Urban Canopy Assessment

An Assessment of Canopy Cover, Social Indicators, and Ecosystem Service Delivery in The Royal Borough of Greenwich

ROYAL borough of GREENWICH

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Treeconomics

Authors

John Rose

Catherine Vaughan-Johncey

Dave Partridge

Reviewed by:

Harry Munt

This Report was written by Treeconomics for Royal Borough Of Greenwich Council.

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Executive Summary

This report focusses on tree canopy cover across the Royal Borough of Greenwich, and the relationship between tree canopy cover and social and environmental factors.

Greenwich has a good level of canopy cover of 24.4%, ranging from 7.2% in Greenwich Peninsula, to 44.3% in Eltham Park & Progress. This is significantly higher than the national average of 16.5%, and higher than the average for Greater London of 21.5%.

In comparison with data from 2016, many wards see an increase in canopy cover over the last 7 years. Overall, canopy cover across Greenwich has increased by 4.4%, with the largest increase in Kidbrooke Village & Sutcliffe, where it rose by 10.3%.

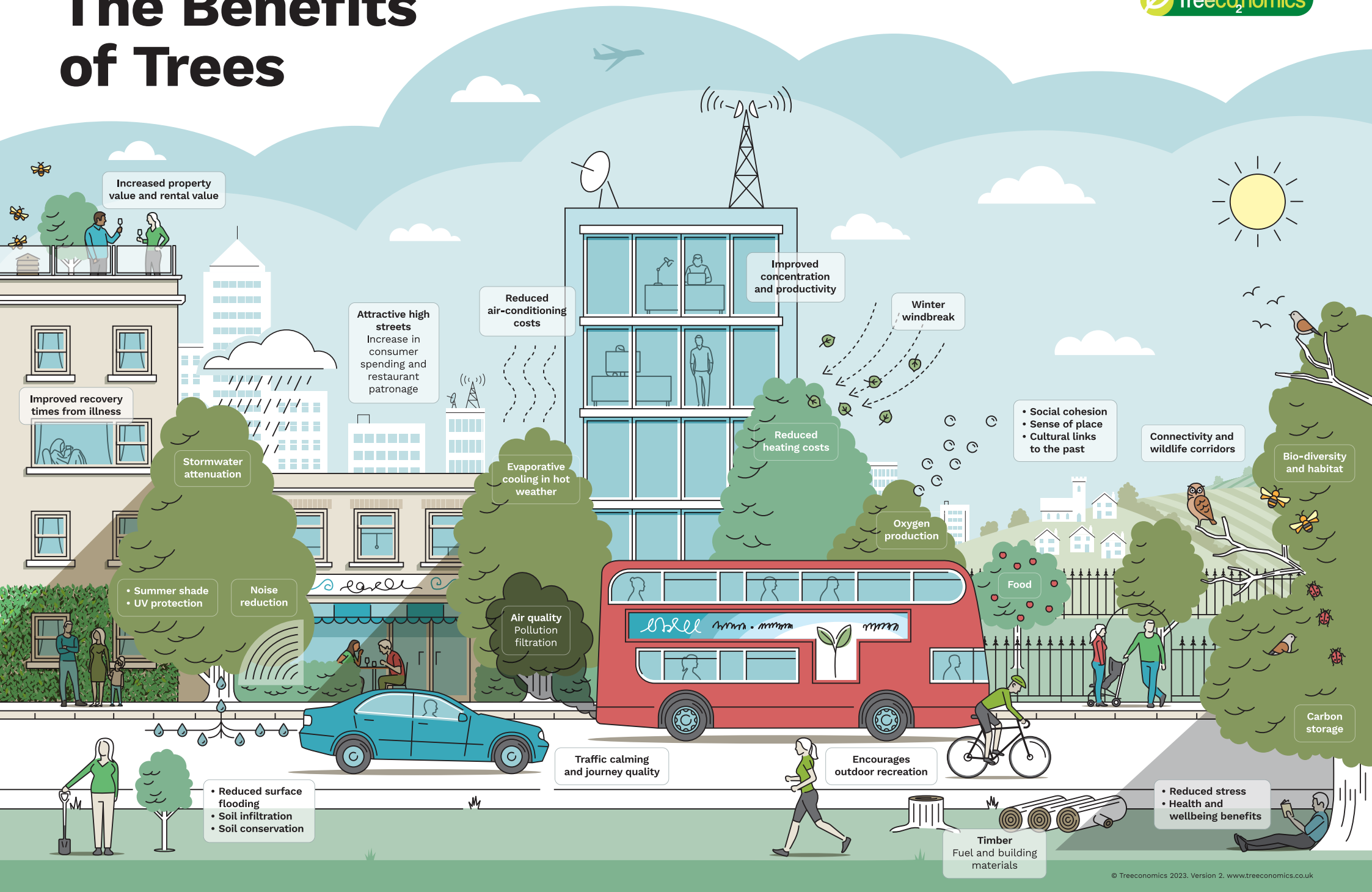
An assessment of tree equity across Greenwich identifies 4 wards where canopy cover is low and urban challenges are high. These wards would benefit most from new tree planting and increased management. The wards are Greenwich Peninsula, Woolwich Arsenal, East Greenwich, and Eltham Page.

The environmental and social factors used to demonstrate the potential effects of tree canopy cover are temperature, air quality, surface water flooding risk, Index of Multiple Deprivation (IMD), educational attainment, crime rates, life expectancy, and hospital admissions. Of these metrics, air quality, heat data, and IMD show the strongest correlation to tree canopy cover, implying that trees can reduce surface temperatures, improve air quality, and could be a an indicator of, or factor in, reducing deprivation.

It is important to note that correlation between canopy cover and these metrics does not necessarily imply causation. Also, other social and environmental factors can affect these metrics, and therefore any lack of correlation does not necessarily mean the canopy cover does not have any effect, rather that other factors may have a stronger effect (the same is of course still true where there is correlation).

The Benefits of Trees

Treeco$_2$nomics



1. The Benefits of Trees

There are some twenty ecosystem services which trees in cities provide to society. They were established by the World Commission on Ecosystem Service Management of the International Union for Conservation of Nature. Work continues to quantify and value each of them.

Those that are quantifiable with valuations adopted by national or local government have been included within this report. They include carbon storage and sequestration, pollution mitigation, avoided stormwater runoff, all determined using i-Tree.

Many UK local authorities have also adopted CAVAT (Capital Asset Valuation of Amenity Trees) to place a valuation upon the amenity of public trees.

There are a large number of other benefits where research continues to help assign meaningful financial valuations.

Increased property or rental value: A series of international third-party studies have shown that trees increase property prices by between 5% to 18%[1].

Increased consumer spending: Consumers are willing to spend more in shopping areas with large, well cared for trees. This has been measured as an increase of 9% to 12%[2].

Climate Adaptation - Temperature Regulation: Urban Trees can reduce peak summer temperatures by up to 7°C[3]. This particular adaptation has long been adopted by cities in warmer locations and forms a key tenet of green infrastructure thinking. Current research extends into examining the cooling effectiveness of individual species.

Reduced Stress and improved mental health: Forest Research recently valued this particular benefit of forests and woodlands nationally at £185m[4]. More trees immediately around the home (less than 100 meters) are associated with a reduced risk of being prescribed antidepressant medication. This association is especially strong for deprived groups[5].

Improved concentration and academic achievement: Greener schools have higher test scores, even after taking income into account. Middle school students get a boost from school greening. Planting trees within 250m of schools has the greatest effect[6].

Improved recovery times from illness: Patients placed in rooms with views of nature experienced shorter stays in the hospital than patients in rooms that faced other buildings[7].

1 CABE Space, 2005 and Morales et al, 1983

2 Wolf, 2005

3 Gill et al. 2007

4 Saraev et al. 2021

5 Taylor et al. 2015

6 Kuo et al. 2021

7 Ulrich 1984

2. Tree Canopy Cover

Tree canopy cover, also referred to as canopy cover, is a basic metric for measuring the extent to which we share our space with trees. Canopy cover can be defined as the area of leaves, branches, and stems of trees covering the ground when viewed from above. It is a two-dimensional metric indicating the spread of tree canopy across an area, and it can be used to gain a basic understanding of the ecosystem services provided by trees.

Tree canopy across Greenwich covers 20.3% of the land area, with a high of 44.3% in Eltham Park & Progress, and a low of just 5.6% in Greenwich Peninsula. This show a huge disparity between the wards which should be addressed to improve green equity.

Canopy cover is a simple way to compare the distribution of trees and woodland across a geographical area. Understanding existing levels sets a benchmark against which future gains/losses can be measured.

The data used in this report, derived from aerial survey, should capture all trees with a height above 3m, which excludes the vast majority of hedgerows. Ward boundaries provide a means to compare coverage in different areas. This can help to facilitate conversations about where resources might be directed for greatest effect.

In urban areas, the tree canopy cover is built up of three main elements: trees in gardens, trees in parks, and street trees. These match approximately to recognisable land use designations giving a good indication of which policy options offer the greatest opportunity for canopy growth.

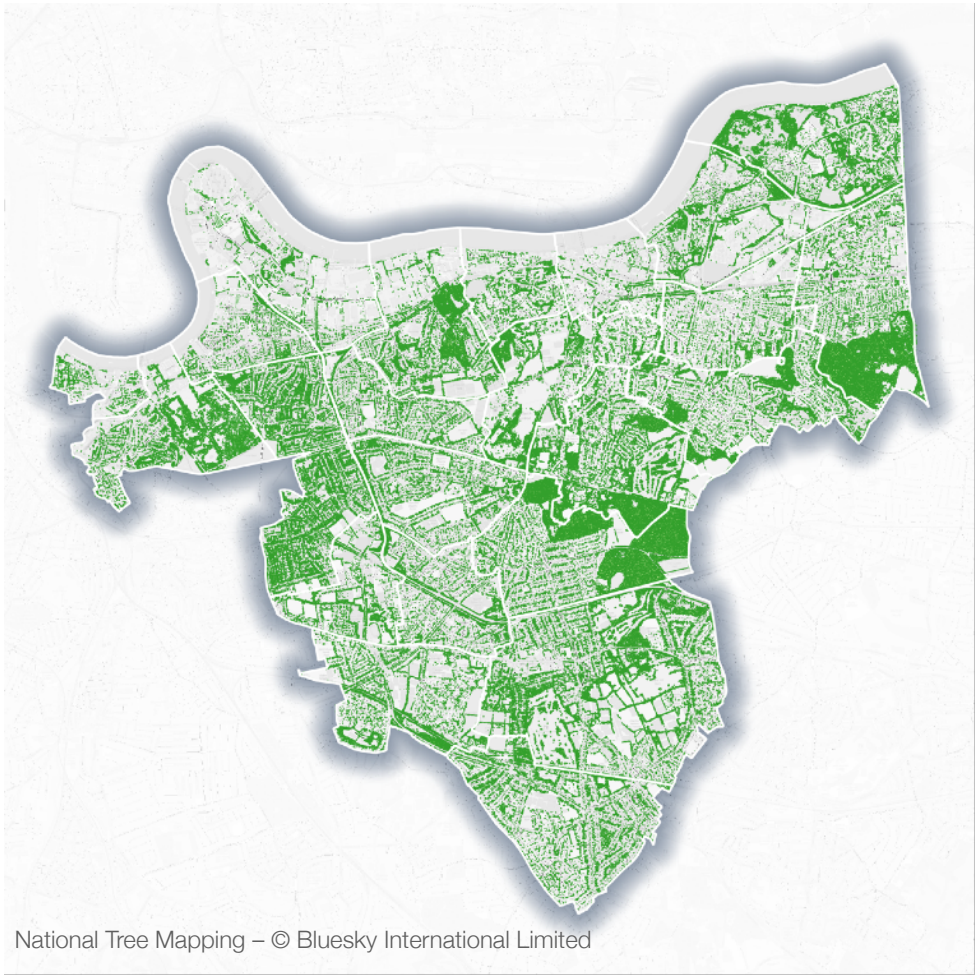


Figure 1: Extent of Tree canopy polygons across Greenwich

2.1 2016 Canopy Cover

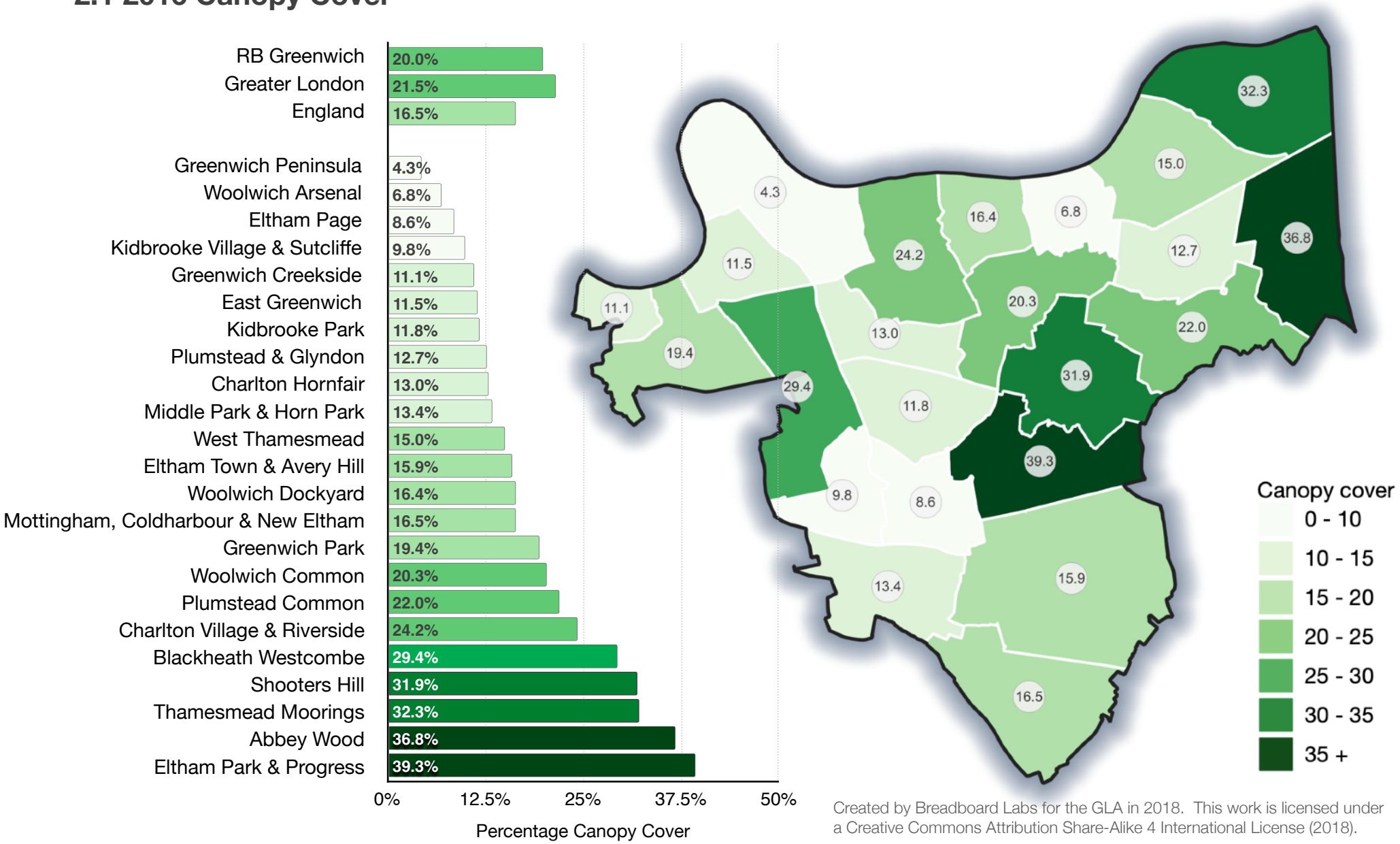


Figure 2: 2016 Canopy Cover By Ward (Cirio)

2.2 2023 Canopy Cover

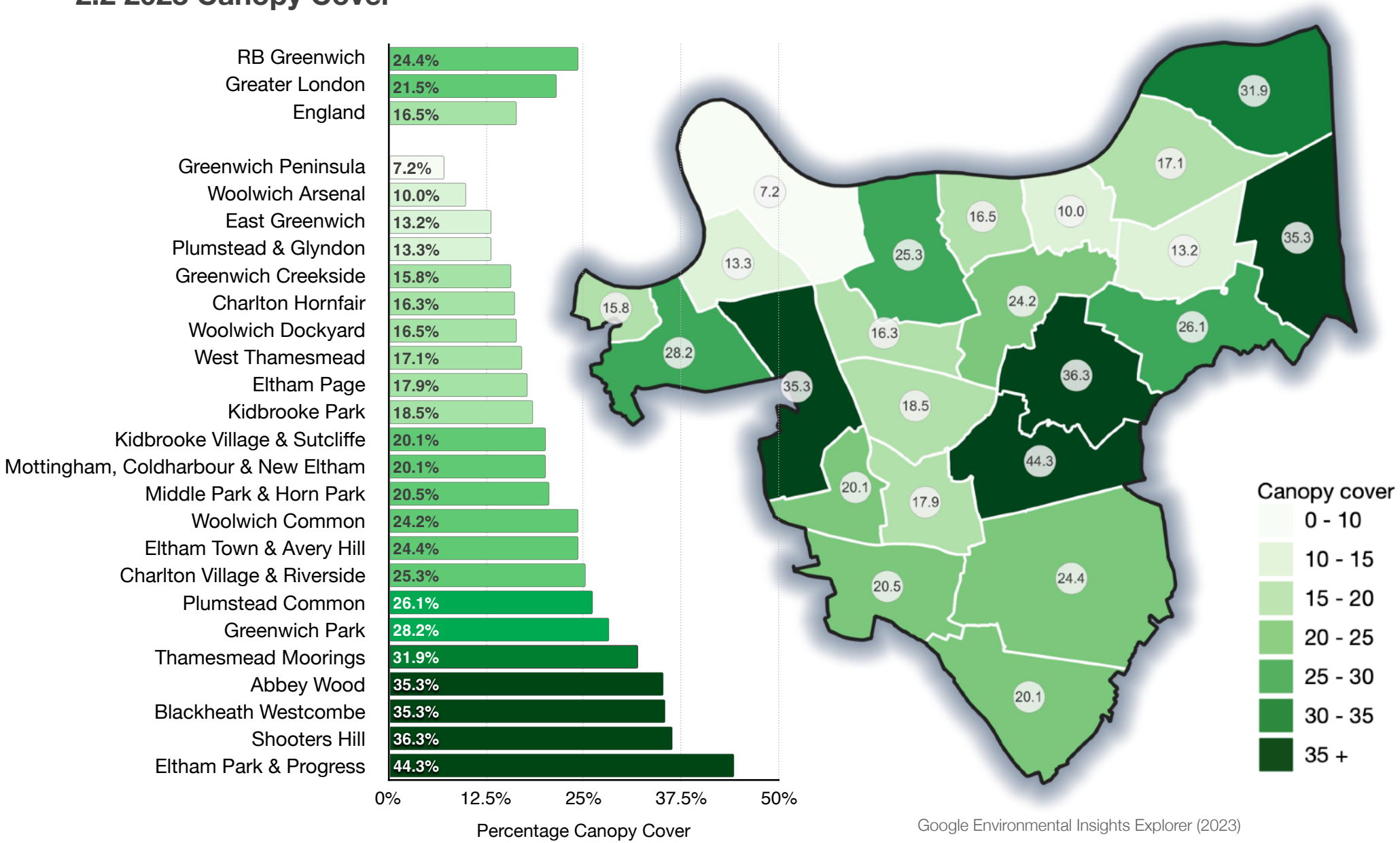


Figure 3: 2023 Canopy Cover By Ward (Google E I E)

Existing canopy cover across Greenwich ranges significantly across the wards and LSOA's. Though at ward level the range is from 7.2% to 44.3%, at LSOA level the range is far larger, from xx% to x%.

Interestingly the LSOA with the highest canopy cover is located in the ward with only the second highest average canopy cover (Abbey Wood). This LSOA skews the average for the entire ward, masking the fact that many of the other LSOA's in Abbey Wood actually have less than 15% canopy Cover.

The situation in Abbey Wood demonstrates the importance of tackling tree planting at neighbourhood level, specifically with street tree and private garden planting.

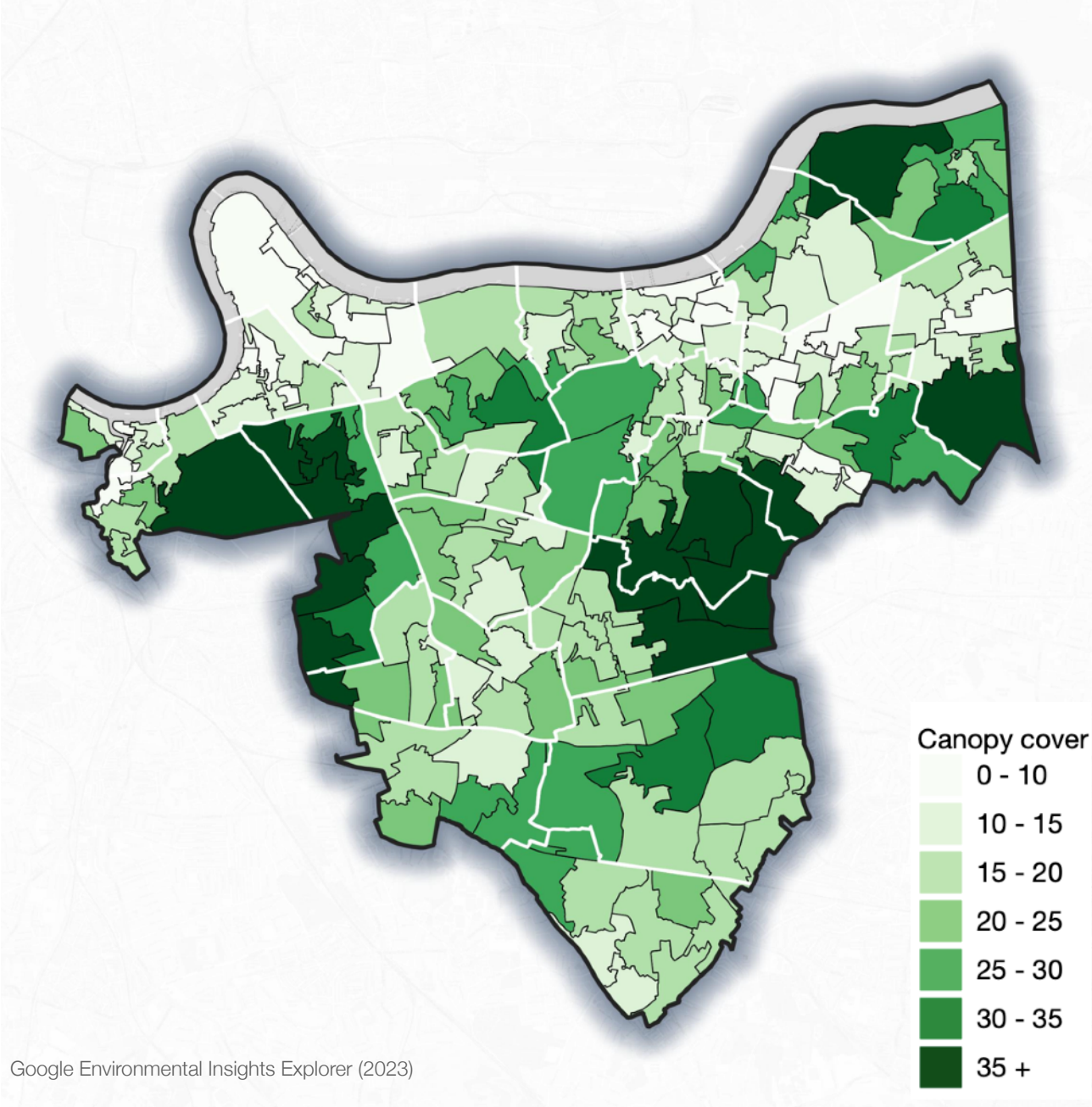


Figure 4: Map of 2023 canopy cover by LSOA

2.3 Tree Height

As figure 5 demonstrates, most of the trees in Greenwich are less than 20m tall. Some sit between 20-30m, but very few exceed 30m.

