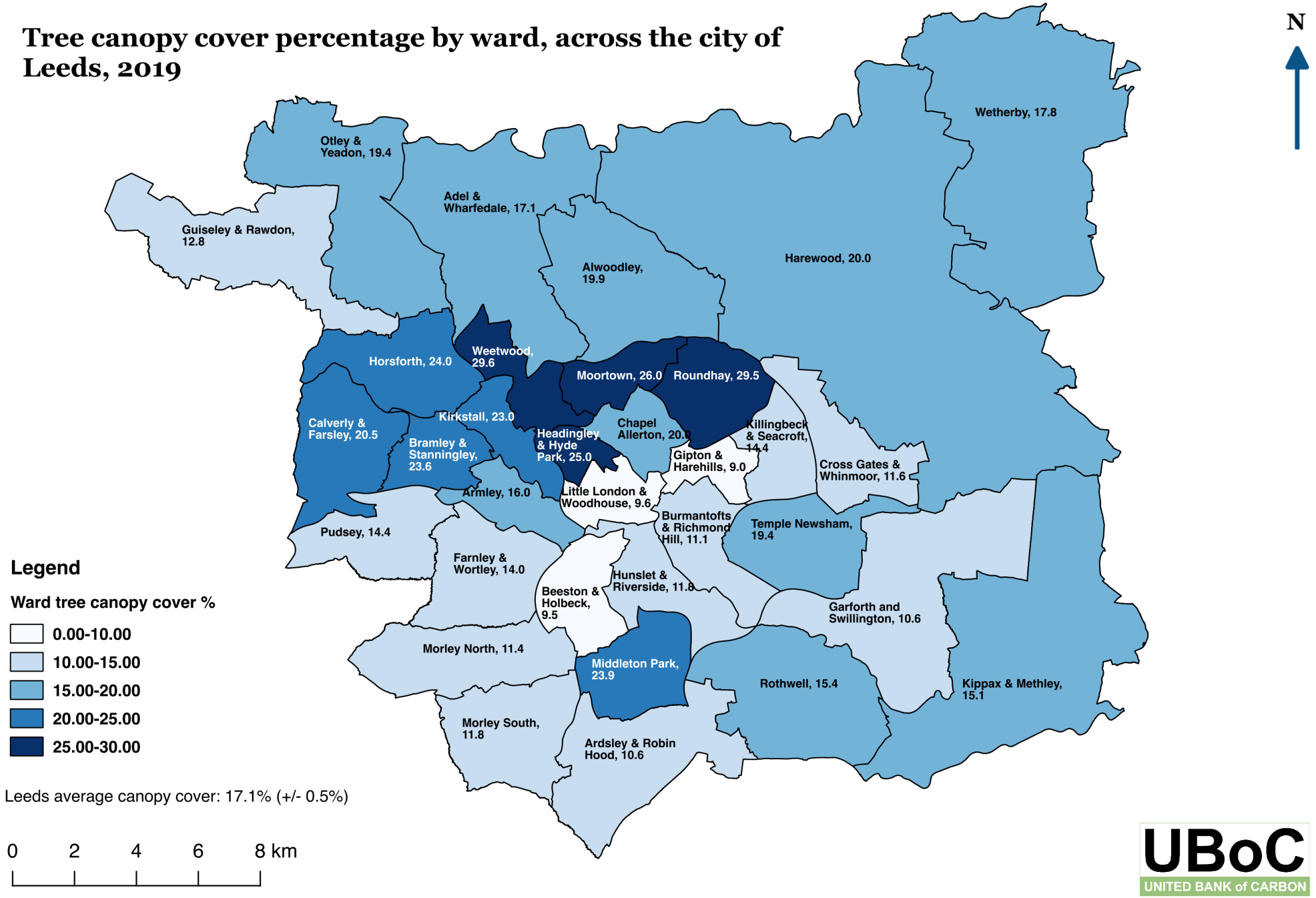


Figure 1. Map to show the estimated percentage tree canopy cover of Leeds wards. Canopy cover estimates calculated using surveys of 800 sample points per ward in i-Tree Canopy v6.1. Map produced using QGIS v2.18. Ward boundary shape-files provided by Leeds City Council.