There are a number of reasons why trees in Greenwich may not be reaching the larger heights; species selection, planting regimes, urban pressures, felling regimes, etc.

Tree growth and life expectancy is often reduced in urban areas because of lack of space (both above and below ground), reduced access to water by hard surfaces, reduced light due to shading from buildings, compression of soils around tree bases, and occasionally high salt content of soils due to road salting in winter.

It is not unusual for trees within a street or neighbourhood to be of the same age and therefore size due to the time they were planted. To maintain a healthy population, it is important to spread planting in neighbourhoods over time, or plant different aged trees where appropriate to avoid a 'boom-and-bust' population.

Species selection may also impact tree height, as smaller species may be preferred so as to reduce impacts on surrounding infrastructure.

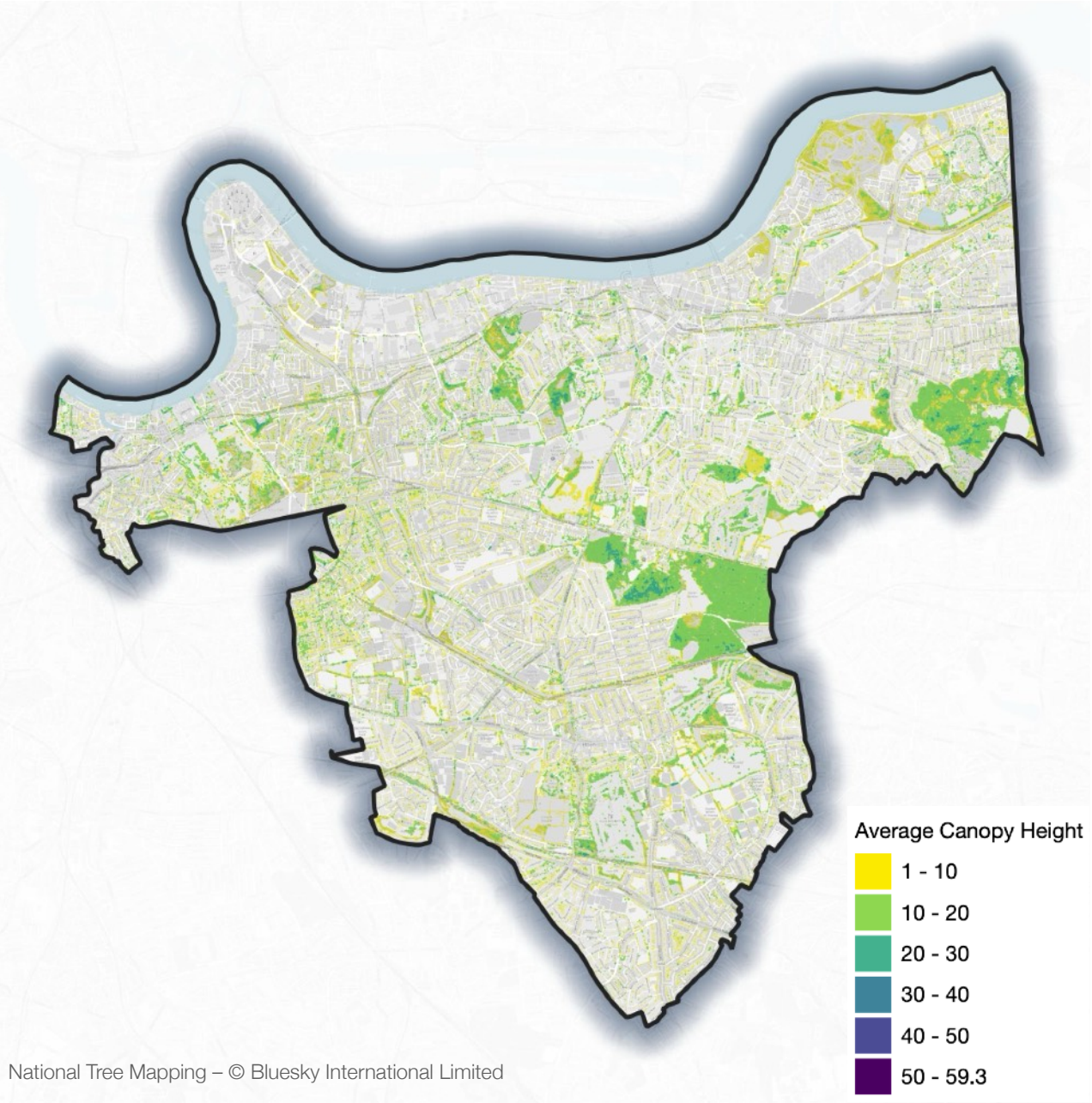


Figure 5: map of tree canopies ranked by tree heights

2.4 Changes in Canopy Cover

Just over half of wards appear to have seen a marked increase in canopy cover over the last seven years (figure 6). Overall, canopy cover in Greenwich has increased by around 4.5%,

Note that determining definitive changes in canopy cover is difficult due to the number of factors that impact leaf cover in individual trees over time. These include the weather on the day, in the immediately preceding week (drought vs rain/sun) and even the preceding winter (harsh/mild). Timing of data collection can also play a role given the different months of the year that different species add and drop leaves. In addition, there will be factors related to data collection technologies and calculation methodologies.

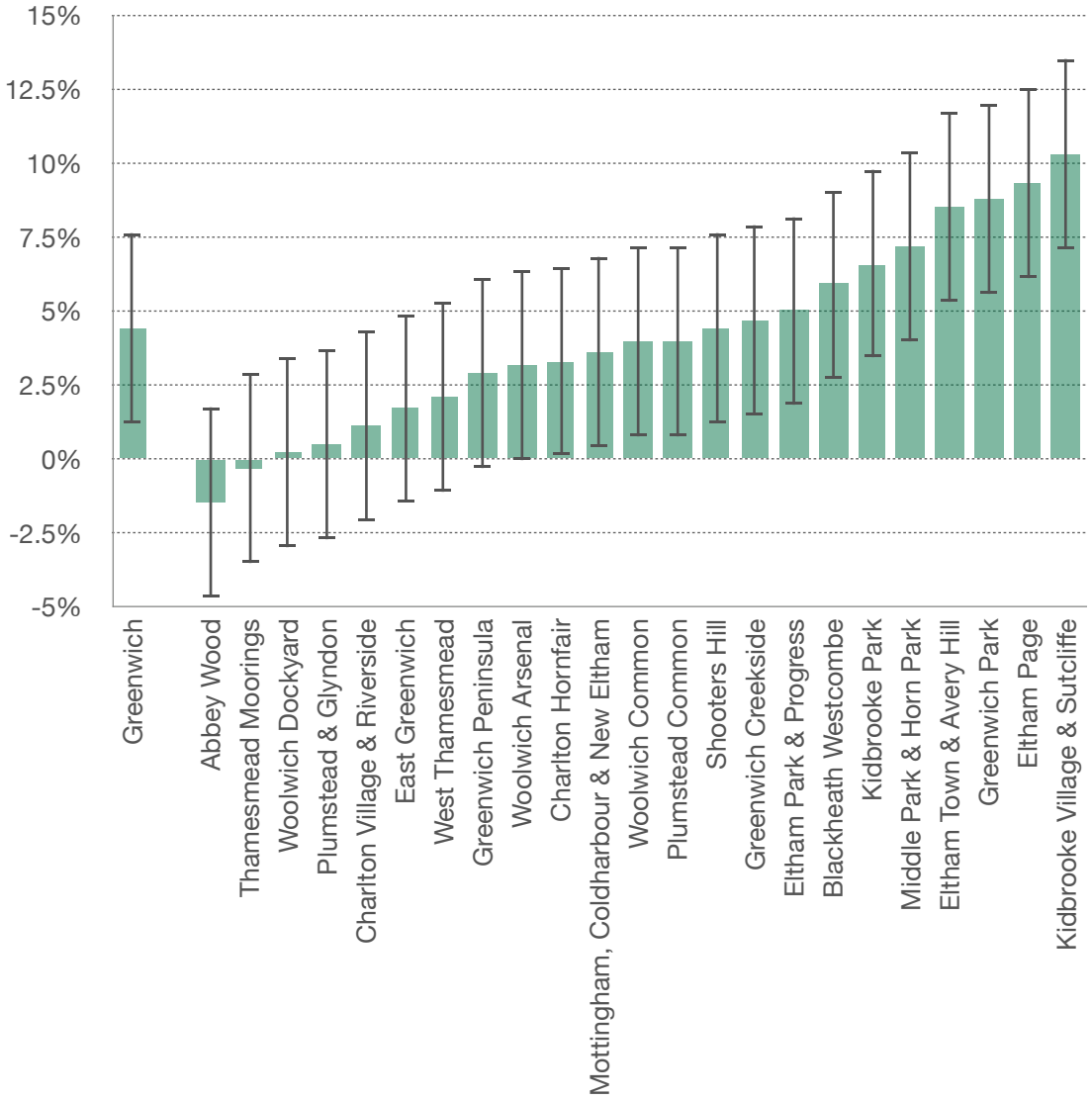


Figure 6: Indicative change in canopy by ward between 2016 and 2023
See box for explanation of error bars

Error bars - comparing different datasets

The error bars shown in Figure 6 help indicate the level of variation inherent in comparing tree canopy over time.

The chart shows the result of comparing two datasets collected at different times, using different technologies and then analysed under different methodologies

They represent the median error calculated across all wards for each dataset, using pixel size at ground level to establish an aggregated basic systematic error level that equates to +/-3.2% in measured tree canopy cover

3. Tree Equity

Tree equity can be understood as the extent to which there are enough trees in an area so that everyone can experience the health, climate and economic benefits.

For this study, areas with high tree equity are defined as those with good street tree canopy cover that also exhibit low risks to excess heat, air pollution, and flooding alongside a low score on the index of multiple deprivation.

Index Multiple Deprivation **Heat** **Air Pollution** **Flood Risk**

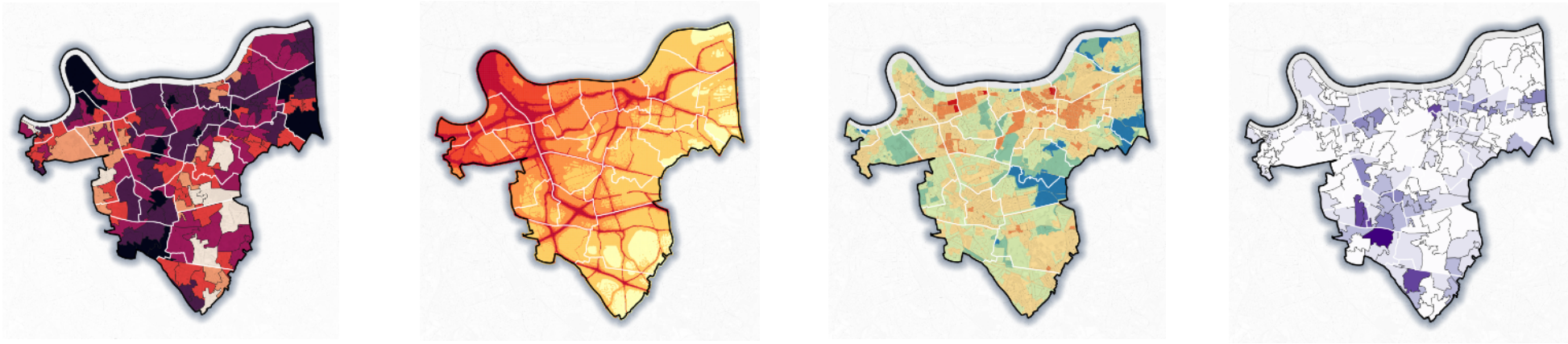


Figure 7: The Four Factors Used To Assess Tree Equity. In Each Case Darker Colours Represent Poorer Conditions

On a tree equity basis, the wards fall into four bands (figure 8), which can help guide prioritisation for tree planting.

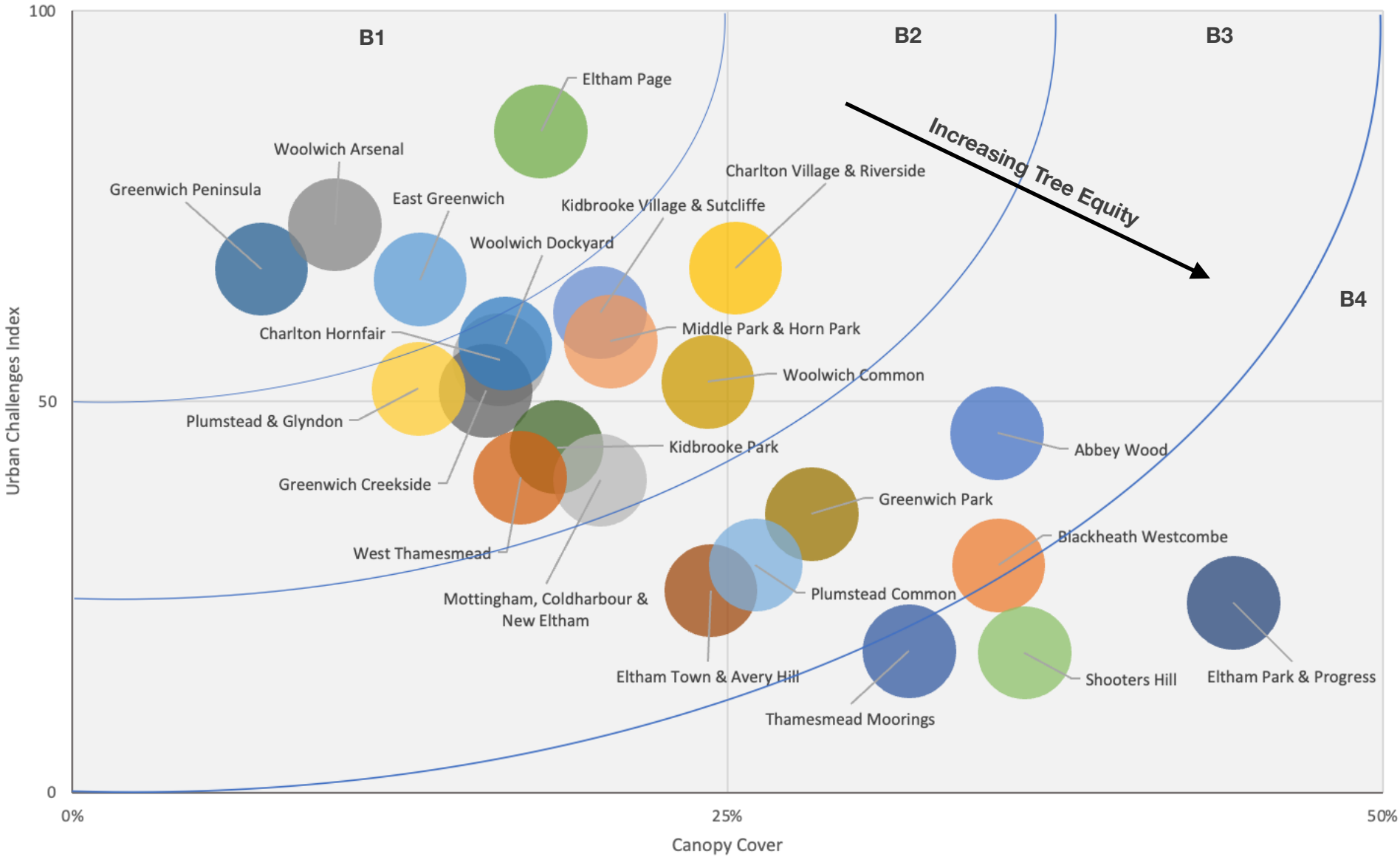
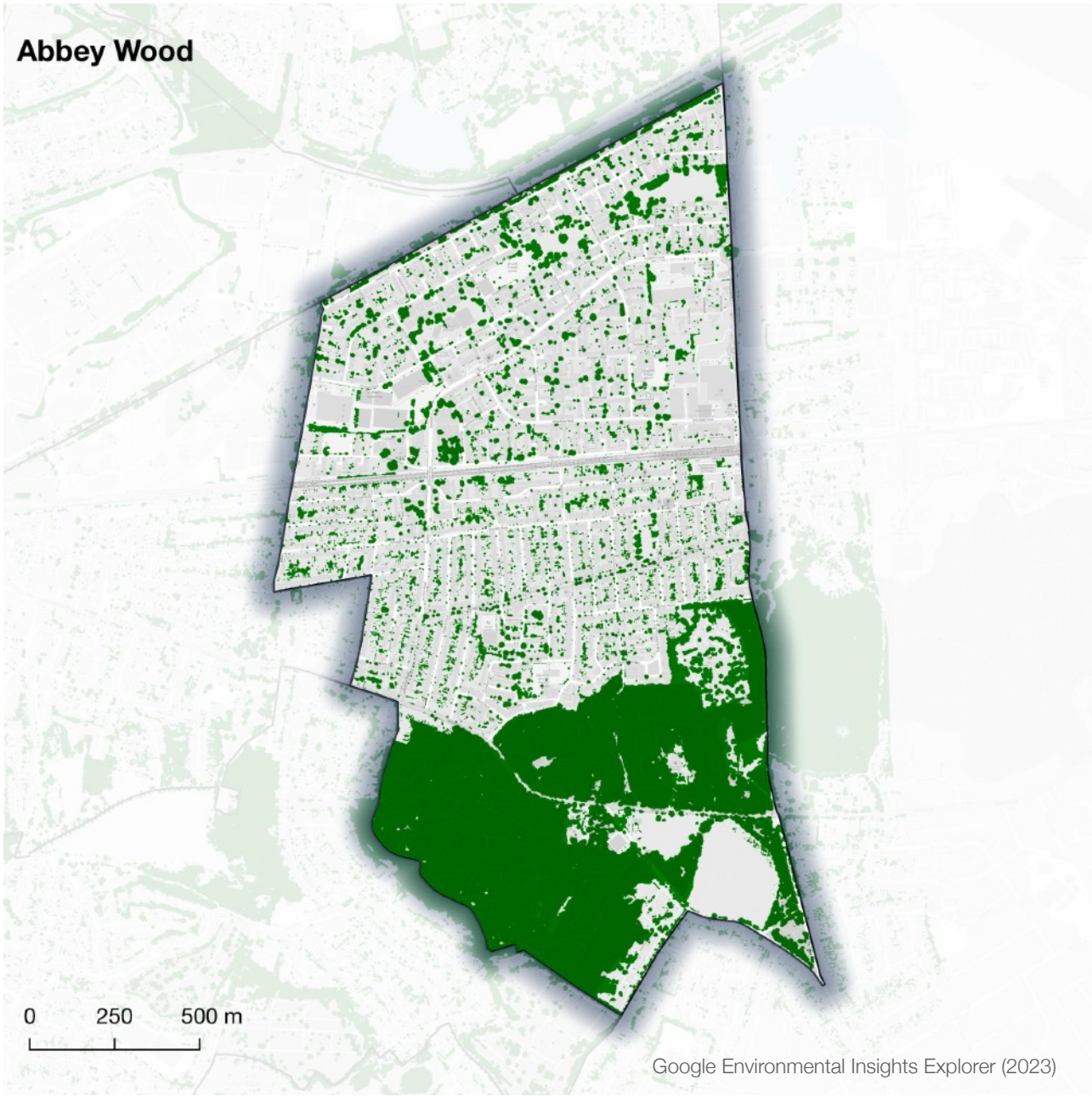


Figure 8: A Representation of tree equity across the wards of Greenwich
Urban challenges indexed (equally weighted between air pollution, flood risk, UHI, IMD) compared to canopy cover
NB. Different colours used simply to aid distinguishing between wards

3.5 Ward Canopy Cover Maps

Abbey Wood

2016 Canopy Cover	**36.8%**
2023 Canopy Cover	**35.3%**
Growth	**- 1.5%**
Tree Equity Band[8]	**B3**

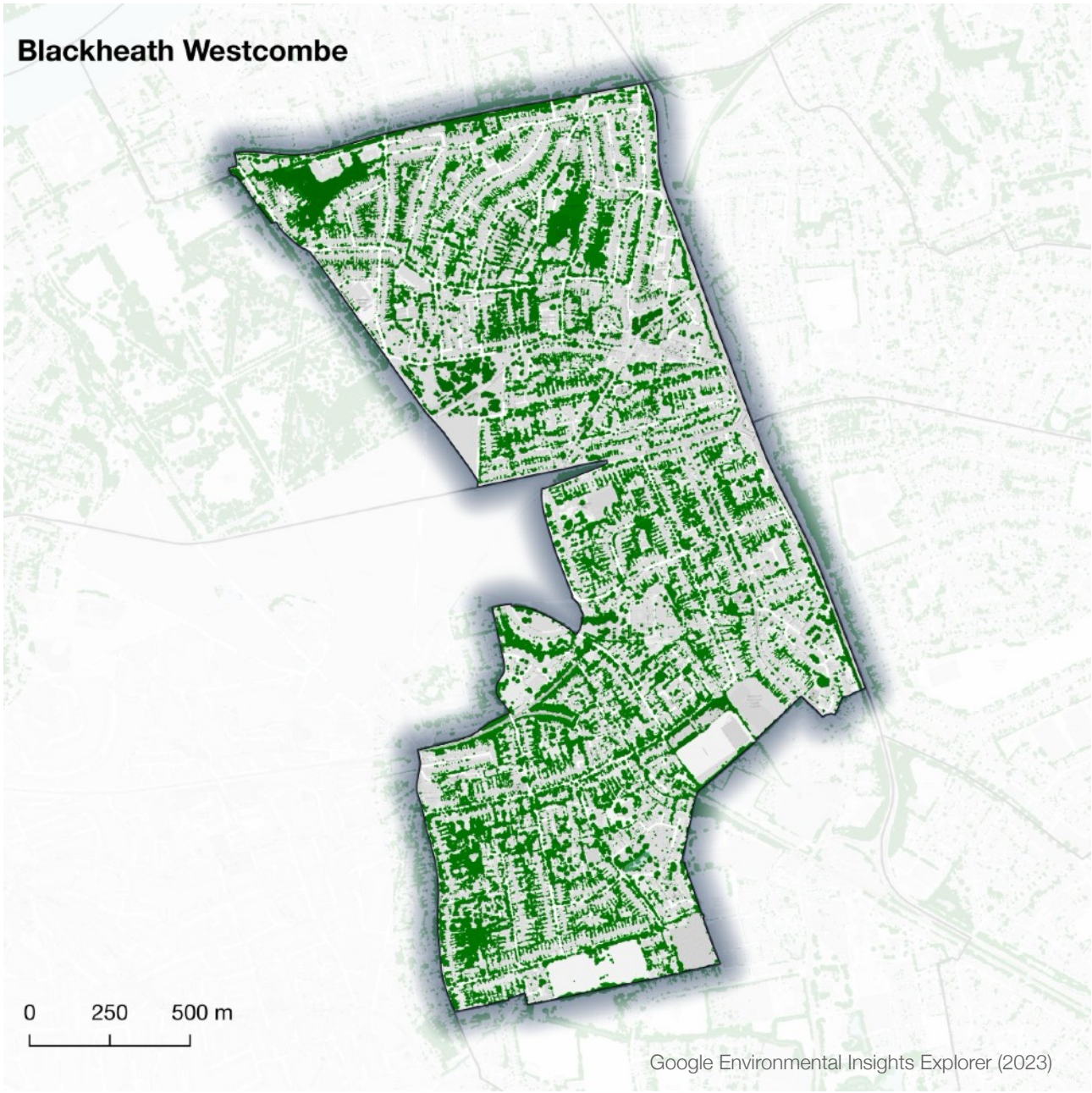


Google Environmental Insights Explorer (2023)

[8] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Blackheath Westcombe

2016 Canopy Cover	**29.4%**
2023 Canopy Cover	**35.3%**
Growth	**5.9%**
Tree Equity Band[9]	**B3**

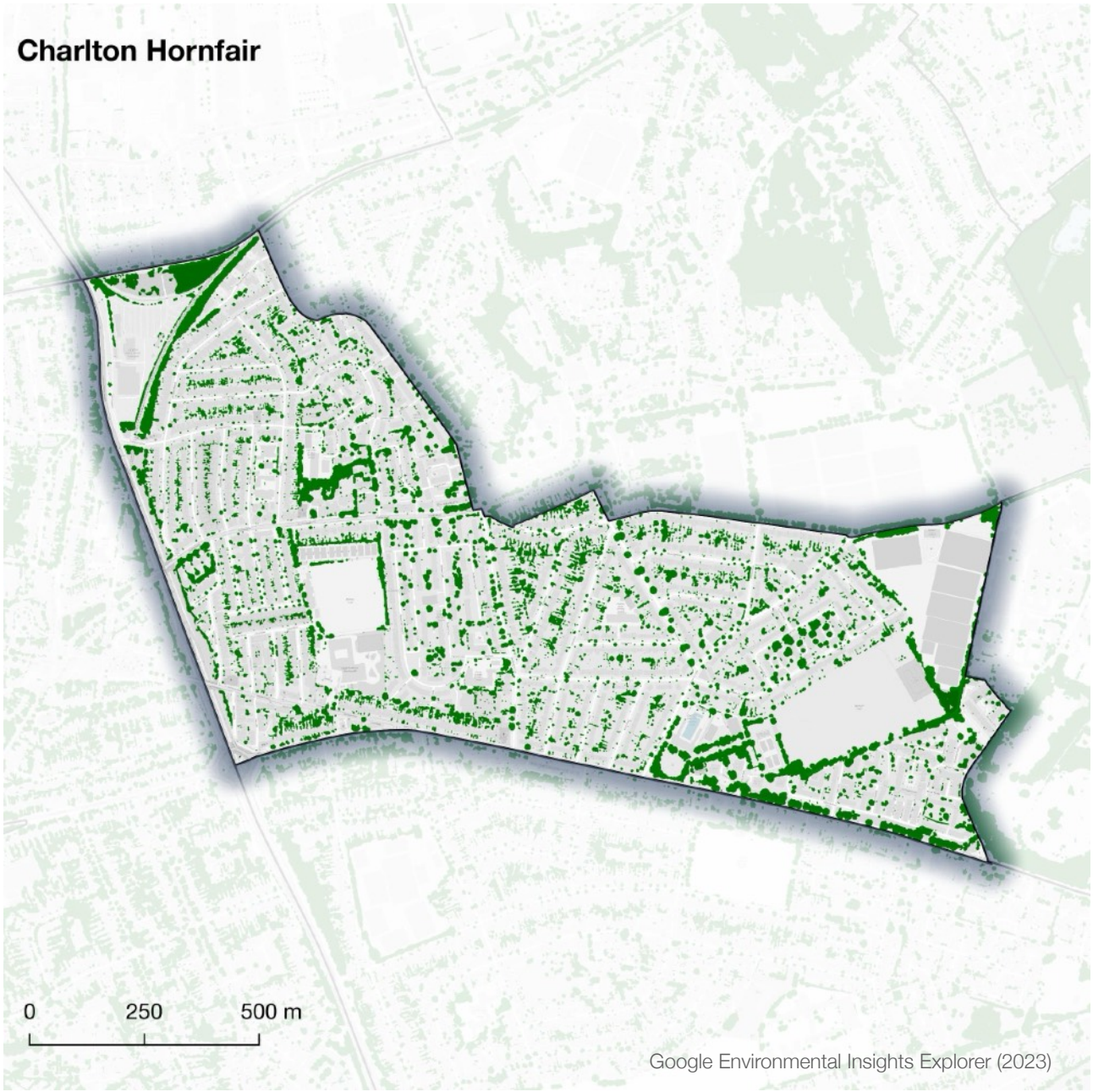


Google Environmental Insights Explorer (2023)

[9] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Charlton Hornfair

2016 Canopy Cover	**13.0%**
2023 Canopy Cover	**16.3%**
Growth	**3.3%**
Tree Equity Band[10]	**B2**

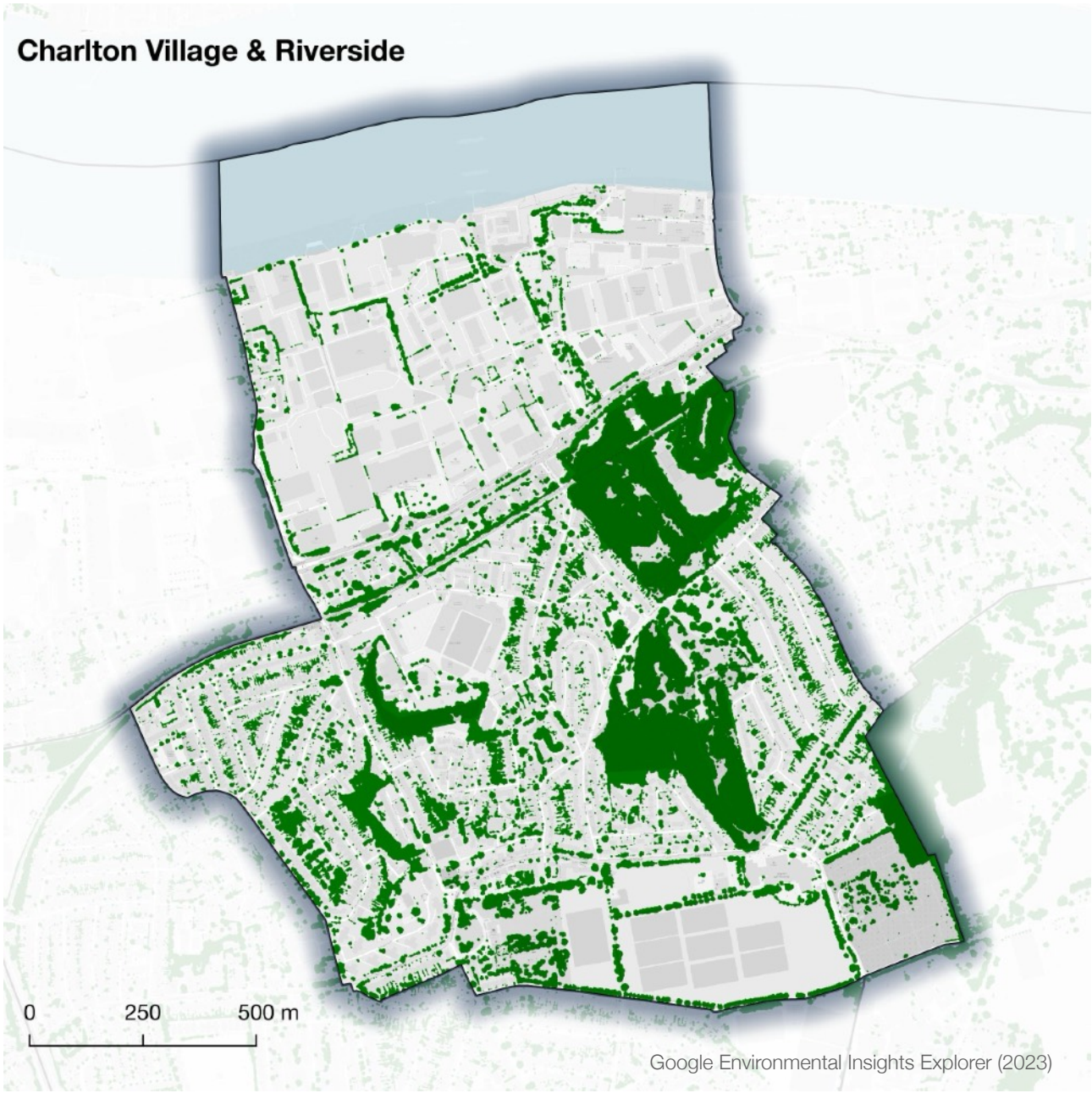


Google Environmental Insights Explorer (2023)

[10] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Charlton Village & Riverside

2016 Canopy Cover	**24.2%**
2023 Canopy Cover	**25.3%**
Growth	**1.1%**
Tree Equity Band[11]	**B2**

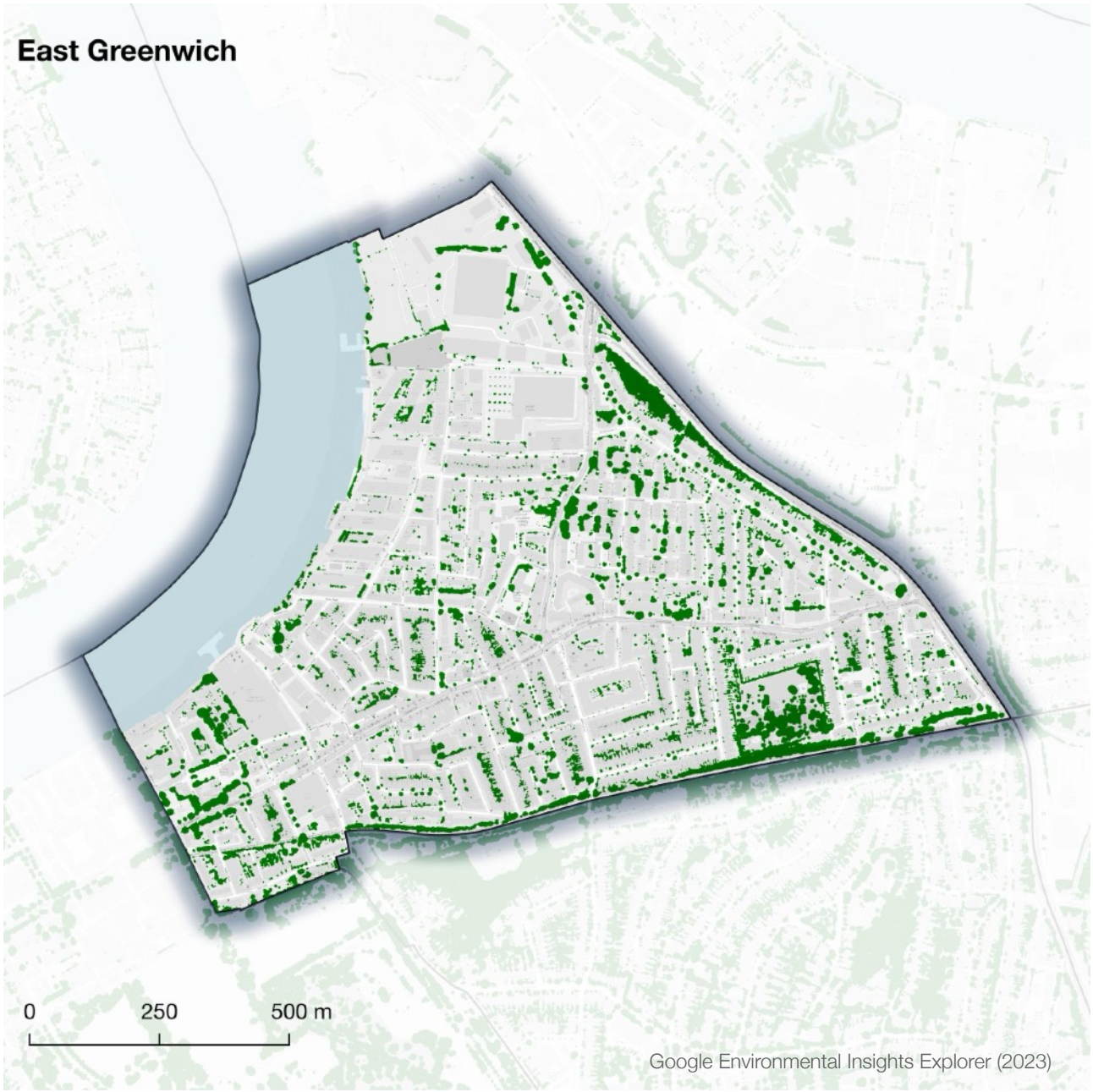


Google Environmental Insights Explorer (2023)

[11] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

East Greenwich

2016 Canopy Cover	**11.5%**
2023 Canopy Cover	**3.3%**
Growth	**1.7%**
Tree Equity Band[12]	**B1**



Google Environmental Insights Explorer (2023)

[12] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Eltham Page

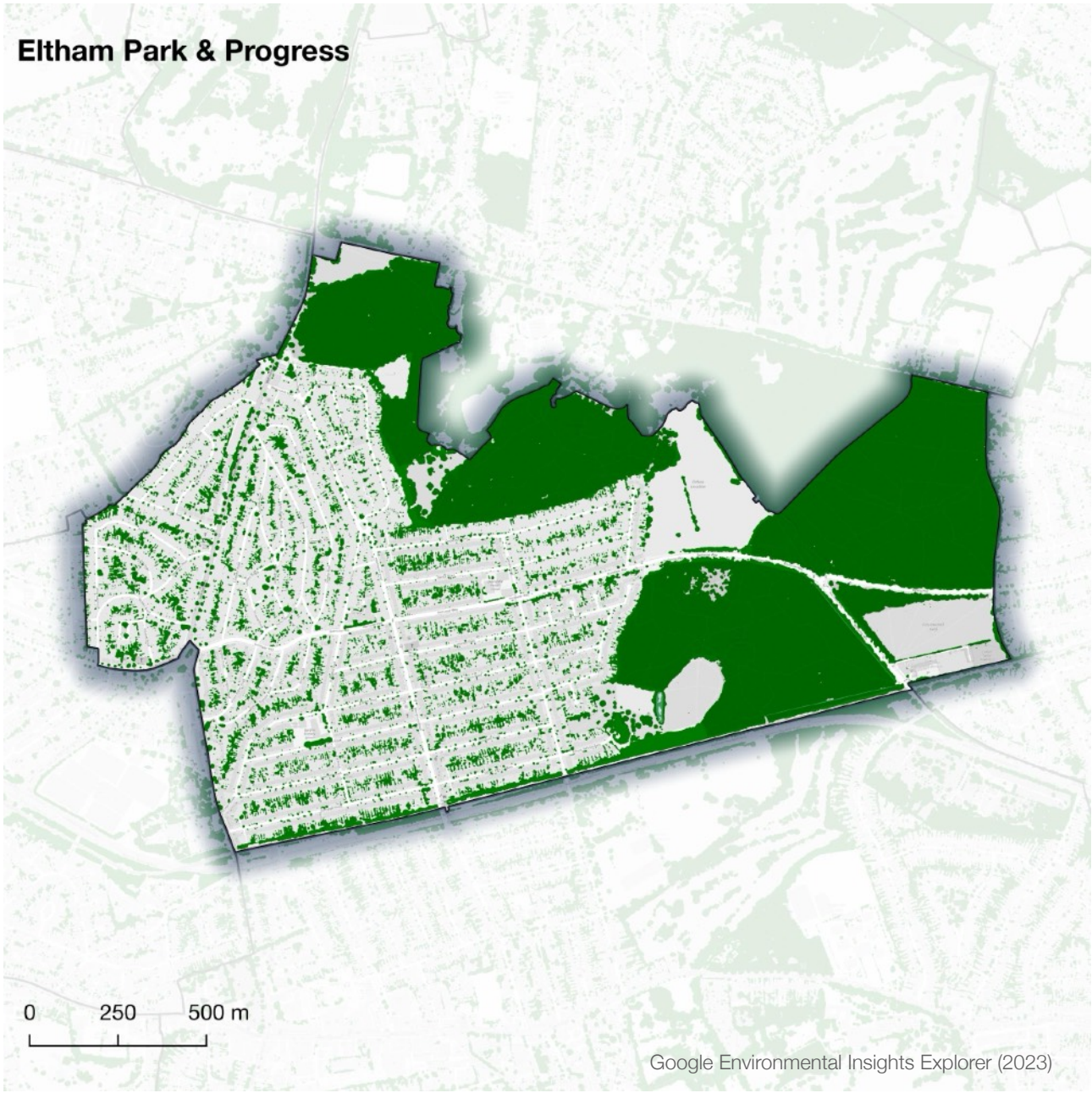
2016 Canopy Cover	8.6%
2023 Canopy Cover	17.9%
Growth	**9.3%**
Tree Equity Band[13]	**B1**

Google Environmental Insights Explorer (2023)

[13] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Eltham Park & Progress

2016 Canopy Cover	**39.3%**
2023 Canopy Cover	**44.3%**
Growth	**5.0%**
Tree Equity Band[14]	**B4**

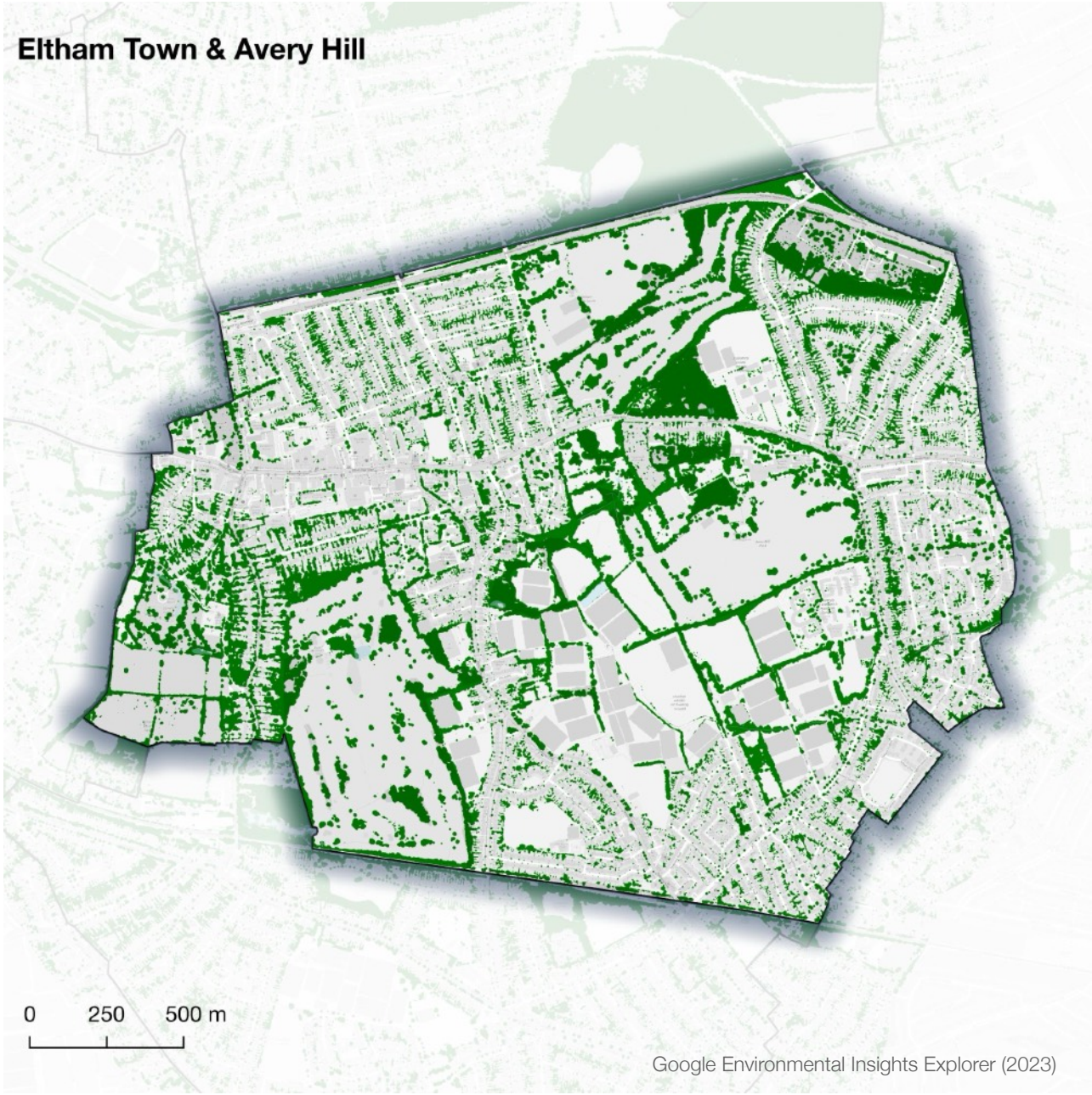


Google Environmental Insights Explorer (2023)

[14] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Eltham Town & Avery Hill

2016 Canopy Cover	**15.9%**
2023 Canopy Cover	**24.4%**
Growth	**8.5%**
Tree Equity Band[15]	**B3**

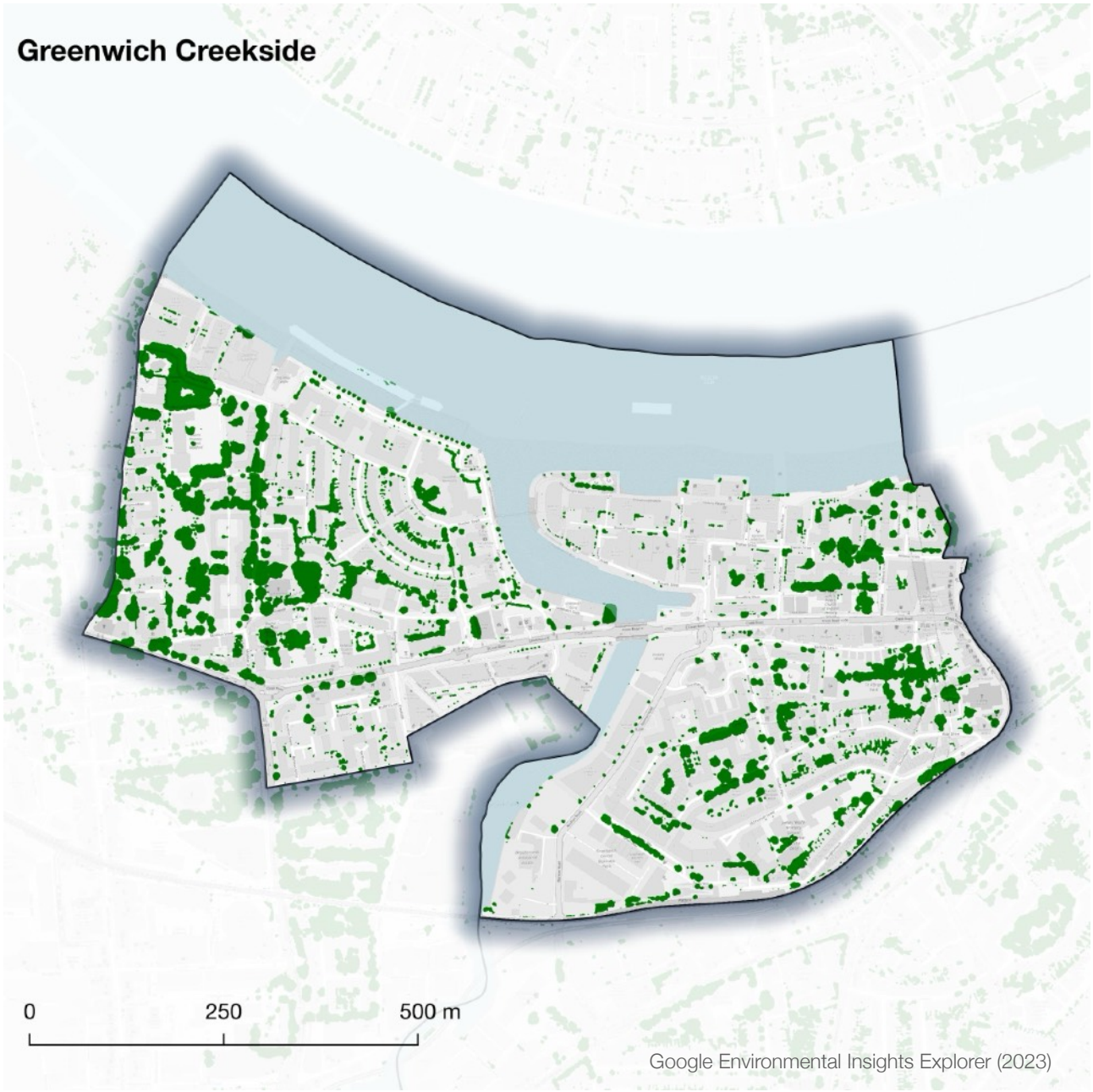


Google Environmental Insights Explorer (2023)