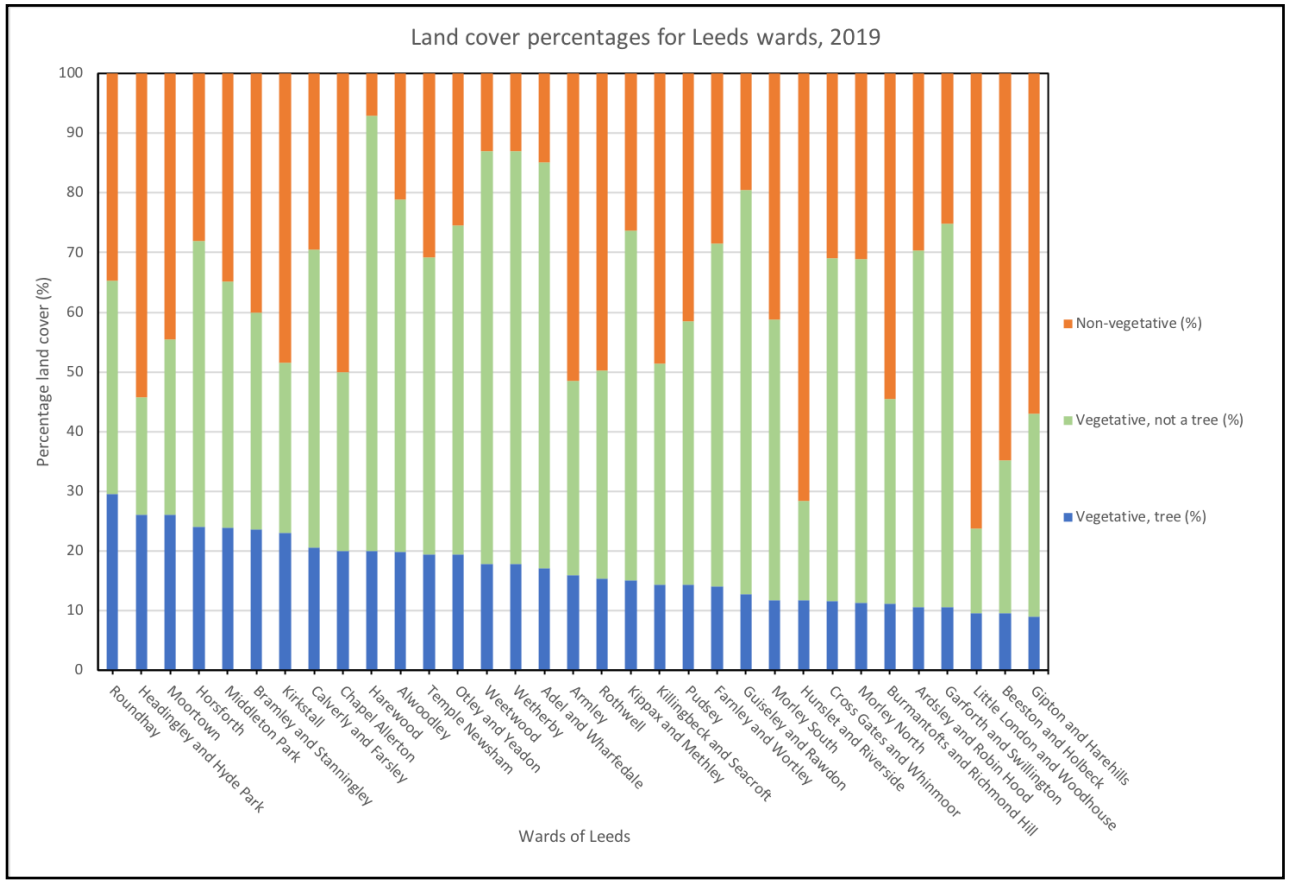
Estimating tree canopy cover across the city of Leeds, using i-Tree Canopy (v6.1)

Context

The pressing challenge of climate change requires us to plan and act now in order to ensure we are on the path to cap global temperature increase at 1.5° C above pre-industrial levels (1). Trees have great potential to help us achieve this, by removing carbon from the atmosphere, and storing this in biomass. It is vital that we recognise the important work trees in our landscape are doing, in order to develop timely solutions to climate change. Trees also offer many other benefits including flood alleviation, air pollution removal, biodiversity enhancement, and benefits for human health and wellbeing. Effective management of forests can enhance the delivery of these benefits.