[15] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Greenwich Creekside

2016 Canopy Cover	1**1.1%**
2023 Canopy Cover	**15.8%**
Growth	**4.7%**
Tree Equity Band[16]	**B2**



Google Environmental Insights Explorer (2023)

[16] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Greenwich Park

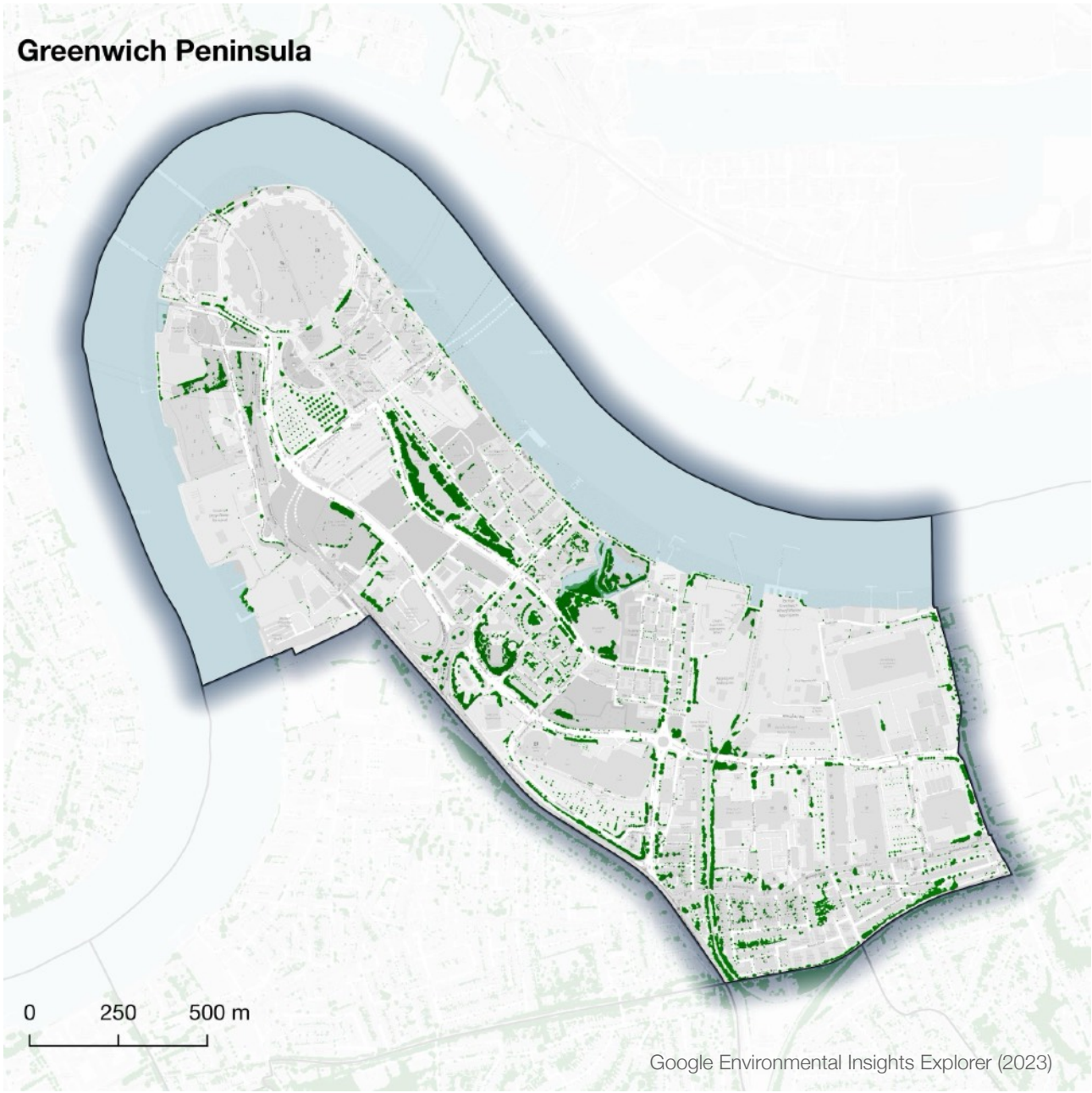
2016 Canopy Cover	**19.4%**
2023 Canopy Cover	**28.2%**
Growth	**8.8%**
Tree Equity Band[17]	**B3**

Google Environmental Insights Explorer (2023)

[17] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Greenwich Peninsula

2016 Canopy Cover	**4.3%**
2023 Canopy Cover	**7.2%**
Growth	**2.9%**
Tree Equity Band[18]	**B1**



Google Environmental Insights Explorer (2023)

[18] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Kidbrooke Park

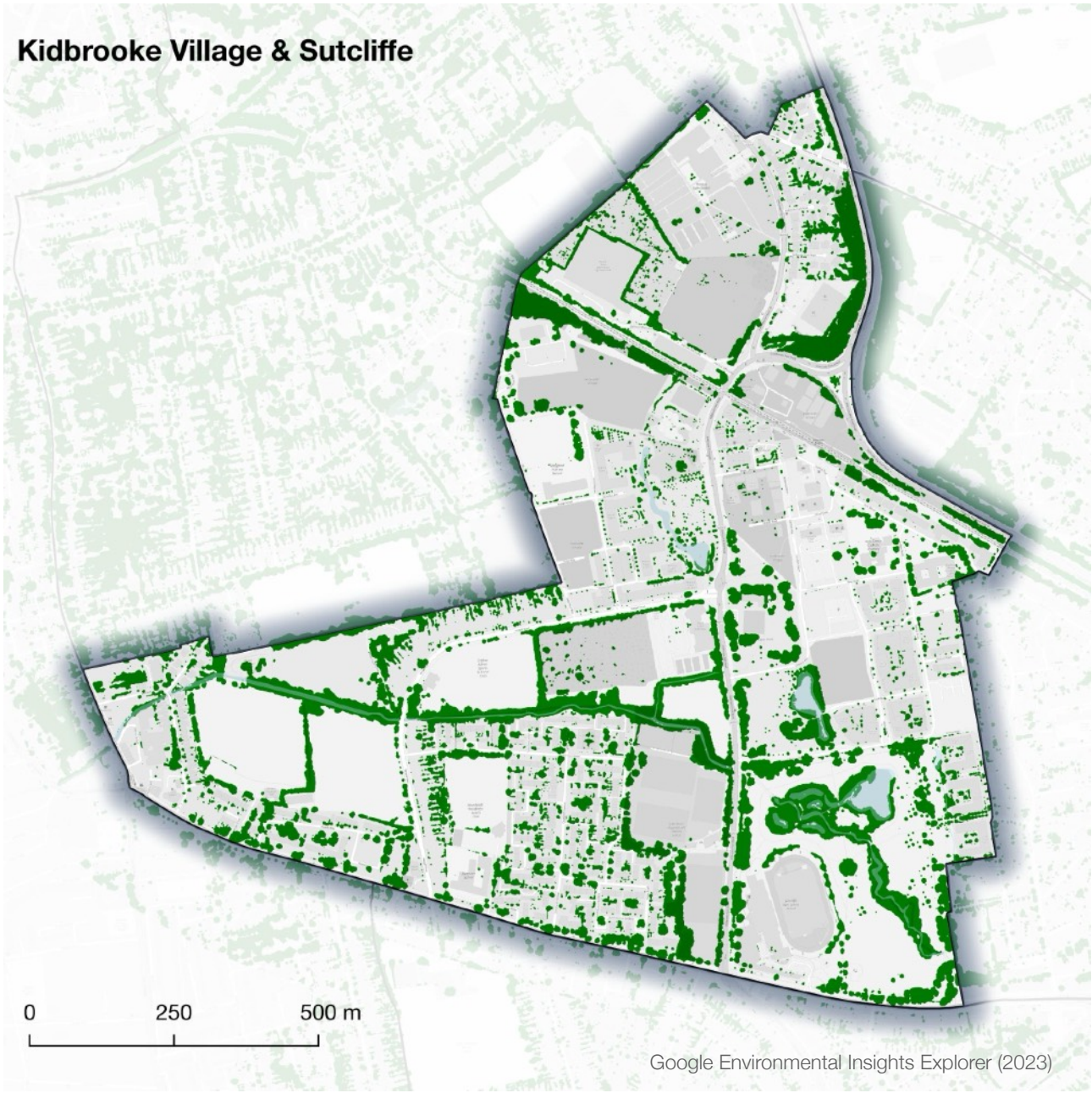
2016 Canopy Cover	**11.8%**
2023 Canopy Cover	**8.5%**
Growth	**6.6%**
Tree Equity Band[19]	**B2**

Google Environmental Insights Explorer (2023)

[19] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Kidbrooke Village & Sutcliffe

2016 Canopy Cover	**9.8%**
2023 Canopy Cover	**20.1%**
Growth	**10.3%**
Tree Equity Band[20]	**B2**



Google Environmental Insights Explorer (2023)

[20] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Middle Park & Horn Park

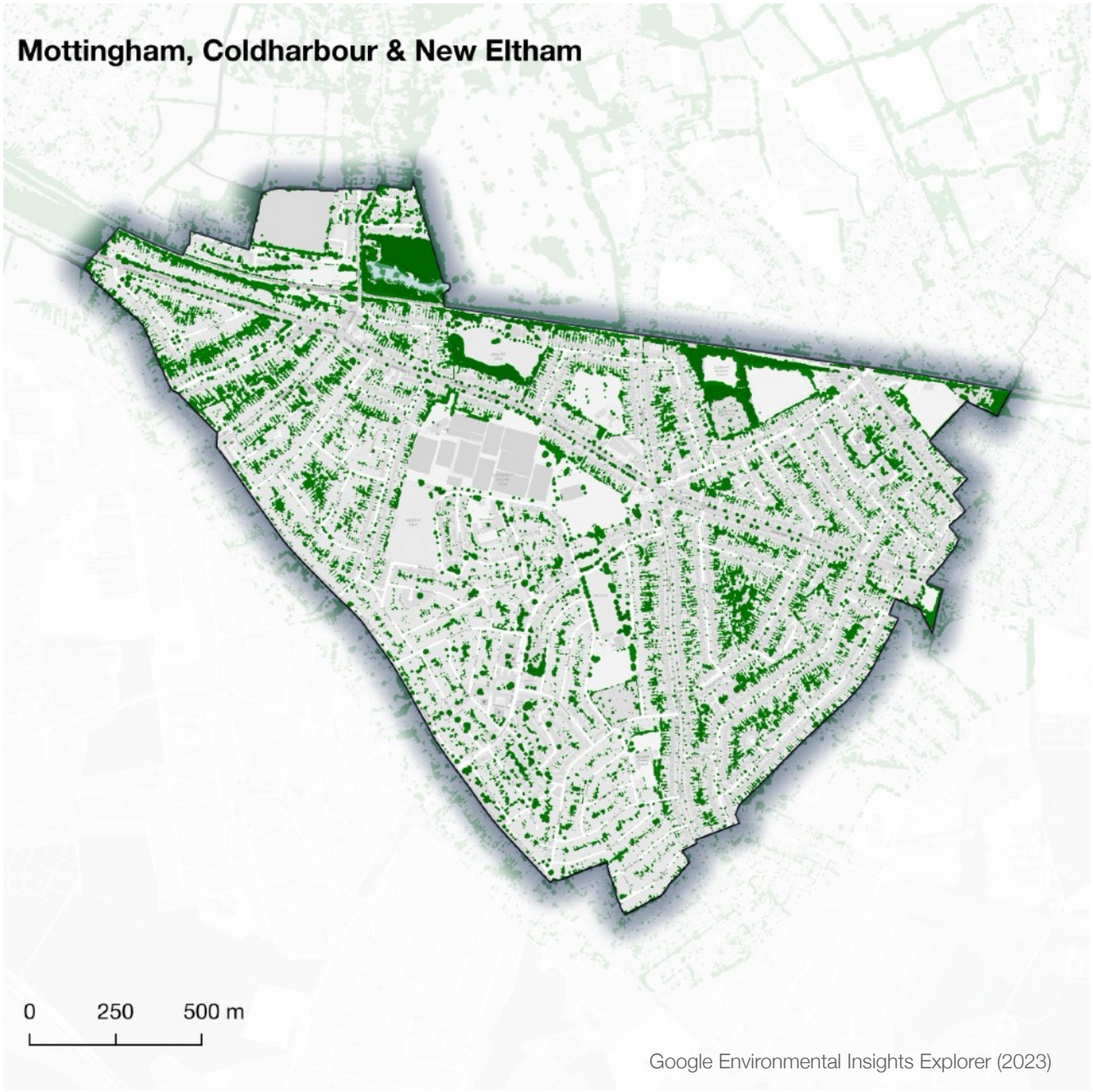
2016 Canopy Cover	**13.4%**
2023 Canopy Cover	**20.5%**
Growth	**7.2%**
Tree Equity Band[21]	**B2**

Google Environmental Insights Explorer (2023)

[21] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Mottingham, Coldharbour & New Eltham

2016 Canopy Cover	**16.5%**
2023 Canopy Cover	2**0.1%**
Growth	**3.6%**
Tree Equity Band[22]	**B2**

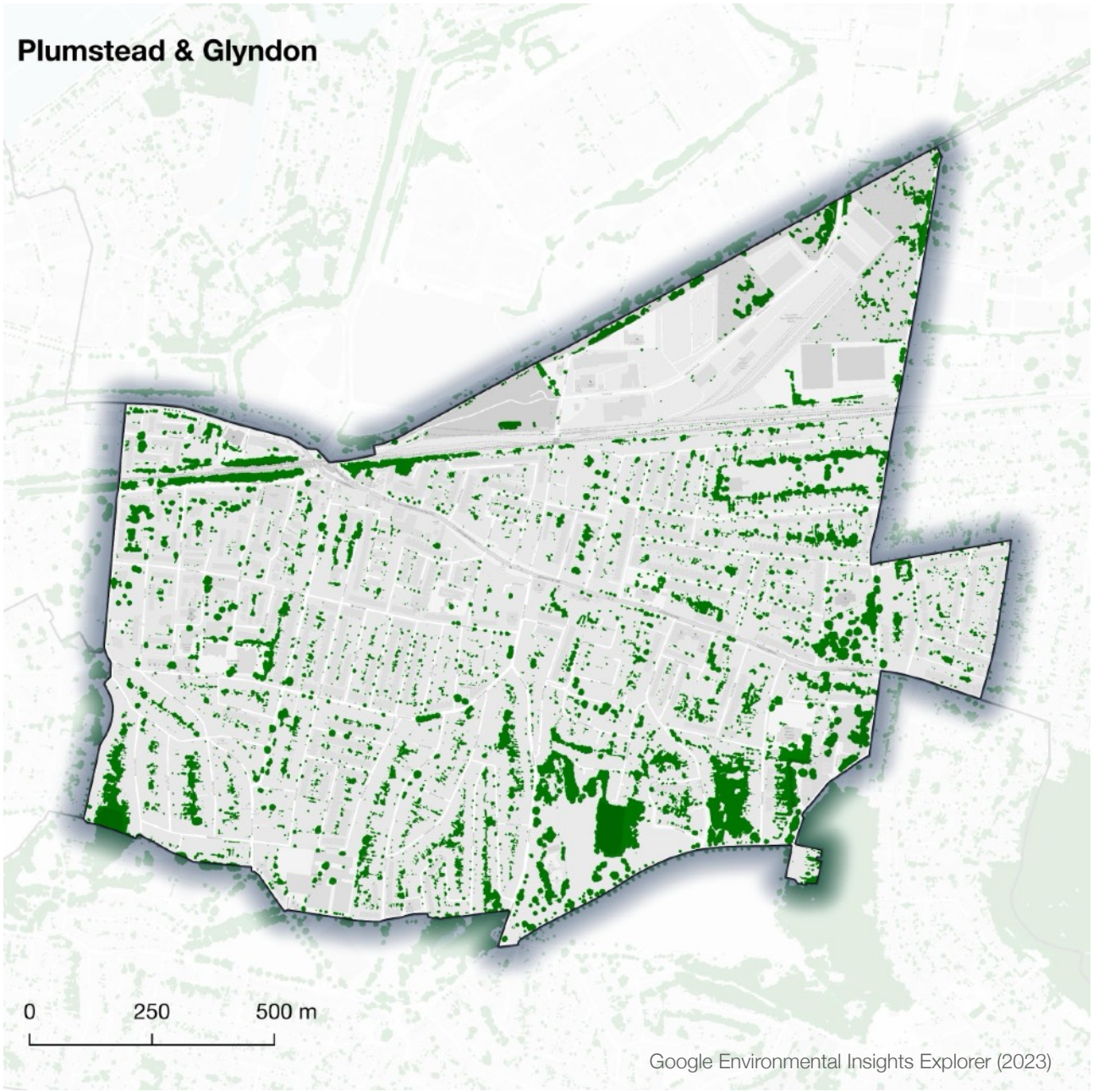


Google Environmental Insights Explorer (2023)

[22] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Plumstead & Glyndon

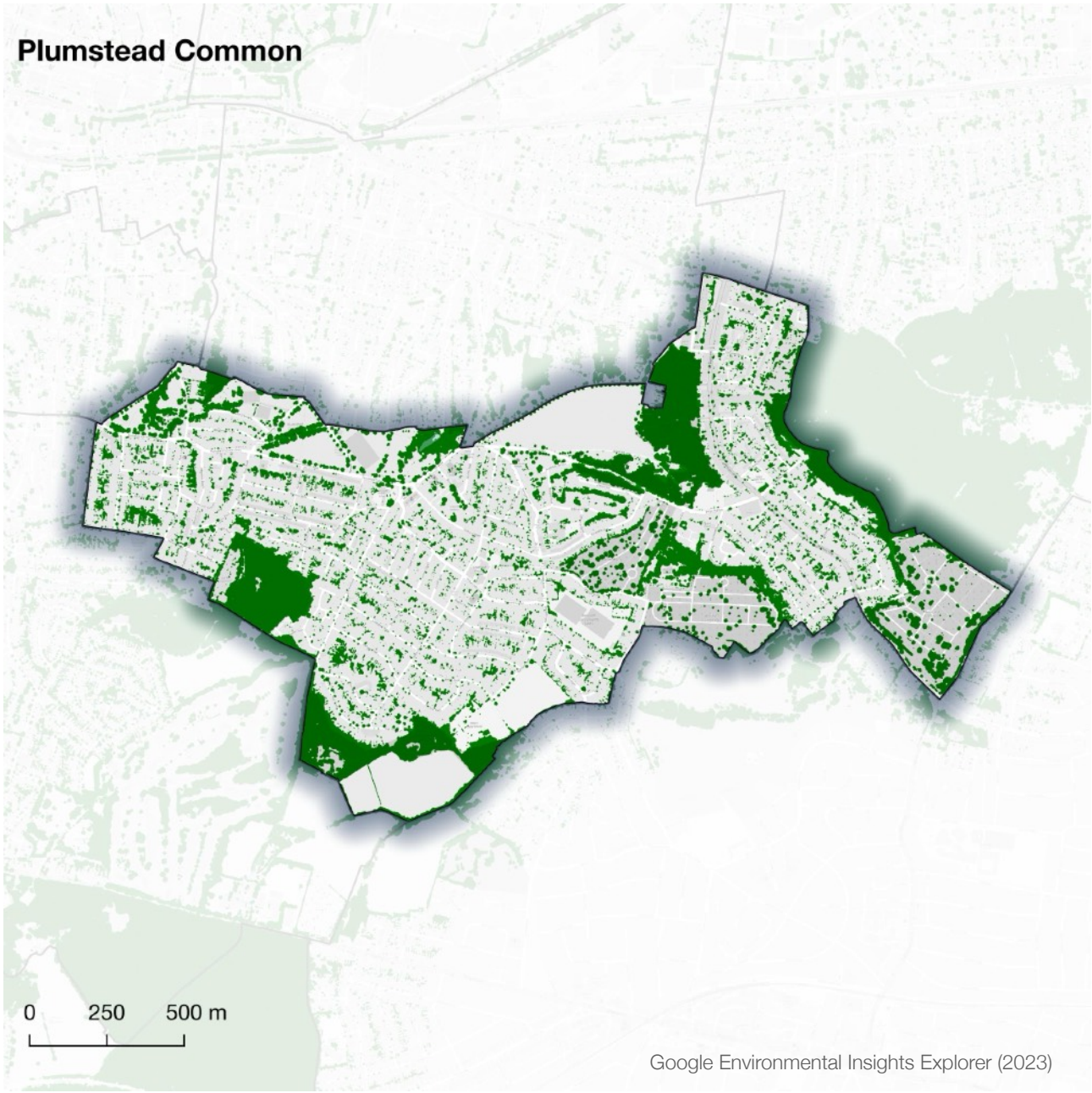
2016 Canopy Cover	**12.7%**
2023 Canopy Cover	**13.2%**
Growth	**0.5%**
Tree Equity Band[23]	**B3**



[23] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Plumstead Common

2016 Canopy Cover	**22.0%**
2023 Canopy Cover	**26.1%**
Growth	**4.0%**
Tree Equity Band[24]	**B3**

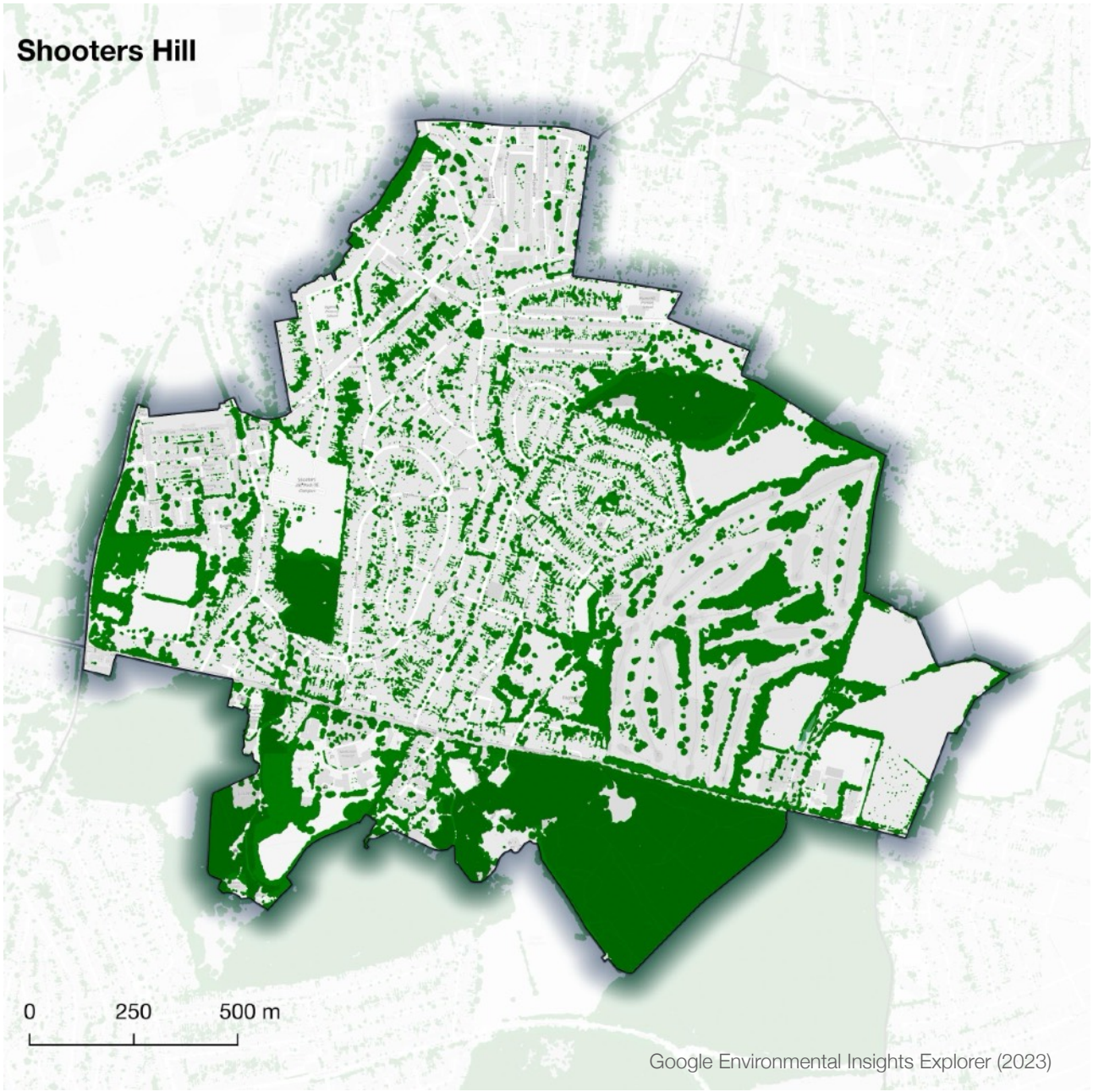


Google Environmental Insights Explorer (2023)

[24] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Shooters Hill

2016 Canopy Cover	**31.9%**
2023 Canopy Cover	**36.3%**
Growth	**4.4%**
Tree Equity Band[25]	**B4**

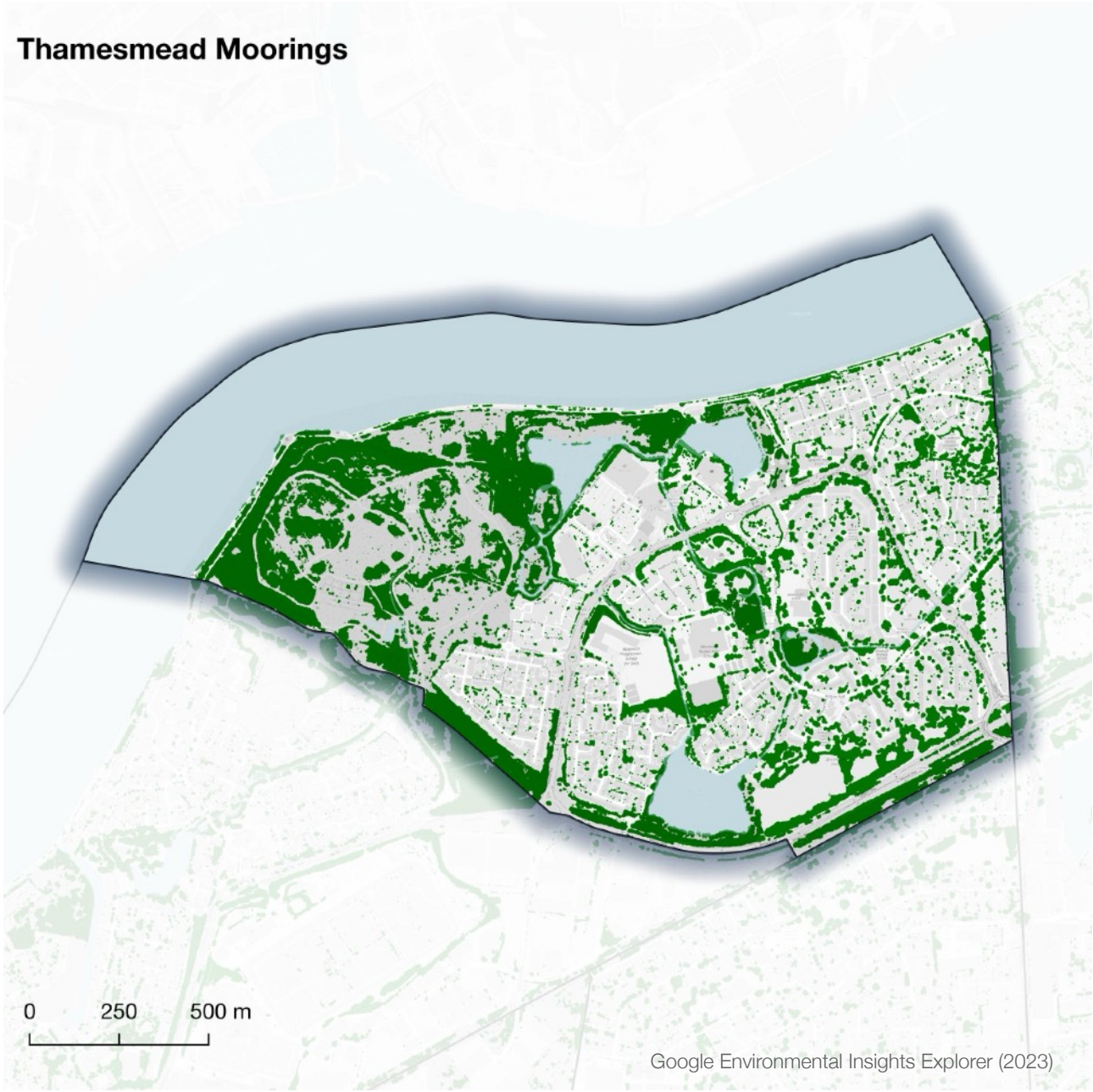


Google Environmental Insights Explorer (2023)

[25] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Thamesmead Moorings

2016 Canopy Cover	**32.3%**
2023 Canopy Cover	**31.9%**
Growth	**- 0.3%**
Tree Equity Band[26]	**B4**

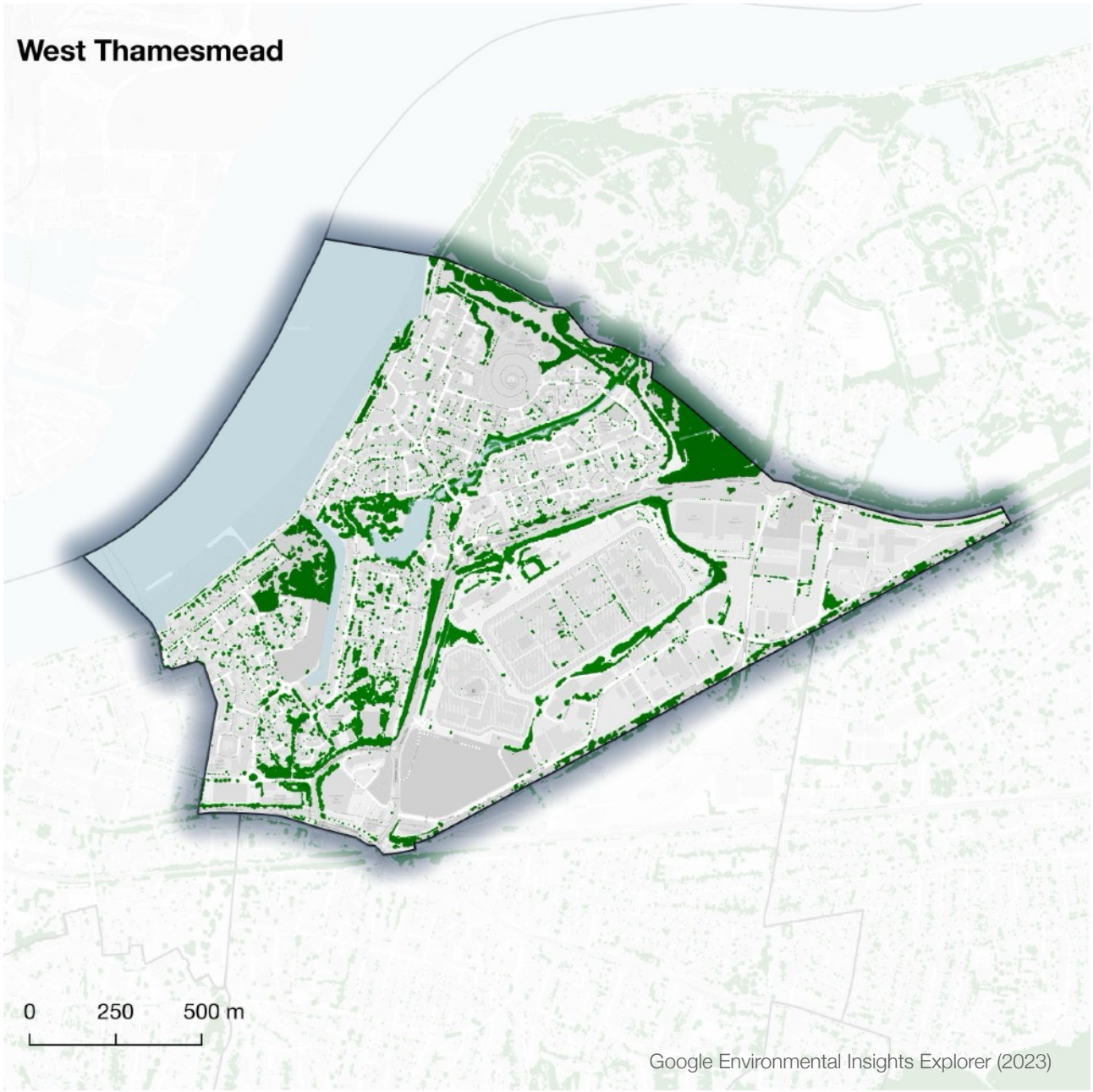


Google Environmental Insights Explorer (2023)

[26] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

West Thamesmead

2016 Canopy Cover	**15.0%**
2023 Canopy Cover	**17.1%**
Growth	**2.1%**
Tree Equity Band[27]	**B2**



Google Environmental Insights Explorer (2023)

[27] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Woolwich Arsenal

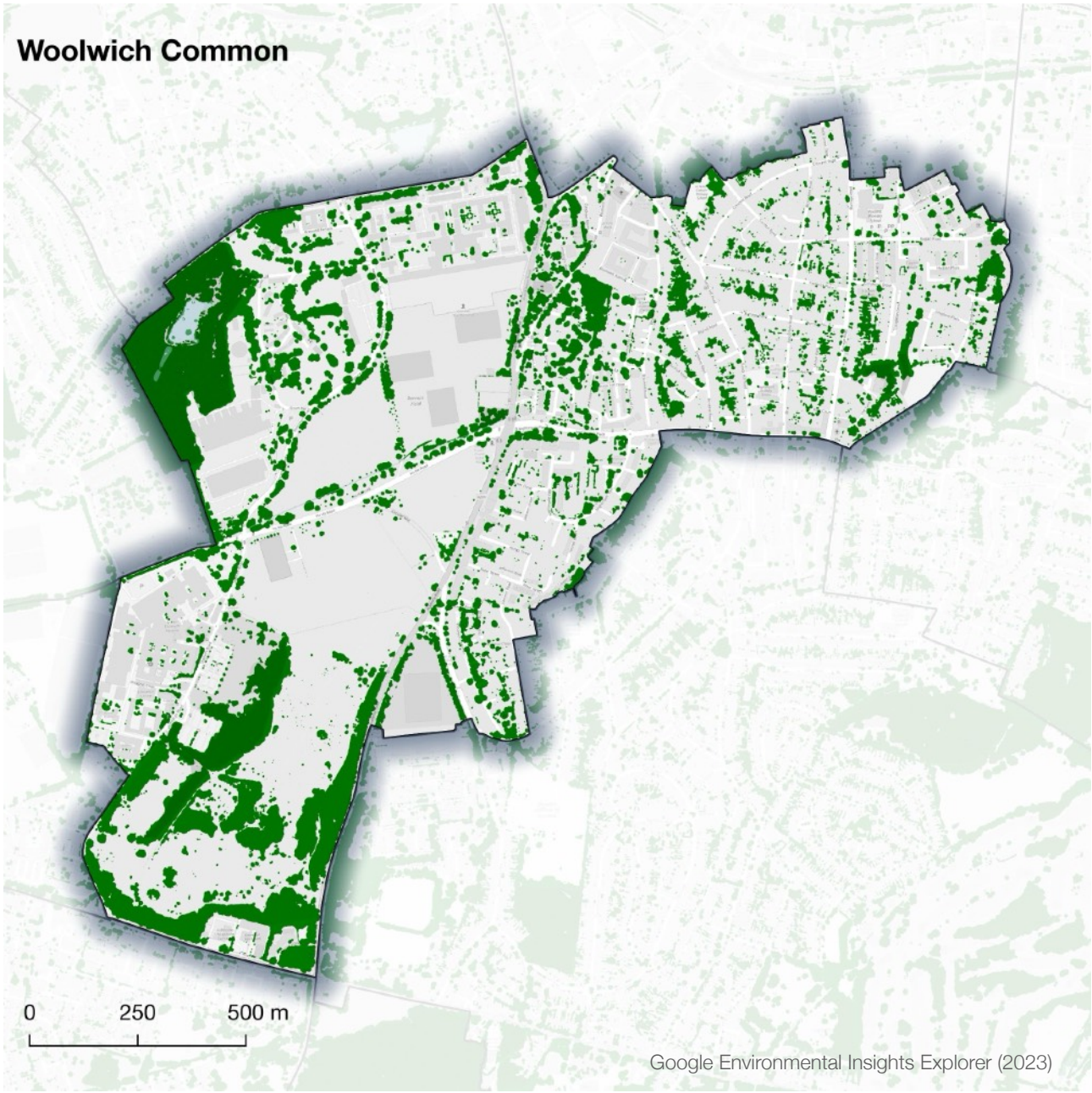
2016 Canopy Cover	**6.8%**
2023 Canopy Cover	**10.0%**
Growth	**3.2%**
Tree Equity Band[28]	**B1**

Google Environmental Insights Explorer (2023)

[28] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Woolwich Common

2016 Canopy Cover	**20.3%**
2023 Canopy Cover	**24.2%**
Growth	**3.9%**
Tree Equity Band[29]	**B2**

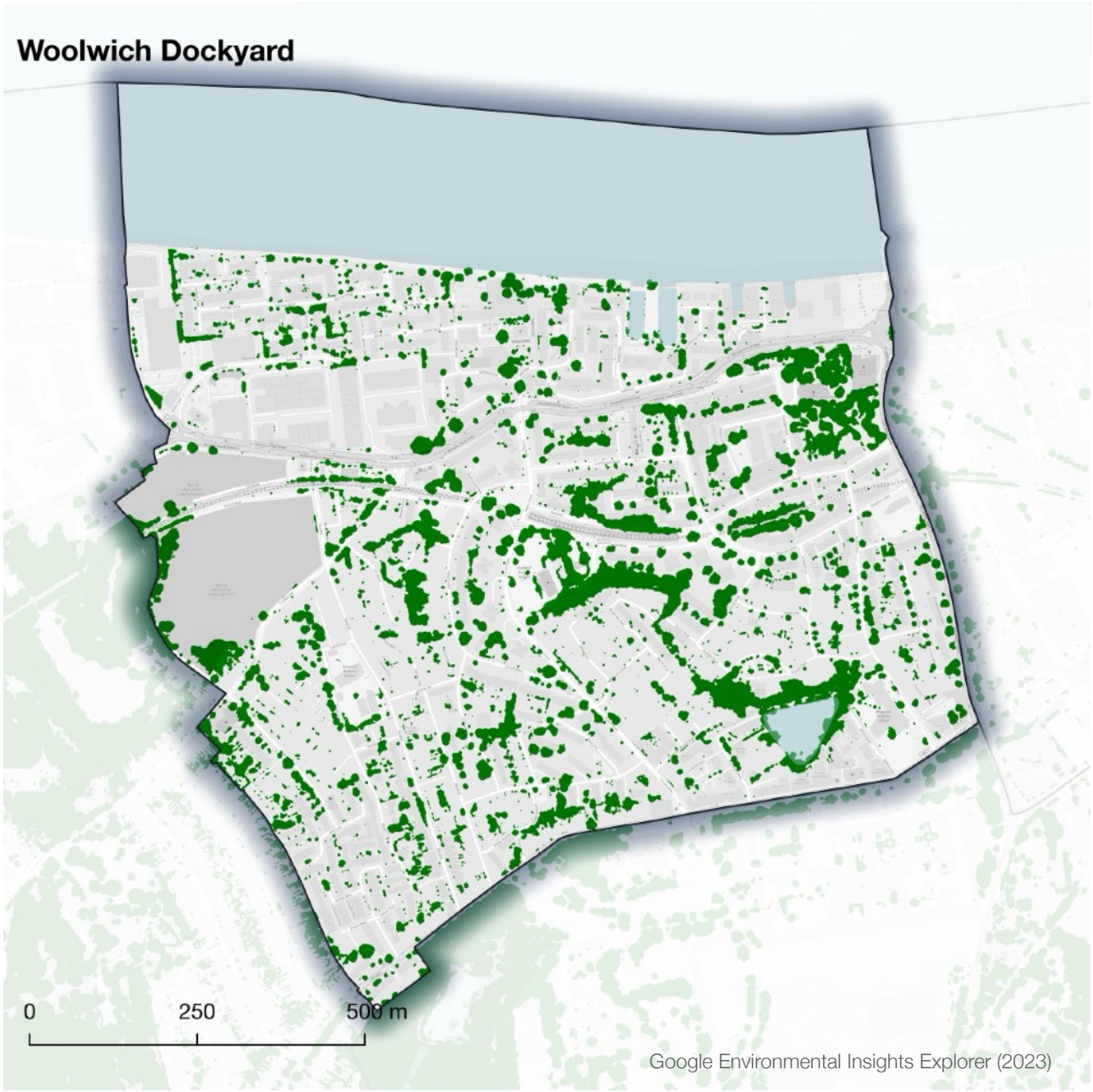


Google Environmental Insights Explorer (2023)

[29] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

Woolwich Dockyard

2016 Canopy Cover	**16.4%**
2023 Canopy Cover	**16.5%**
Growth	**0.1%**
Tree Equity Band[30]	**B2**



[30] Based on Tree Equity Assessment (Figure 8) where B1 is least equitable and B4 is most equitable

4. Ecosystem Service Delivery

Trees in cities bring with them both benefits and costs. Whilst many of the costs are well known, the benefits can be more difficult to quantify. Nevertheless, a considerable and expanding body of research exists on the benefits that urban trees provide to those who live and work in our cities, to green infrastructure, and to the wider urban ecosystem.

Tree benefits can be separated into ecological benefits and societal benefits; ecosystem services fall into the former category. Though not all ecosystem services are fully understood or measurable, the i-Tree Canopy tool* can provide valuations for carbon storage and sequestration, pollution removal, and avoided rainwater runoff. Air quality, flooding and drainage, and rising temperatures greatly impact the urban environment, and can be costly to manage, however increasing the urban canopy can greatly reduce the impact and cost of these issues.

These ecosystem services are of particular relevance to Greenwich, given its location on the banks of the River Thames, in the centre of London where there is a significant amount of hard surfaces, more traffic than most areas in the UK, and a high population density. These factors mean that the residents of Greenwich are more likely to be disproportionately affected by climate change than others across the UK, and natural protections from these threats will help considerably going forward.

Understanding and valuing these services allows us to make more informed planting and management decisions. It also provides a platform from which to advocate for trees in the urban forest, which can help secure funding for future tree planting and management.

Headline Figures		
Total Carbon Storage (t)	88,700	£82,000,000
Annual Carbon Sequestration (t/yr)	3,500	**£23,260,000**
Annual Pollution Removal (t/yr)	29.2	**£7,630,000**
Annual Avoided Runoff (m^3/yr)	270,000	**£256,000**
Total Annual Benefits*	**£31,146,000**	

Table 1: Headline figures for RB Greenwich's urban forest
Ecosystem Services are high level estimates based on national averages linked to local valuation bands using i-Tree Canopy

Carbon storage: The total amount of carbon (C) bound up in the above-ground and below-ground parts of woody vegetation, valued at £252/tonneCO_2e.

Carbon sequestration: The annual removal of carbon (C) from the air by trees in the form of carbon dioxide. This amount is sequestered annually, and adds to the amount of carbon stored.

Pollution removal: The total amount of pollution removed including nitrogen dioxide, sulphur dioxide, and particulate matter <2.5 microns in size, valued at £64,773 /tonne, £7064.42 /tonne, and £1,252,102 / tonne respectively.

Avoided Runoff: This is based on the amount of water held in the tree canopy and evaporated after rainfall events, valued using Thames Water volumetric sewerage charge of £0.95/m^3.

**It should be noted that these valuation methods do not represent the full value of the trees. It is a conservative estimate; a great many benefits, cannot yet be valued.*

4.1 Ecosystem Services by Ward

Ward	Total Carbon Storage (t)	Total Carbon Storage (£)	Annual Carbon Sequestration (t/yr)	Annual Avoided Runoff (m^3/yr)	Anual NO_2 Removal (kg/yr)	Anual SO_2 Removal (kg/yr)	Anual PM2.5 Removal (kg/yr)	Total Annual Benefits (£/yr)
Abbey Wood	1,675	1,547,912	67	5,098	393	64	94	£483,833
Blackheath Westcombe	1,145	1,058,325	46	3,486	269	44	65	£337,054
Charlton Hornfair	7,006	6,474,383	279	21,325	1,643	266	395	£1,092,936
Charlton Village & Riverside	602	556,497	24	1,833	141	23	34	£617,552
East Greenwich	754	696,471	30	2,294	177	29	43	£210,541
Eltham Page	4,308	3,980,620	172	13,111	1,010	164	243	£1,236,051
Eltham Park & Progress	7,284	6,730,800	290	22,169	1,708	277	410	£156,998
Eltham Town & Avery Hill	7,352	6,793,385	293	22,376	1,724	279	414	£439,706
Greenwich Creekside	1,249	1,154,260	50	3,802	293	48	70	£143,949
Greenwich Park	9,834	9,087,520	392	29,932	2,306	374	554	£880,621
Greenwich Peninsula	2,682	2,478,044	107	8,162	629	102	151	£924,011
Kidbrooke Park	3,498	3,232,748	139	10,648	820	133	197	£553,624
Kidbrooke Village & Sutcliffe	1,821	1,682,450	73	5,542	427	69	103	£250,633

Ward	Total Carbon Storage (t)	Total Carbon Storage (£)	Annual Carbon Sequestration (t/yr)	Annual Avoided Runoff (m^3/yr)	Anual NO_2 Removal (kg/yr)	Anual SO_2 Removal (kg/yr)	Anual PM2.5 Removal (kg/yr)	Total Annual Benefits (£/yr)
Middle Park & Horn Park	2,598	2,400,963	104	7,908	609	99	146	£326,570
Mottingham, Coldharbour & New Eltham	1,254	1,159,187	50	3,818	294	48	71	£75,693
Plumstead & Glyndon	4,913	4,540,277	196	14,954	1,152	187	277	£526,851
Plumstead Common	8,696	8,035,331	346	26,466	2,039	330	490	£228,841
Shooters Hill	4,192	3,873,441	167	12,758	983	159	236	£94,731
Thamesmead Moorings	2,086	1,927,982	83	6,350	489	79	118	£690,189
West Thamesmead	1,994	1,842,671	79	6,069	468	76	112	£157,668
Woolwich Arsenal	3,849	3,557,171	153	11,716	903	146	217	£915,498
Woolwich Common	4,405	4,070,281	175	13,406	1,033	167	248	£541,429
Woolwich Dockyard	5,491	5,074,310	219	16,713	1,288	209	309	£262,237

Table 2: Estimate of the ecosystem services amounts and values provided by trees in each ward

These figures are an estimate of the expected ecosystem services provided by the trees across the urban forest. They do not account for species, size, or health of the trees, but calculated from the area of tree canopy in each ward.