Tree canopy cover (TCC) analysis enables us to evaluate the distribution of trees across Leeds. TCC is defined as 'the area of leaves, branches, and stems of trees cover the ground when viewed from above' (2). Forest Research identified that the national average TCC for towns and cities in England is approximately 16% (3). Using i-Tree Canopy software (v6.1) (4), the TCC of all 33 wards within the city of Leeds have been estimated and mapped, using 800 survey points per ward to reduce standard error (Figure 1). **The average canopy cover for the city was estimated, weighted by area, to be approximately 17.1%.** The TCC of the wards is varied, with some parts of Leeds having only one third of the tree coverage of their neighbouring wards. All ward values and standard errors are listed in Figure 3. The Committee on Climate Change have advised that tree planting rates of at least 30,000 hectares per year will be required in order for the UK to reach net-zero greenhouse gas emissions (GHG) by the year 2050 (5). **If Leeds contributes to this in line with its current share of national GHG emissions (approximately 1% (6), and plants trees within the city boundary (Figure 1), the planting would be equivalent to almost doubling current TCC to approximately 33%.** Tree planting to reach this target must be considered alongside long term maintenance of mature trees.

Figure 2. Total percentage land cover by ward. Percentages estimated using i-Tree Canopy survey results.



Technical detail

Surveying in i-Tree Canopy

The survey used a point-based assessment in i-Tree Canopy (v6.1) (4), a free to use tool that generates random points across a defined area of Google maps, to be categorised within surveyor defined categories, as tree or non-tree (7). In this survey 16 land use categories were used, with totals then grouped by 'non-vegetative', 'vegetative, not a tree' and 'vegetative, tree' (Figure 2). 800 sample points were surveyed per ward, as this largely reduced the standard error for each land use category.

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Sampling at ward level

The survey area of Leeds covers an area of 55170 hectares and is made up 33 wards. The individual ward areas were defined in i-Tree Canopy using ward boundary shape files (8). Using the sampling results for the categories, total canopy cover percentage per ward was calculated (*(total number of 'vegetative, tree' points/total number of survey points)/100*). Standard error for each value was calculated to provide a lower and upper confidence interval for each ward value. Standard error= $\sqrt{}$ (p*q/N)) (*where N= total number of surveying points, n= total number of points on a tree, p= n/N and q= 1-p*). To calculate the lower and upper limits of the 95% confidence interval, standard error was multiplied by 1.96 (7) (Figure 3).

Calculating the city average and standard error

To calculate the average TCC for the city of Leeds, percentage TCC for each ward was weighted by area. Area data for the wards was sourced from ONS (9) (converted from m^2 to hectares). Ward area was calculated as a fraction of the total Leeds area (*ward area/ 55170*). For each ward, the fraction was then multiplied by the corresponding TCC % to produce an area weighted canopy cover fraction. The sum of all 33 area weighted canopy cover values was calculated to provide the total weighted average canopy cover for Leeds, 17.1% with a 95% confidence interval of +/- 0.5%.

The values were then mapped in QGIS to show the variation in canopy cover across the city, and illustrate the differences (10). All values presented in this document are correct to 1 decimal place.

Figure 3. Total percentage canopy cover and 95% confidence intervals.

Ward name	Total canopy cover (%)	95% confidence interval +/- (%)
Adel and Wharfedale	17.1	+/-2.6
Alwoodley	19.9	+/-2.8
Ardsley and Robin Hood	10.6	+/-2.1
Armley	16.0	+/-2.5
Beeston and Holbeck	9.5	+/-2.0
Bramley and Stanningley	23.6	+/-2.9
Burmantofts and Richmond Hill	11.1	+/-2.2
Calverley and Farsley	20.5	+/-2.8
Chapel Allerton	20.0	+/-2.8
Crossgates and Whinmoor	11.6	+/-2.2
Farnley and Wortley	14.0	+/-2.4
Garforth and Swillington	10.6	+/-2.1
Gipton and Harehills	9.0	+/-2.0
Guiseley and Rawdon	12.8	+/-2.3
Harewood	20.0	+/-2.8
Headingley and Hyde Park	26.0	+/-3.0
Horsforth	24.0	+/-3.0
Hunslet and Riverside	11.8	+/-2.2
Killingbeck and Seacroft	14.4	+/-2.4
Kippax and Methley	15.1	+/-2.5
Kirkstall	23.0	+/-2.9
Little London and Woodhouse	9.6	+/-2.0
Middleton Park	23.9	+/-3.0
Moortown	26.0	+/-3.0
Morley North	11.4	+/-2.2
Morley South	11.8	+/-2.2
Otley and Yeadon	19.4	+/-2.7
Pudsey	14.4	+/-2.4
Rothwell	15.4	+/-2.5
Roundhay	29.5	+/-3.2
Temple Newsham	19.4	+/-2.7
Weetwood	29.6	+/-3.2
Wetherby	17.8	+/-2.6

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