5. Surface Temperature

The Urban Heat Island (UHI) effect is understood as the area of increased surface temperatures over an urban area vs the surrounding countryside. Trees in cities can alleviate this problem. Figure 9 shows the the average summertime daytime land surface temperatures.

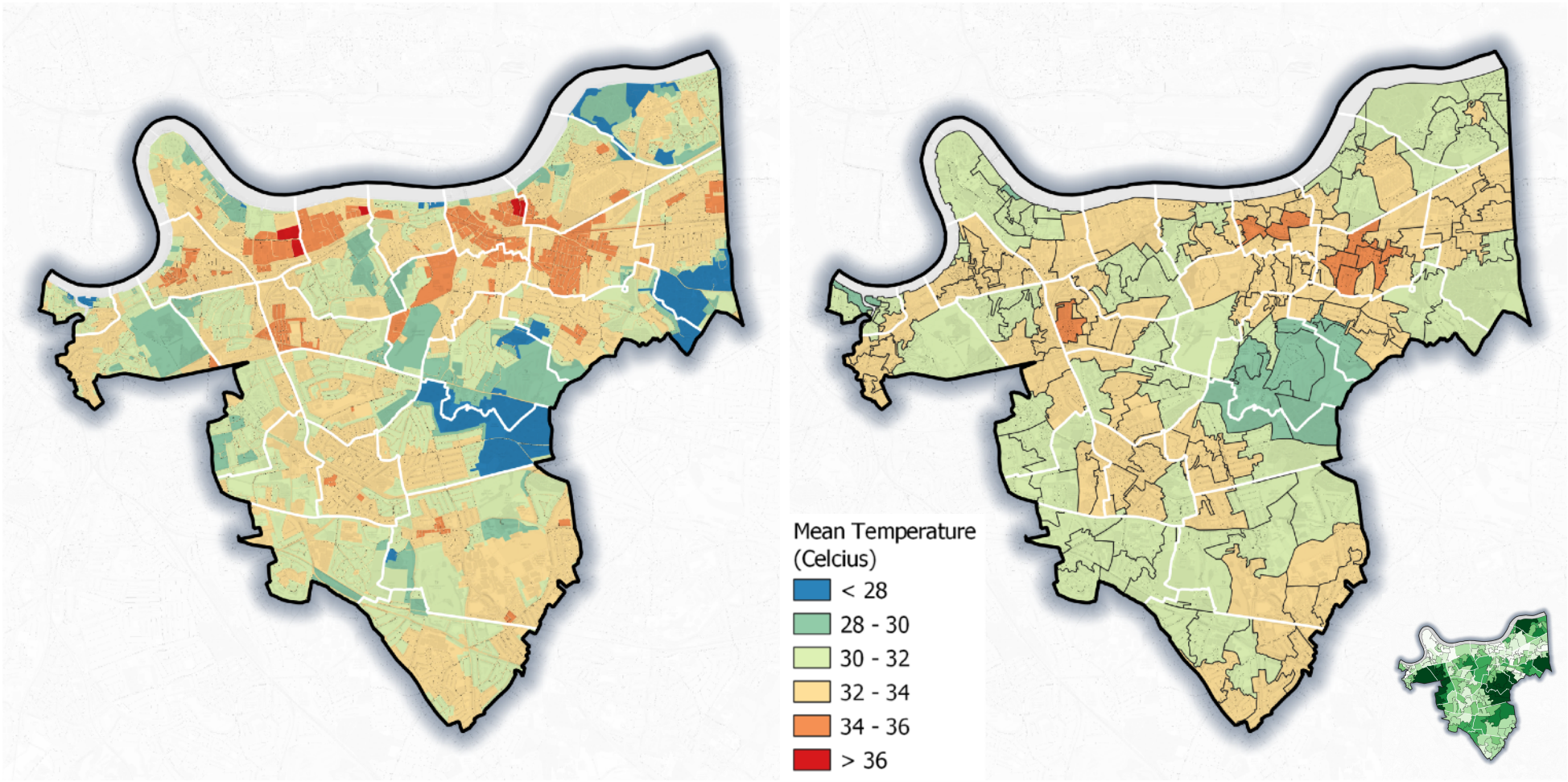


Figure 9: Map Of Average Summertime Daytime Temperatures. Averages For Each LSOA Have Been Calculated And Displayed (Right)

Figure 9 shows how canopy cover impacts surface temperatures at LSOA level; areas with significant canopy cover, for example parts of Shooters Hill, Eltham Park & Progress, Thamesmead Moorings, and Abbey Wood, have some of the lowest temperatures in the summer months. Overall, Shooters Hill has the lowest temperatures, whilst Plumstead & Glynston has. The highest summertime temperatures. Some areas along the Thames may experience reduced temperatures due to the river itself and the wind effect caused by it.

An inverse correlation between average summertime daytime land surface temperatures and canopy cover would be expected.

As shown in figure 10, areas with the highest canopy cover of almost 40% have average temperatures more than 2 degrees lower than ward with 10% canopy.

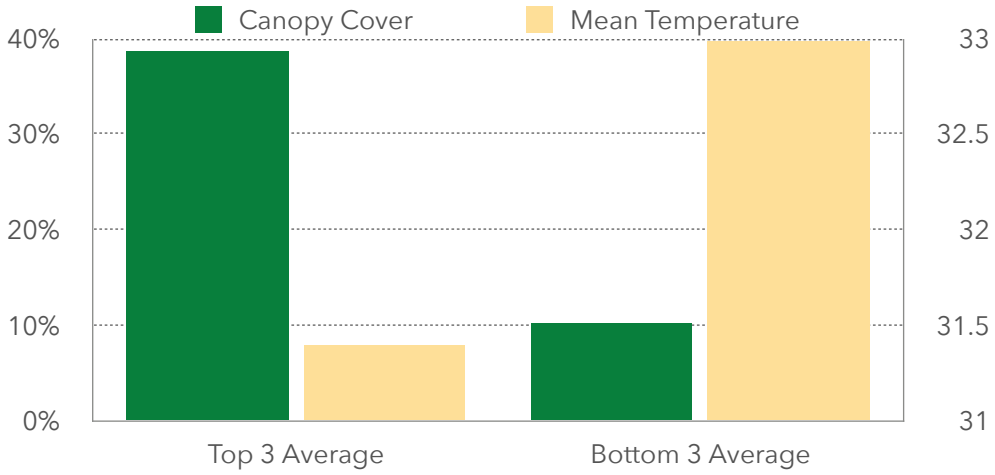


Figure 10: average summertime daytime land surface temperatures compared to canopy cover for the top (left) and bottom (right) three wards

6. Air Quality

Air quality continues to be a major concern in London; the heavy traffic, tall building, and narrow streets can cause pollutants to build up and remain trapped at ground level rather than dissipating. Urban trees can help to improve air quality by directly removing pollutants from the air. They intercept and absorb airborne pollutants through leaf surfaces, and trap particulates on leaves and bark.

As shown by the left-hand maps in figures 13 and 14, the pollution concentration is linked far more with the road network than with canopy cover, however this does not diminish the effect which trees can have on air quality. Figures 11 and 12 show an inverse correlation between canopy cover and air quality, with reduced concentrations of NO2 and PM2.5 in wards with higher canopy cover. This is what would be expected.

Wards with the best air quality are Mottingham, Coldharbour & New Eltham, Abbey Wood, and Thamesmead Moorings.

Targeting the neighbourhoods with the highest pollution concentration can significantly improve the health, quality of life, and amenity of neighbourhoods, particularly in wards such as Greenwich Peninsula, East Greenwich, and Greenwich Creekside which have the lowest canopy cover and the highest pollution levels.

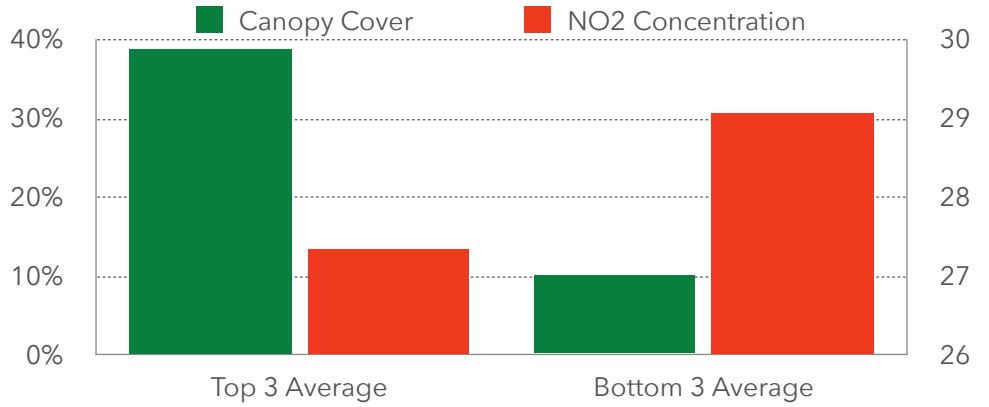


Figure 11: concentration of NO_2 compared to canopy cover for the top (left) and bottom (right) three wards

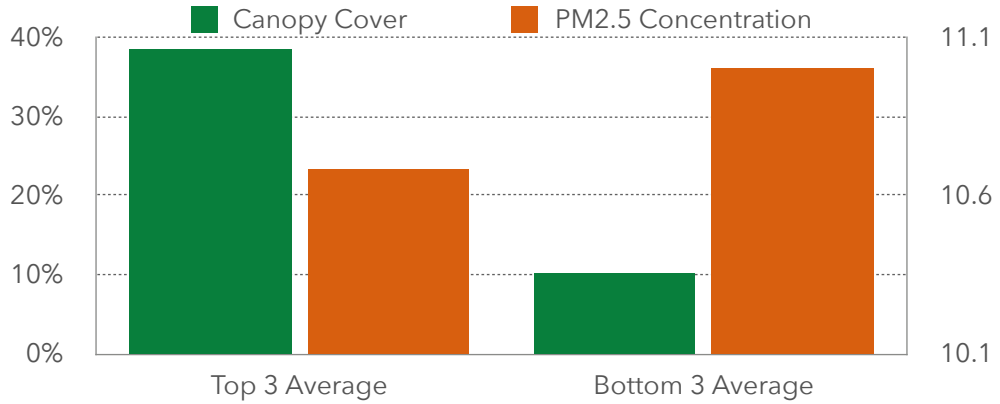


Figure 12: concentration of PM2.5 compared to canopy cover for the top (left) and bottom (right) three wards

6.1 Air Quality - NO_2

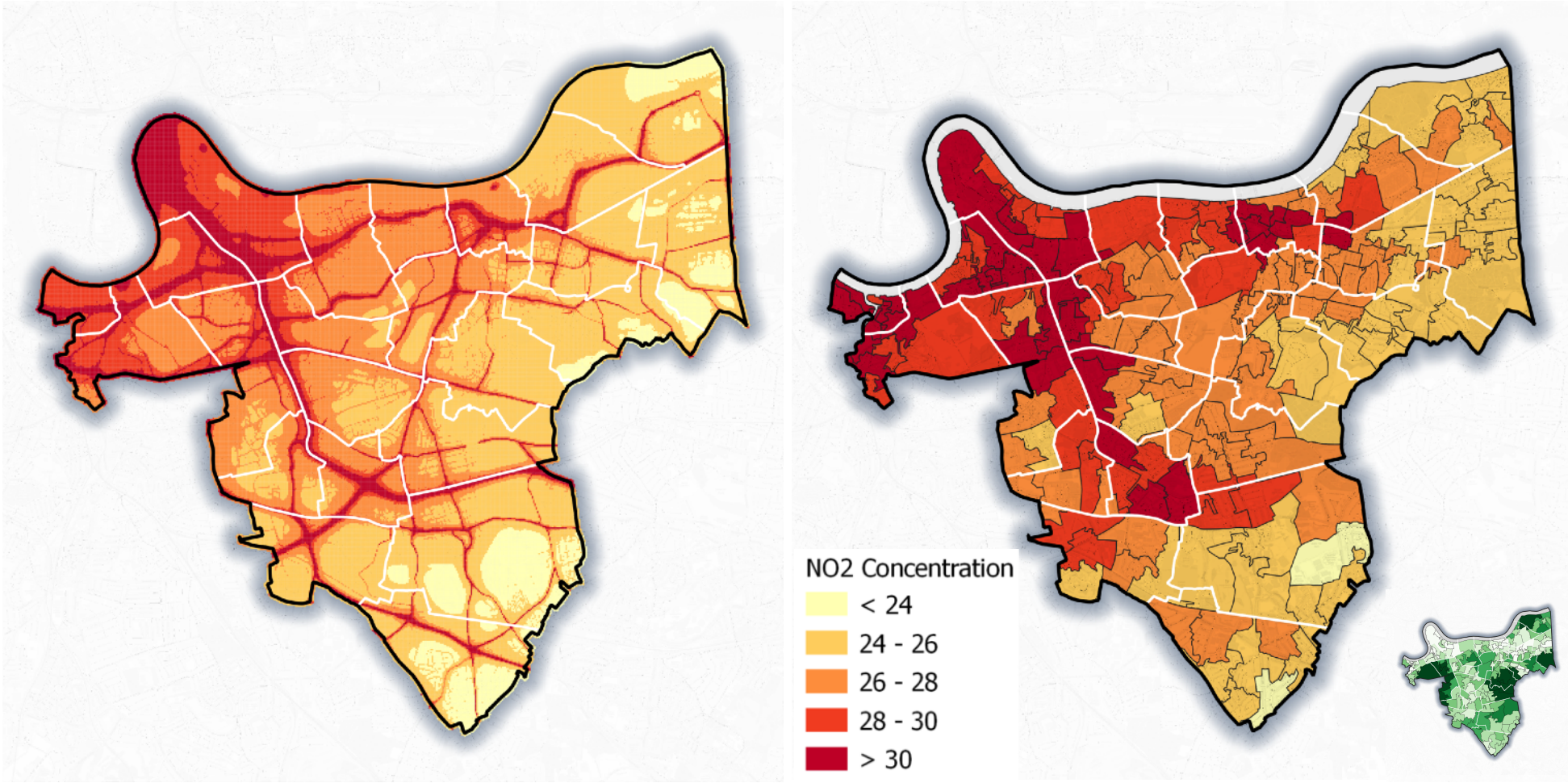


Figure 13: Map Of NO_2 Concentrations. Averages For Each LSOA Have Been Calculated And Displayed (Right)

6.2 Air Quality - PM2.5

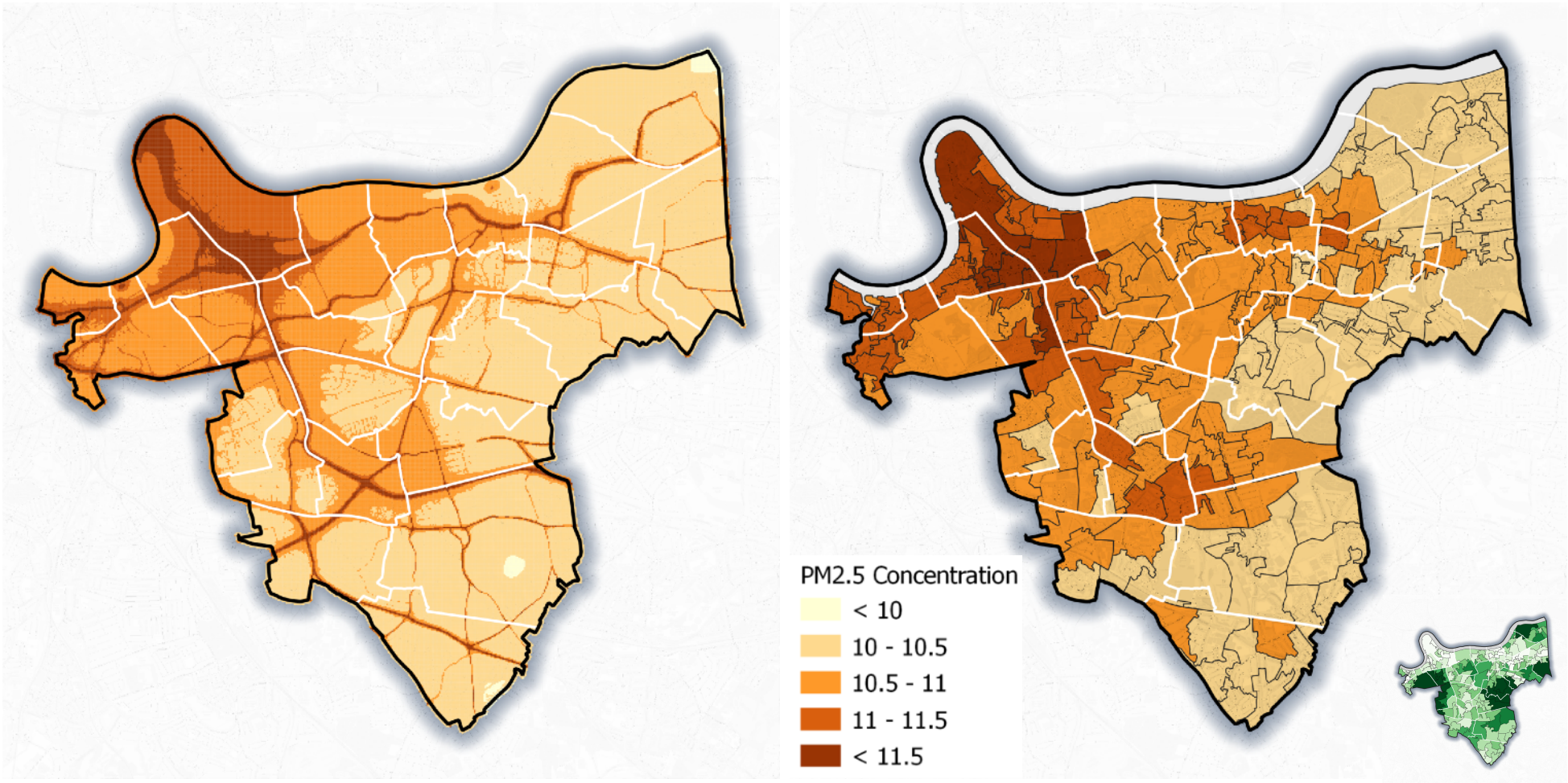


Figure 13: Map Of PM2.5 Concentrations. Averages For Each LSOA Have Been Calculated And Displayed (Right)

7. Surface Water Flooding

Surface water flooding is influenced by geography, hard surfaces, and drainage systems. Areas which have reduced ground level, an abundance of hard surfaces, and reduced drainage capacity are at more risk of significant surface flooding.

Kidbrooke Village & Sutcliffe and Middle Park & Horn Park are the most at risk of surface flooding despite their fairly high canopy cover. The northern LSOAs of Abbey Wood and Plumstead & Glyndon are also at risk, possibly due to low canopy cover and proximity to main roads and Railways.

An inverse correlation between area at risk of surface water flooding and canopy cover could be expected. In Greenwich however, this is not the case, as shown by figure 14. The landscape and drainage systems may play a more significant part than canopy cover in the risk of surface water flooding.

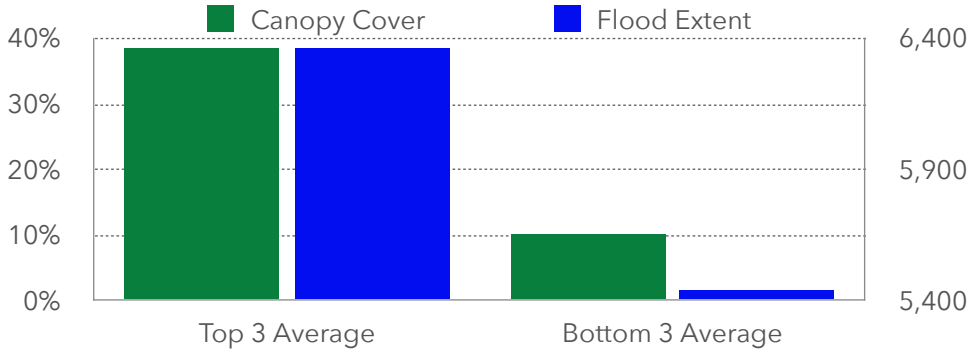


Figure 14: Extent of Surface water flooding in the event of a 1-in-30 event to canopy cover for the top (left) and bottom (right) three wards

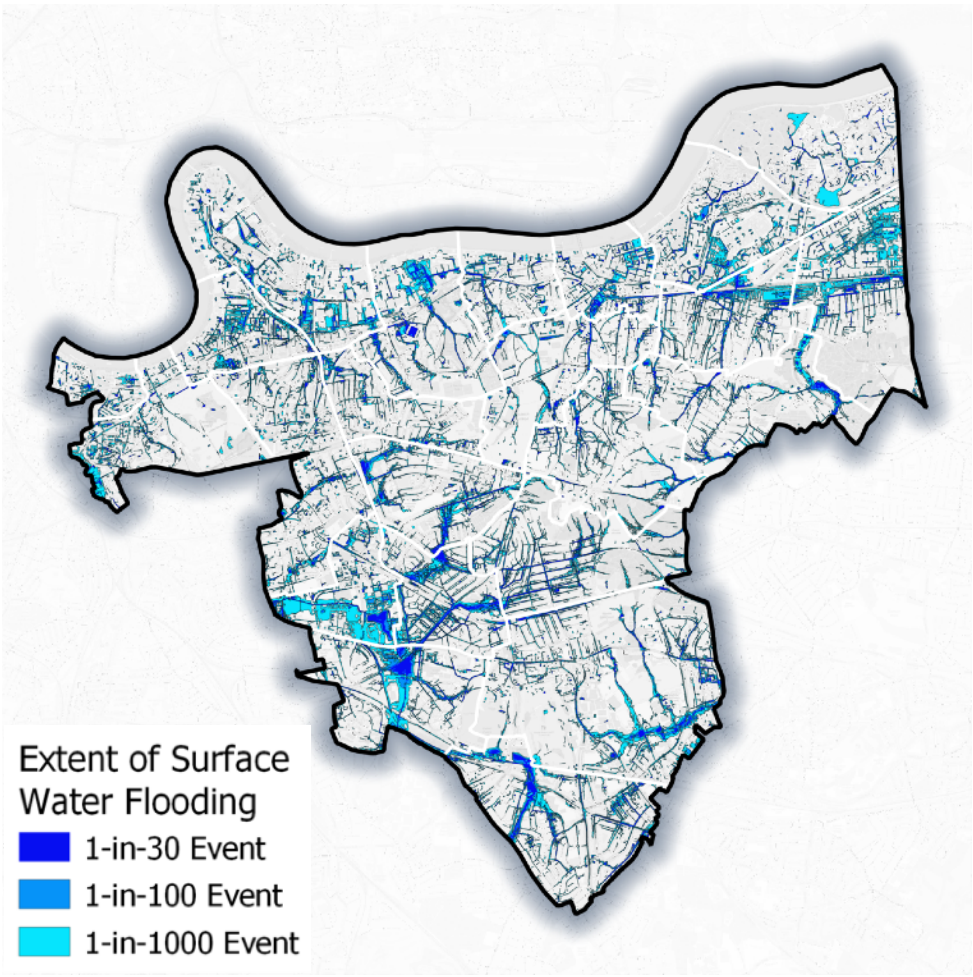


Figure 15: Map Of Surface Water Flooding Extent Given A Series Of Different Flood Event Scenarios

7.1 1-in-30 Events

This is the most likely flood extent in the event of excessive rainfall. It may cause disruption to traffic in some areas, though is unlikely to pose a serious threat to people or property.

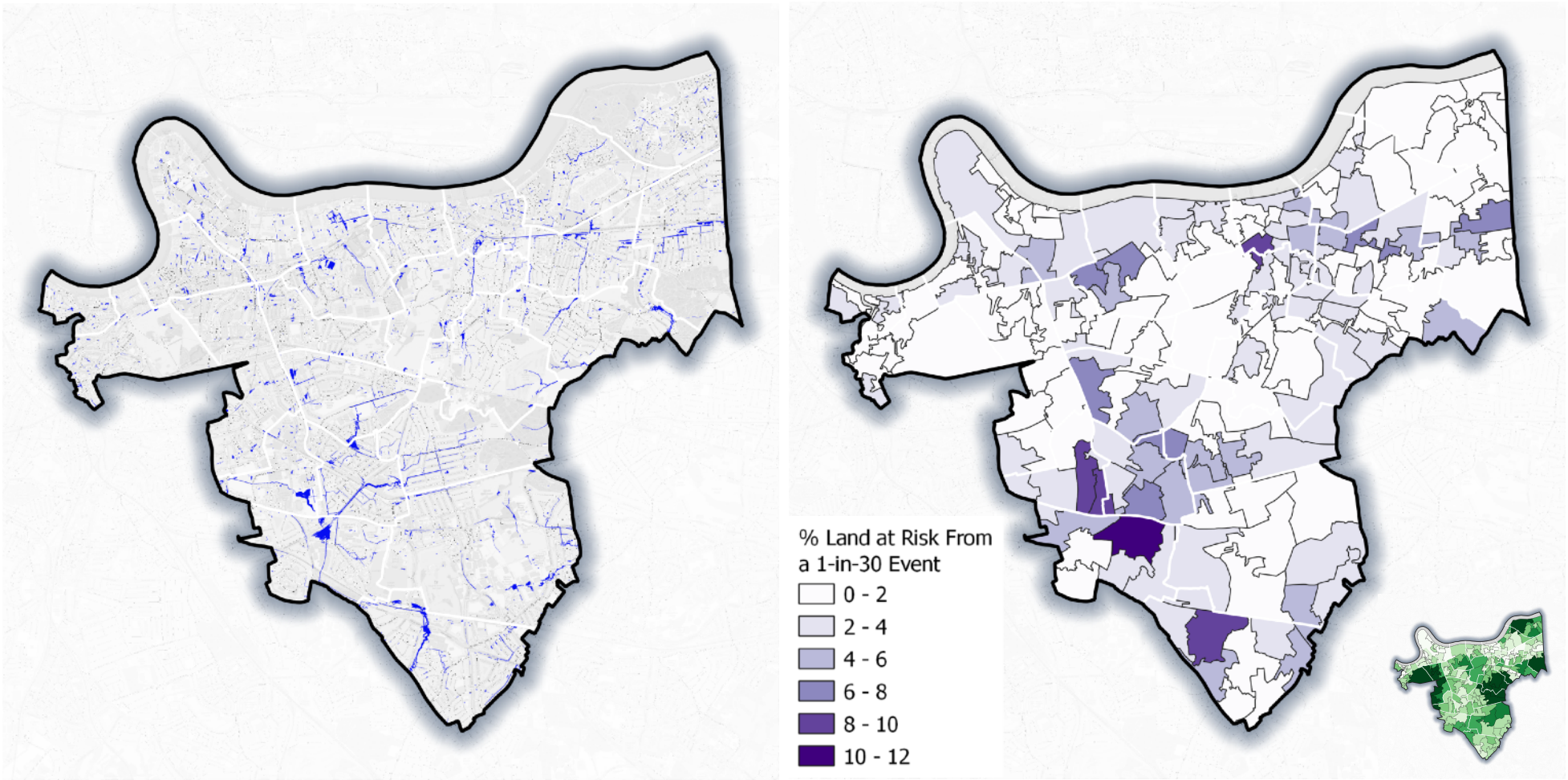


Figure 16: Map Of Surface Water Flooding Extent Given a 1-in-30 Flooding Event. A Percentage of Land Flooded for Each LSOA Is Displayed (Right)

8. Index of Multiple Deprivation

The Index of Multiple Deprivation, commonly known as the IMD, is the official measure of relative deprivation for small areas in England. The IMD ranks every small area in England from 1 (most deprived area) to 32,844 (least deprived area).

Interestingly, the LSOA with the highest canopy cover (in Abbey Wood Ward) has one of the lowest IMD Ranks in Greenwich, implying that it is one of the most deprived areas alongside Greenwich Peninsula, Woolwich Dockyard, Charlton Village & Riverside, and Middle Park & Horn Park. Eltham Park & Progress and Shooters Hill have some of the highest IMD Ranked LSOAs, and some of the highest canopy cover.

A correlation between IMD and canopy cover would be expected, and is demonstrated in Greenwich where areas with the highest canopy cover have a much higher rank (and therefore lower deprivation levels) than wards with lower canopy cover.

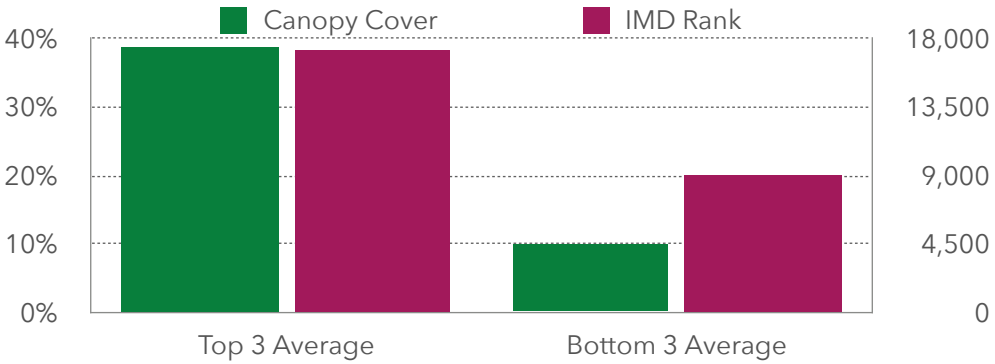


Figure 19: IMD rank compared to canopy cover for the top (left) and bottom (right) three wards

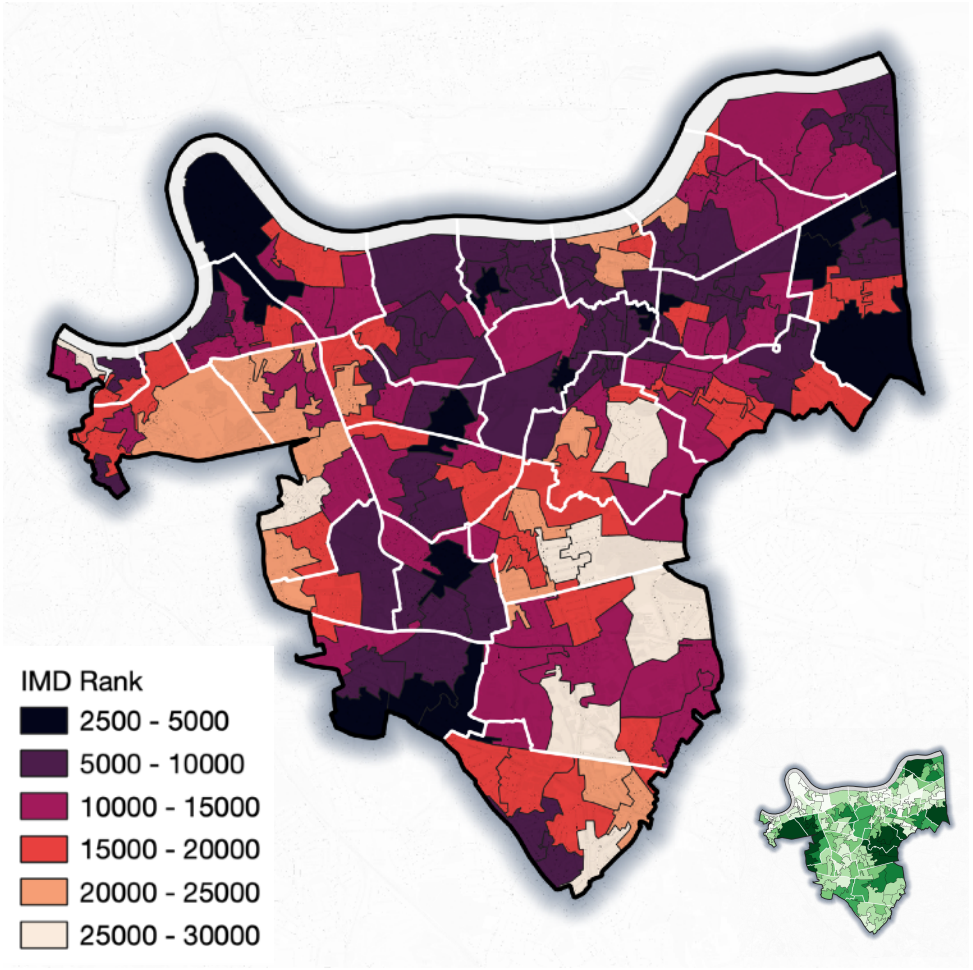


Figure 20: Map Of IMD Rank By LSOA (Low Rank Indicates Higher Deprivation)

9. Educational Attainment

This is a Rank based on the level of education, skills and training across the LSOAs: it is used within the IMD and is ranked similarly.

Greenwich Park and Blackheath Westcombe have the highest levels of education, skills and training; they are also within the top Band of wards for canopy cover. Middle Park & Horn Park and Eltham Page have the lowest levels. These two wards have less canopy than the national average, with 15.5% and 14% respectively.

A correlation between educational attainment and canopy cover would be expected, and is demonstrated in Greenwich where areas with the highest canopy cover have a much higher rank (and therefore lower deprivation levels) than wards with lower canopy cover.

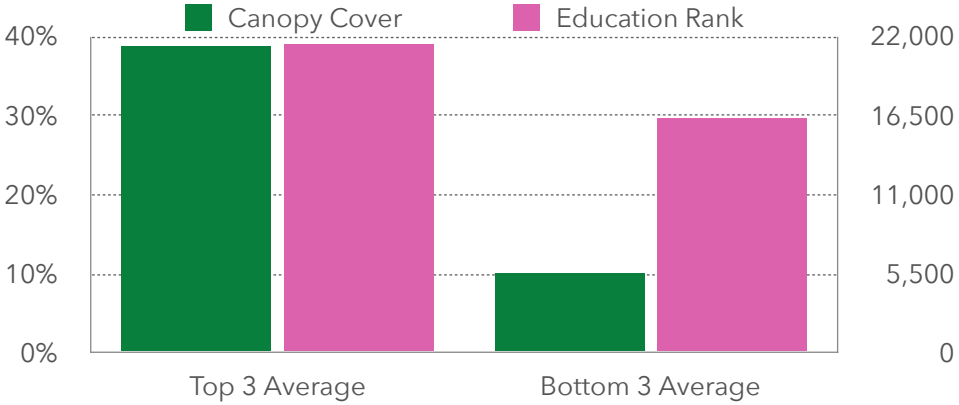


Figure 21: Education, skill & training rank compared to canopy cover for the top (left) and bottom (right) three wards

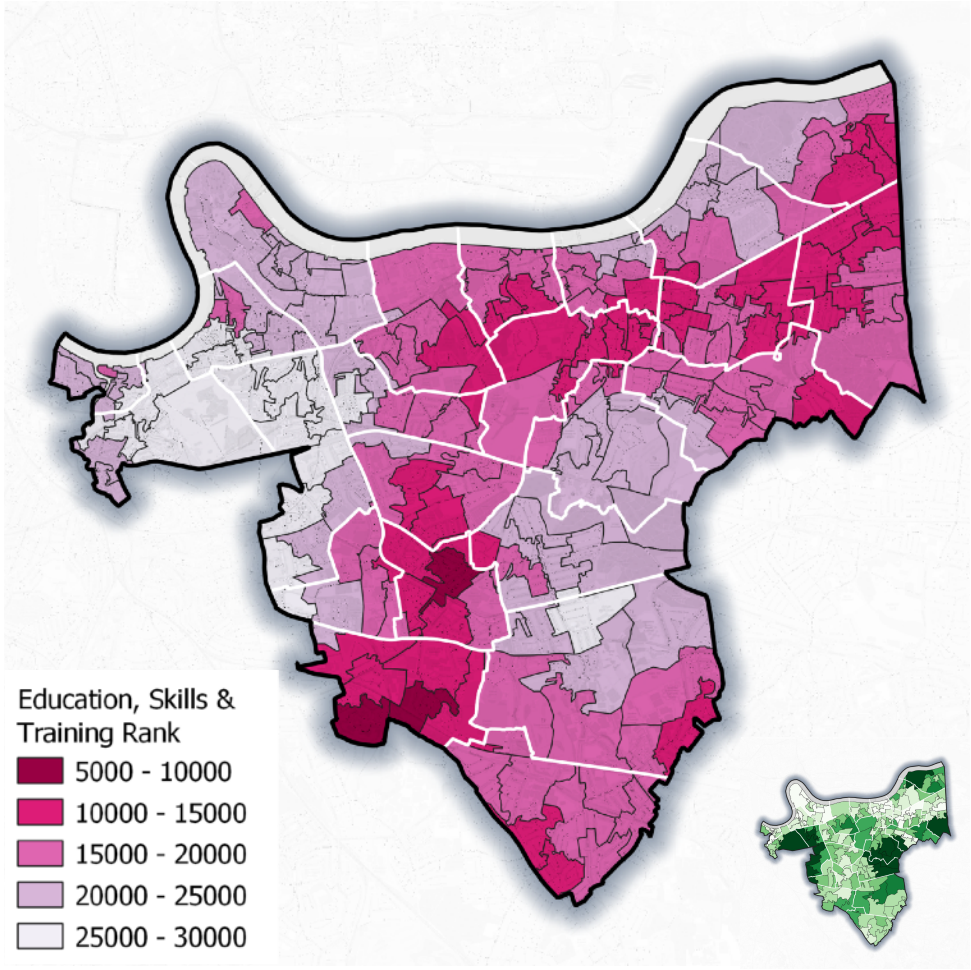


Figure 22: Map Of Education, Skills And Training Rank By LSOA (Low Rank Indicates Lower Educational Attainment)

10. Crime Rates

Crime rates are influenced by a significant number of factors, including land use, income, education, employment and more, however numerous studies have found correlation between crime rates and green space in urban areas.

Crime across Greenwich is fairly low, with most LSOAs seeing less than 0.1 crimes per capita, however Charlton Village & Riverside sees areas where crime is three and a half times more common.

An inverse correlation between crime rates and canopy cover could be expected. In Greenwich however, this is not the case; total crime levels are higher per capita in the top 3 wards than in the bottom 3 wards.

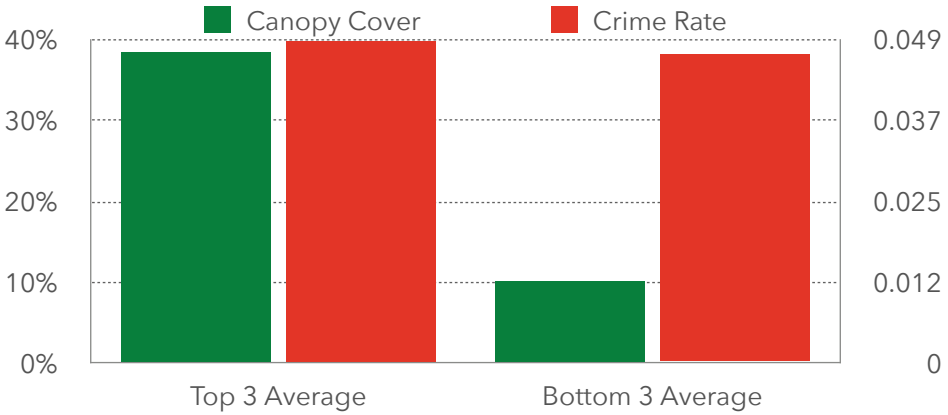
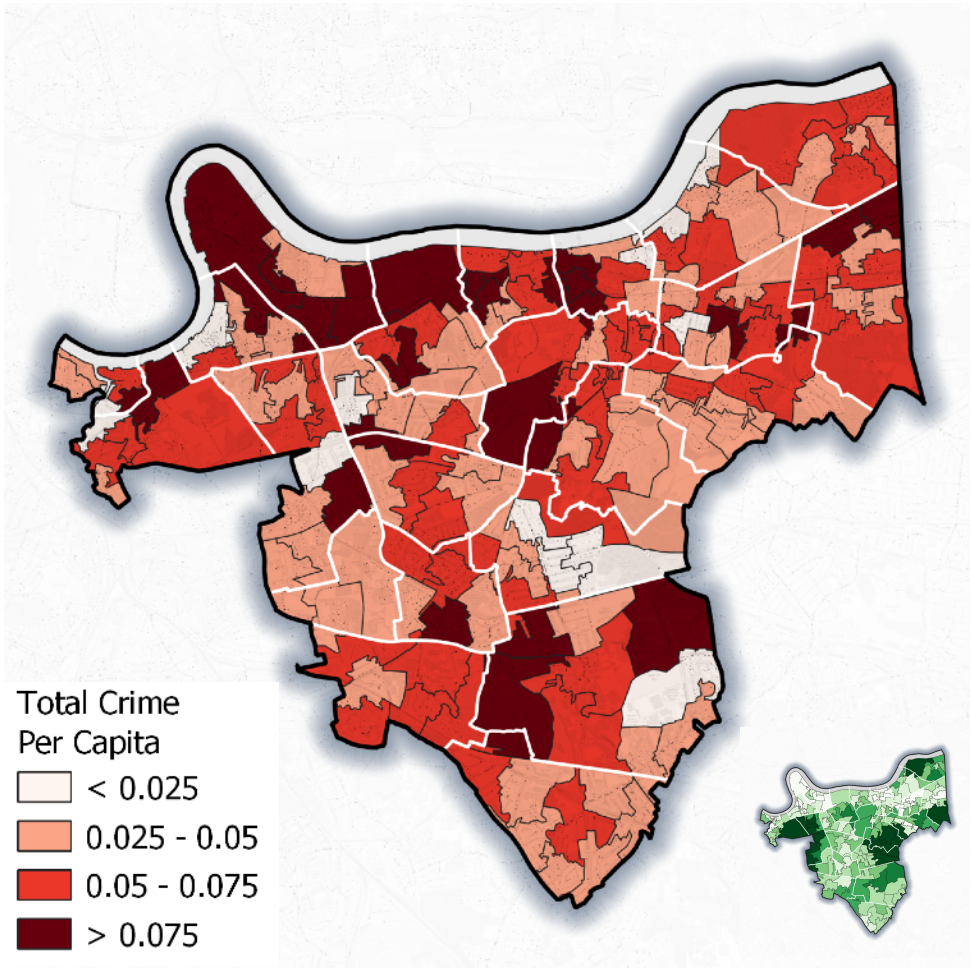


Figure 23: total crime rate compared to canopy cover for the top (left) and bottom (right) three wards



Source: https://ukcrimestats.com/

Figure 24: Map Of Total Crime Rate By LSOA

10.1 Antisocial Behaviour Rates

This antisocial behaviour (ASB) rate is one of the metrics which makes up the total crime rate. It has been displayed separately as some studies[31] [32] have identified a link between canopy cover and ASB.

As with the rates of total crime, an inverse correlation between antisocial behaviour rates and canopy cover could be expected between antisocial behaviour and canopy cover. In contrast to the total crime rate, this correlation is demonstrated in Greenwich.

The wards with the highest rates of ASB per capita are Woolwich Dockyard, Eltham town 7 Avery Hill, and Kidbrooke Village & Sutcliffe, all of which have canopy cover less than the Greenwich mean. The wards with the lowest rates of ASB per capita are Mottingham, Coldharbour & New Eltham, Charlton Hornfair, and Eltham Park & Progress.

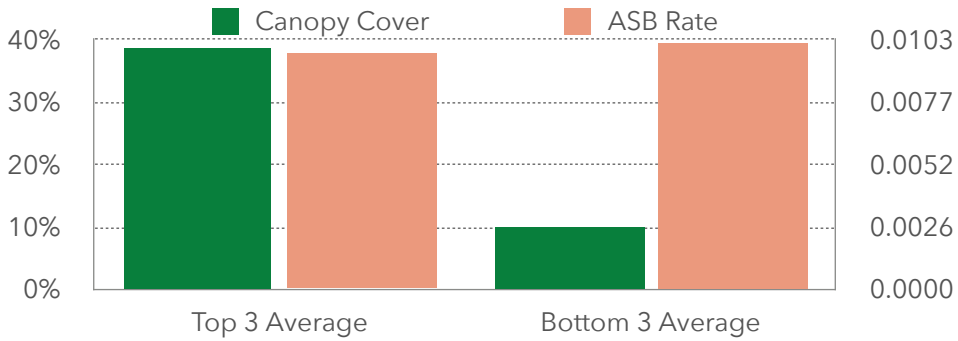


Figure 25: Antisocial Behaviour rate (crimes per person) compared to canopy cover for the top (left) and bottom (right) three wards.

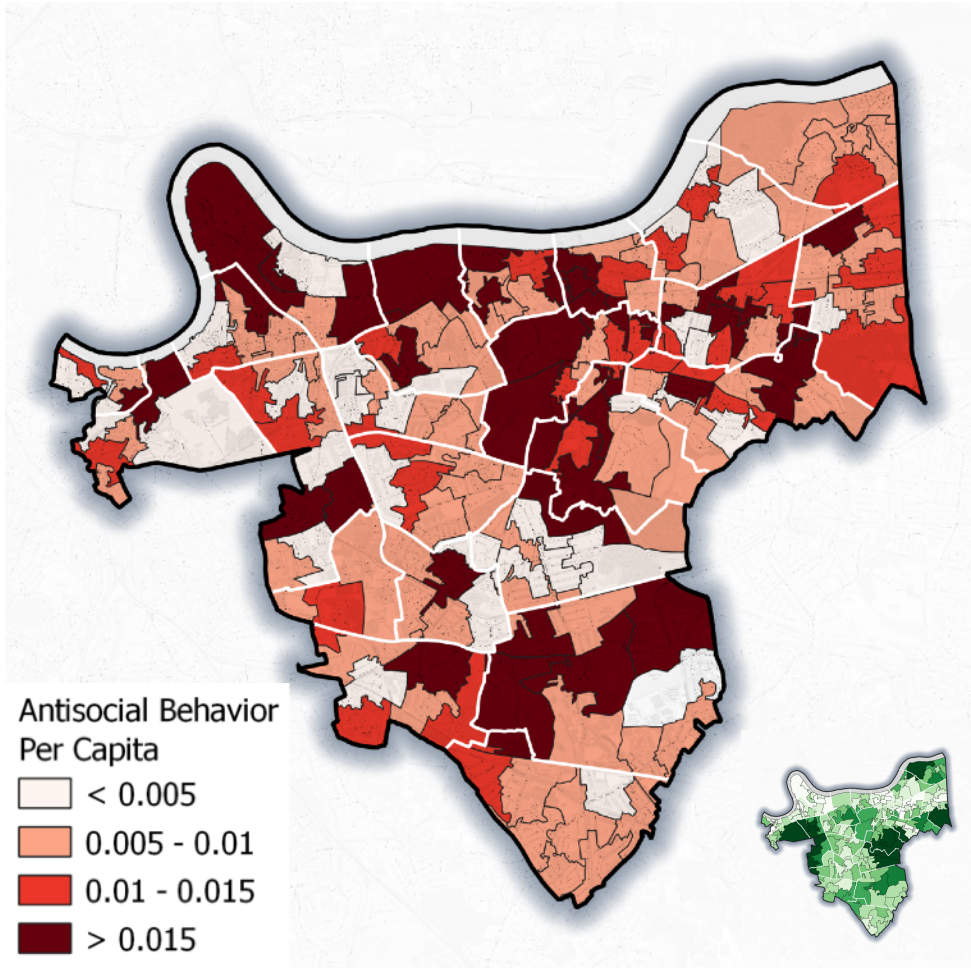


Figure 26: Map Of Antisocial Behaviour Rate By LSOA

31 Troy, 2012

32 Brunson, 1999

11. Life Expectancy

11.1 Females

A correlation between life expectancy and canopy cover is both expected, and shown in greenwich. Figure 27 shows that females living in the greenest areas of Greenwich could expect to live an extra 1.5 years compared to those living in the least green wards.

As figure 28 shows, the ward with the highest life expectancy is Eltham Park and Progress at 84 years, while the lowest is Thamesmead Moorings at 78.5 years (despite it having the 5th highest canopy cover of the wards).

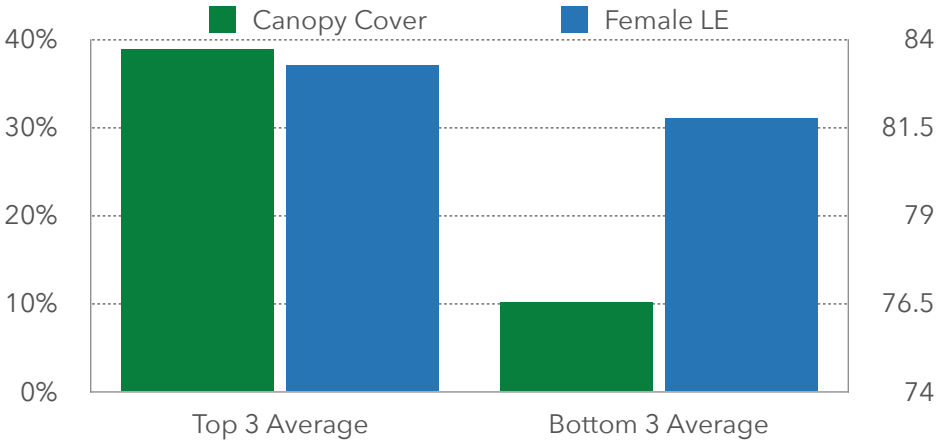


Figure 27: Life Expectancy for females compared to canopy cover for the top (left) and bottom (right) three wards. Note RH Axis starts at 74

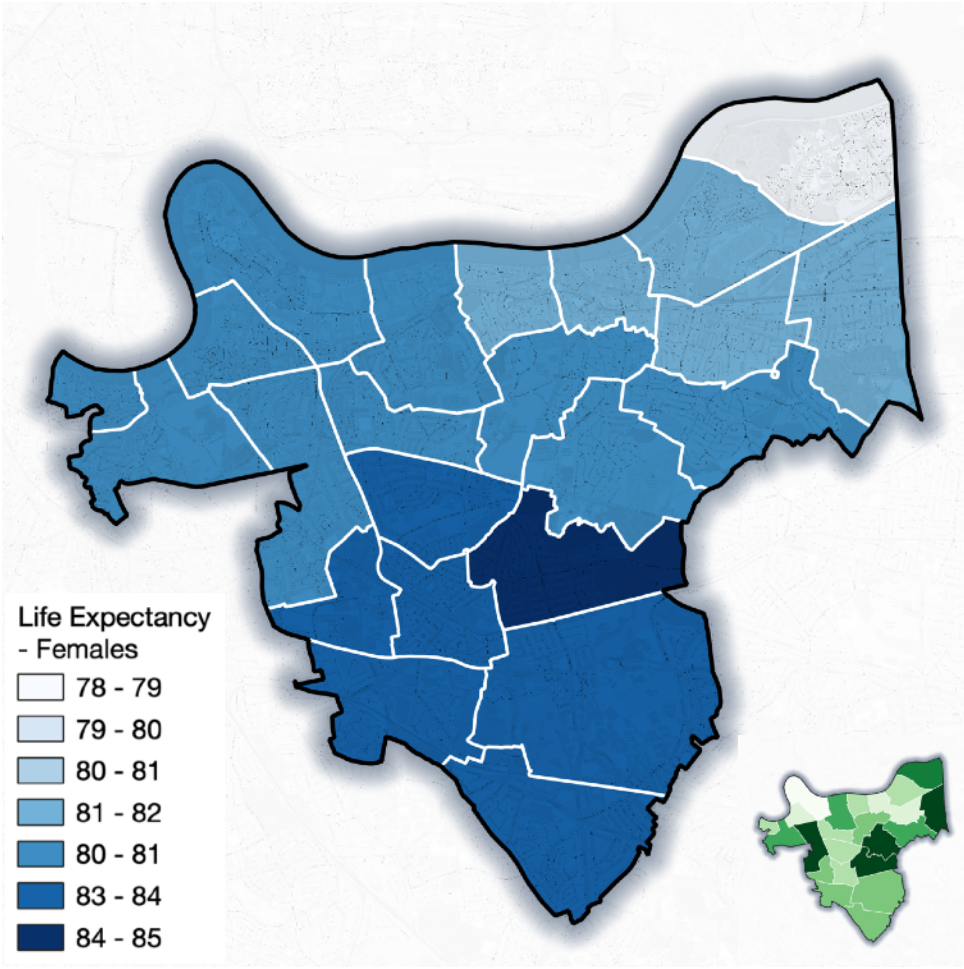


Figure 28: Map Of Life Expectancy For Females By Ward

11.2 Males

A correlation between life expectancy and canopy cover is both expected, and shown in greenwich. Figure 29 shows that males living in the greenest areas of Greenwich could expect to live an extra 1.5 years compared to those living in the least green wards, the same as females.

The ward with the highest life expectancy is Eltham Park and Progress at 80.5 years, while the lowest is Thamesmead Moorings at 76.8 years (despite it having the 5th highest canopy cover of the wards).

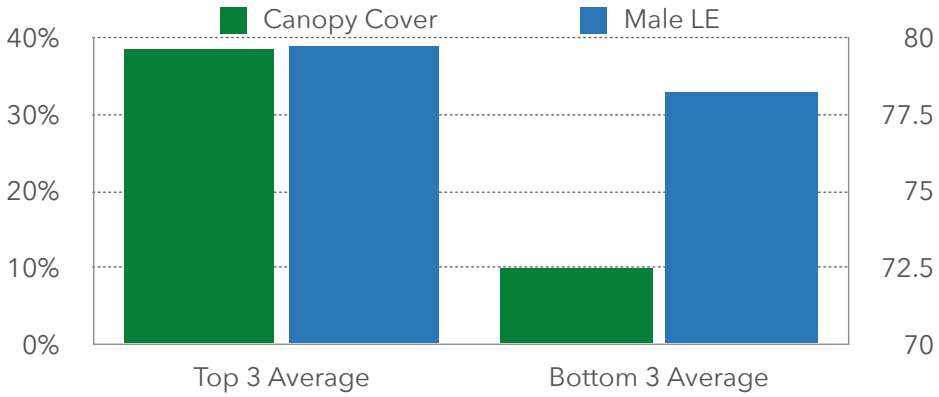


Figure 29: Life Expectancy for males compared to canopy cover for the top (left) and bottom (right) three wards Note RH axis starts at 70

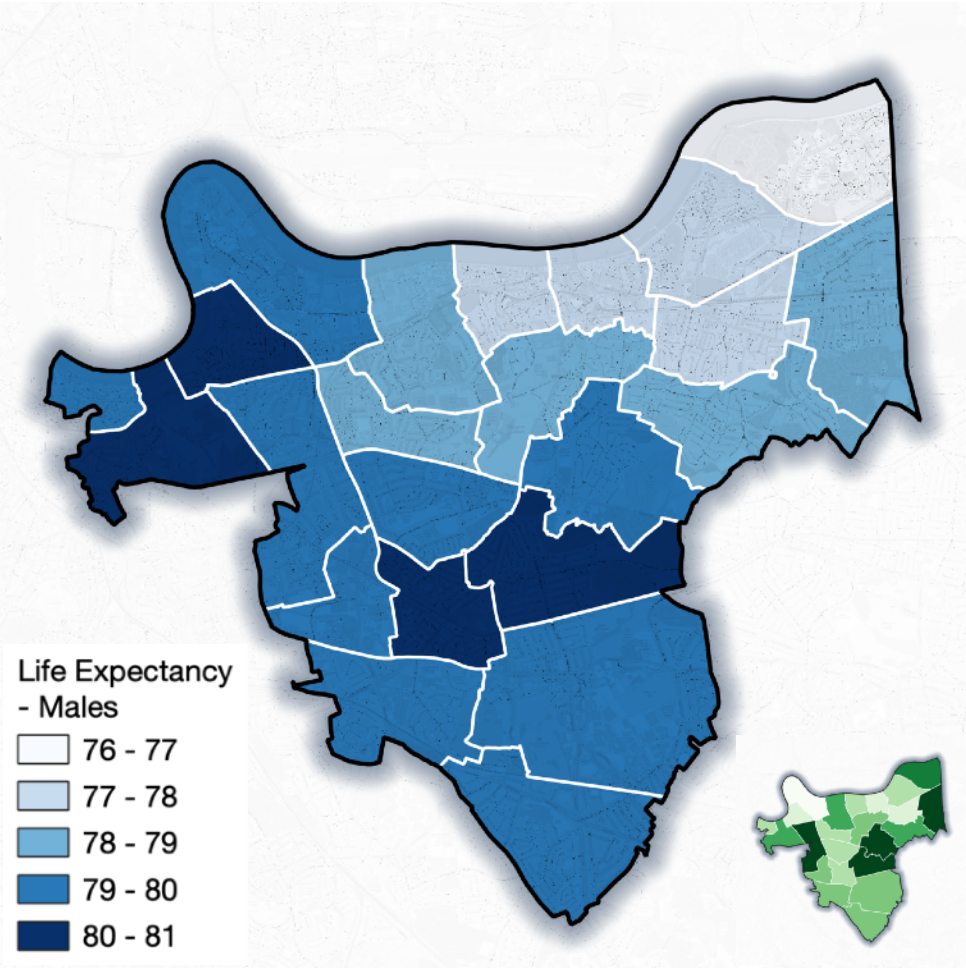


Figure 30: Map Of Life Expectancy For Males By Ward

12. Hospital Admissions

Increased tree cover can help to promote good health (and therefore reduced numbers of hospital admissions) passively, by filtering air pollution and lowering peak summer temperatures, for example, and by promoting physical activity and reducing stress. Where green space is available it can be used for physical activity and may help to reduce social health inequalities, which is important because 1 in every 15 deaths in Europe is associated with a lack of physical activity[33].

As may be expected, wards with higher canopy over have, on average, lower numbers of emergency hospital admissions for all causes than wards with lower canopy cover.

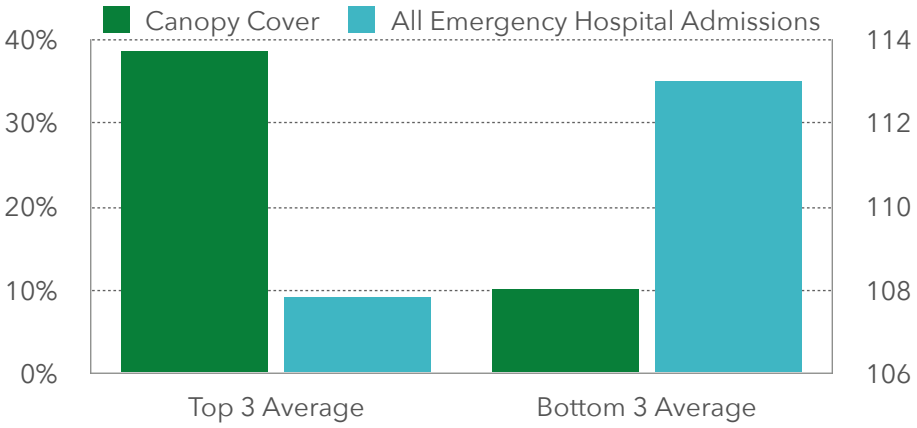


Figure 31: All Emergency Hospital admissions compared to canopy cover for the top (left) and bottom (right) three wards

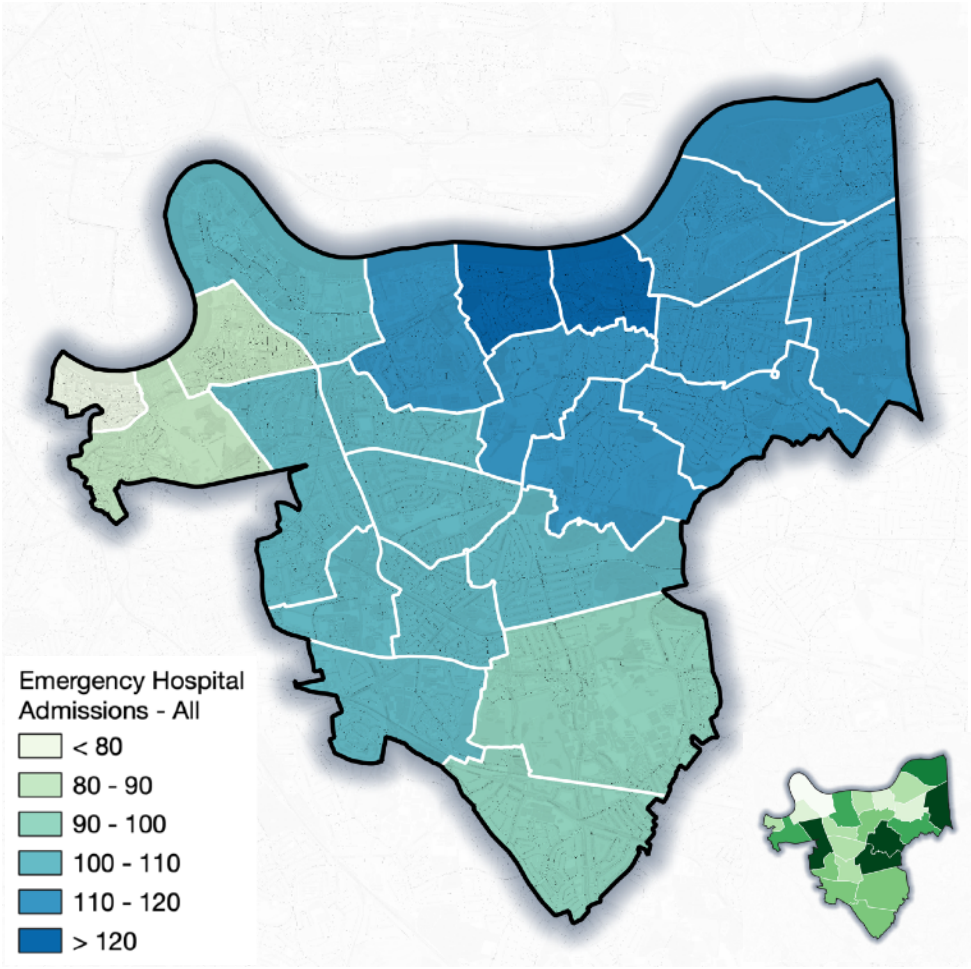


Figure 32: Map Of Emergency Hospital Admissions By Ward

33 Mitchell & Popham, 2008

12.1 Hospital Admissions for Chronic Obstructive Pulmonary Disease (COPD)

Trees are able to remove some airborne pollutants from their surroundings by trapping particulates on bark and leaf surfaces, and through air filtration during photosynthesis. Air quality relies heavily on the infrastructure around streets, and trees can either encourage good airflow or trap pollution beneath the canopy. It is therefore important to consider where trees should be planted to alleviate air quality issues, rather than simply focus on tree planting.

As may be expected, wards with higher canopy over have, on average, lower numbers of emergency hospital admissions for COPD than wards with lower canopy cover.

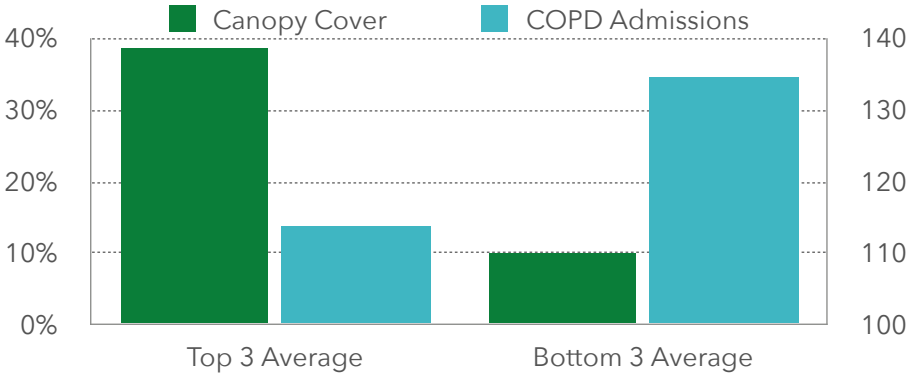


Figure 33: Hospital admissions for COPD compared to canopy cover for the top (left) and bottom (right) three wards

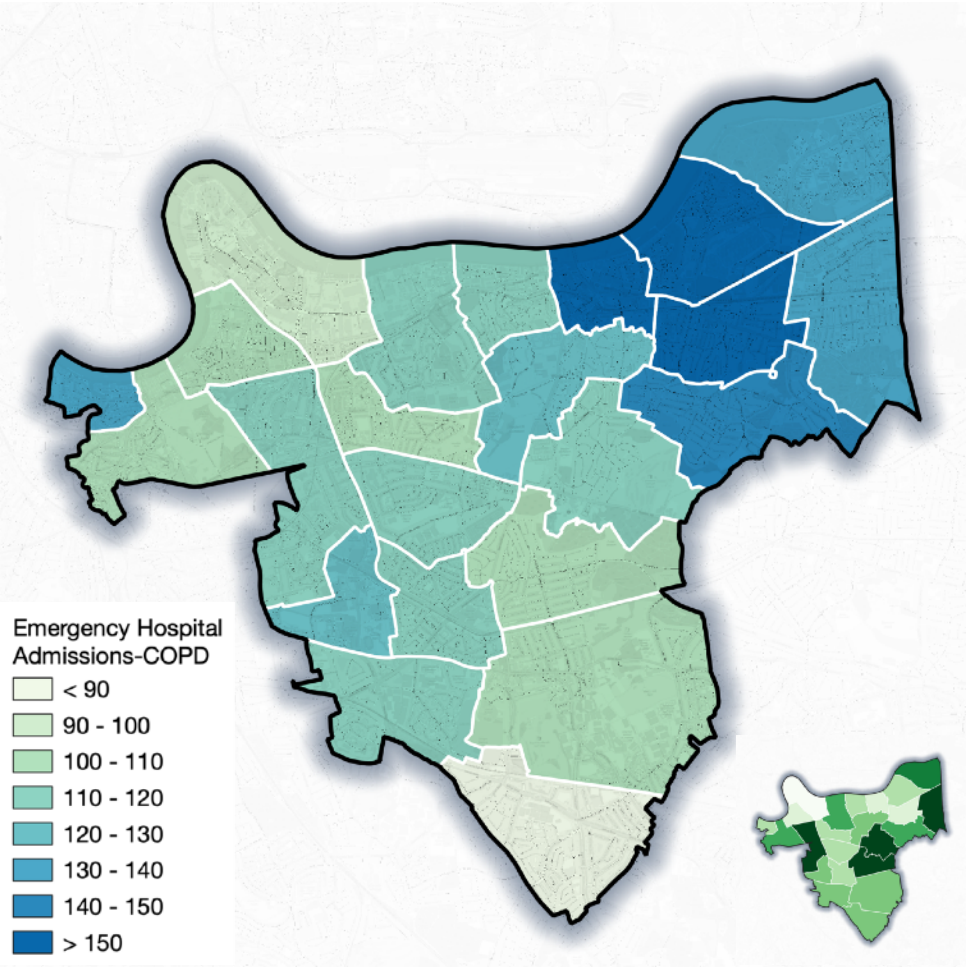


Figure 34: Map Of Emergency Hospital Admissions For COPD By Ward

13. Conclusions and Recommendations

Canopy cover across Greenwich Is generally high, especially when compared to the national average and the average for Greater London, however the tree cover is not evenly distributed, and some wards have considerably lower tree cover than most.

Tree cover across the borough appears to have grown significantly since 2016; the average for Greenwich has grown by 4.4%, and 17 wards show measurable growth between 2-11%. The remaining 6 wards show no measurable change beyond the margin of error.

This canopy expansion is evidence of effective and successful tree planting, and management practices which support the longevity of trees, allowing them to grow in sufficient space to a reasonable size. It is critical that this is maintained to ensure that the population has a good age diversity and continues to consistently deliver ecosystem services to future generations of residents in Greenwich.

Links between tree canopy cover and social factors can be used to identify where tree planting could have the largest impact on the local population. Trees are likely to have a greater impact on environmental factors such as temperature, air quality and surface runoff due to the direct relationship between tree canopy functions and these factors, compared to the indirect impact on social factors.

Tackling the environmental and social inequalities associated with tree cover will be more effective at a neighbourhood level than at ward level in Greenwich; as indicates within Abbey Wood and Thamesmead Moorings, canopy cover and social inequalities can vary significantly even across a single ward. Consideration should be given not only to local canopy cover, but also access to parks and green spaces in neighbourhoods in order to better address the social challenges across Greenwich.

14. Appendix

Canopy Data

Satellite mapping was used to collect information on the canopy cover of trees above three meters in height. These figures established percentages of tree canopy cover across Greenwich, and were used to scale the values of ecosystem services to the ward canopy cover percentages.

- For 2016, data from the GLA (by Breadboard Labs) was used.
- For 2023, Google Environmental Insights Explorer data was used.
- Tree height data was collected from Bluesky National Tree Map.

Ecosystem service valuations

i-Tree Canopy was used to collect the information on the ecosystem services provided by the urban forest. The tool provides values for carbon storage, carbon sequestration, avoided runoff and pollution removal per hectare of tree canopy cover, which is then scaled to the area of canopy cover in each ward.

Carbon storage and carbon sequestration values are calculated based on CO_2e and the DBEIS figures of £252/tonneCO_2e.

Pollution removal was valued at £64,773 /tonne, £7064.42 /tonne, and £1,252,102 /tonne respectively.

Avoided Runoff was valued using Thames Water volumetric sewerage charge of £0.95/m^3.

Mapping

Where possible, map data was categorised at Lower Super Output Area (LSOA), to give a higher level of granularity, and provide more useable and actionable information in comparison with tree cover maps. Where data was not available at this level, ward averages were used.

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