



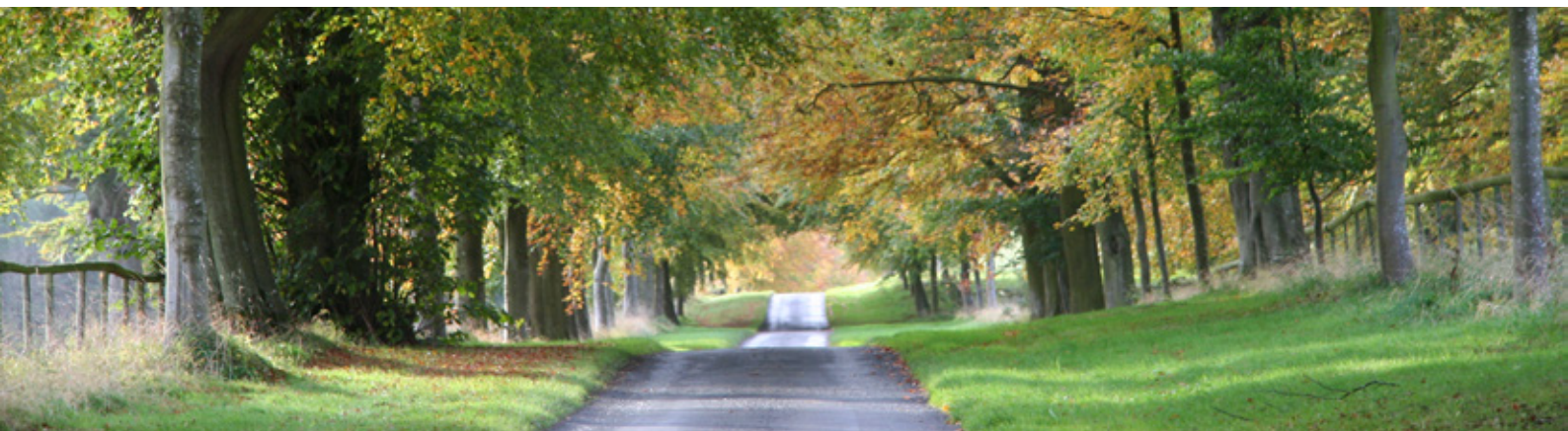
**Cyfoeth
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Wales**

Tree Cover in Wales' Towns and Cities

Understanding canopy cover to better plan and manage our urban trees



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Lywodraeth Cymru
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Our purpose is to champion the sustainable management of Wales' natural resources and apply the principles of sustainable management of natural resources as we carry out our work.

Wales' landscape, environment and wildlife are amongst its greatest resources, worth more than £8bn to the Welsh economy.

Natural Resources Wales will:

- Work for Wales' economy so that the sustainable use of natural resources support jobs and enterprise. We will help businesses and developers to understand and consider environmental impacts when they make important decisions.
- Work for the communities of Wales to protect people and their homes as far as possible from environmental incidents such as flooding and pollution. We will provide opportunities for communities to learn, use and benefit from Wales' natural resources.
- Work to maintain and improve the quality of the environment for everyone, and towards making the environment and natural resources more resilient to climate change and other pressures.

Natural Resources Wales brings together the work of the Countryside Council for Wales, Environment Agency Wales and Forestry Commission Wales, as well as some functions of Welsh Government.

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Foreword



Emyr Roberts



Diane McCrea

Introducing a world-first for Wales is a great pleasure, particularly as it relates to greater knowledge about the hugely valuable woodland and tree resource in our towns and cities.

We are the first country in the world to have undertaken a country-wide urban canopy cover survey. The resulting evidence base set out in this study will help all of us - from community tree interest groups to urban planners and decision-makers in local authorities and our national

government - to understand what we need to do to safeguard this powerful and versatile natural asset.

Trees are an essential component of our urban ecosystems, delivering a range of services to help sustain life, promote well-being, and support economic benefits. They make our towns and cities more attractive to live in - encouraging inward investment, improving the energy efficiency of buildings - as well as removing air borne pollutants and connecting people with nature. They can also mitigate the extremes of climate change, helping to reduce storm water run-off and the urban heat island.

Natural Resources Wales is committed to working with colleagues in the Welsh Government and in public, third and private sector organisations throughout Wales, to build on this work and promote a strategic approach to managing our existing urban trees, and to planting more where they will deliver the greatest benefits.

Dr Emyr Roberts
Chief Executive

Diane McCrea
Chair



Table of Contents

Foreword	3
Table of Contents, List of Figures and Tables	4
Acknowledgements, Acronyms and Abbreviations	8
Executive Summary	11
1. Introduction	16
1.1 Why a 'Tree Cover in Wales' Towns and Cities' study?	17
1.2 Who is this study for?	19
1.3 How was the study developed? An overview	22
1.4 A world first, revealing opportunities for sustainable growth	26
2. National, county and town canopy cover findings	28
2.1 National urban canopy cover	30
2.2 County canopy cover comparisons	30
2.3 Town canopy cover comparisons	34
2.4 International comparisons	57
2.5 Summary: actionable findings	61
3. Distribution, composition and changes to canopy cover	63
3.1 Urban canopy cover distribution across land-uses	65
3.2 Balance between urban woodland and amenity trees	70
3.3 Monitoring the extent of urban tree canopy over time - losses and gains	74
3.4 Tree types (broadleaf, mixed and conifer)	82
3.5 Summary: actionable findings	82
4. Neighbourhood canopy cover - a focus on deprived wards	84
4.1 Best and worst canopied urban wards	86
4.2 Multiple deprivation and canopy cover	88
4.3 Air quality and canopy cover	99
4.4 Summary: actionable findings	103
5. Estimating the potential for tree planting - a pilot exercise	104
5.1 Estimating the realm of the possible: the TCWTC method - potential canopy cover (PCC)	106
5.2 Potential green areas for targeting tree planting in 27 pilot towns	107
5.3 Cardiff Bay case study - Where are the ward-level 'easy to plant' areas to target for action?	110
5.4 Summary: actionable findings	116
6. Conclusion: disseminating, refining and updating the data	118
6.1 Disseminating the data	118
6.2 Improving and updating the dataset	119
6.3 Using the findings - Sustaining and growing canopy cover	121
References	123
APPENDICES	126
Appendix 1: The economic, social and environmental value of trees for towns and cities	127
Appendix 2: Obtaining canopy cover data - the approach and methodology	131



List of Figures and Tables

List of Figures

Figure 1:	Blaenavon	9
Figure 2:	Planned housing estates - Hubberston, Milford Haven and Prestatyn	10
Figure 3:	Ferndale, Rhondda Fach	15
Figure 4:	The urban tree cover is a collective responsibility	18
Figure 5:	Two milestone documents; <i>Trees in Towns II</i> and <i>Trees in the Townscape</i>	19
Figure 6:	Aberystwyth University	21
Figure 7:	Top end of Rhondda Fawr with urban extent highlighted	23
Figure 8:	Urban areas by size category	24
Figure 9:	San Francisco Urban Forest Map	27
Figure 10:	Wrexham tree and woodland strategy 2016-2026	27
Figure 11:	County canopy cover - below the national average	31
Figure 12:	County canopy cover - above the national average	31
Figure 13:	High canopy cover example - Treharris (30%)	32
Figure 14:	Low canopy cover example - Rhyl (5.5%)	32
Figure 15:	2013 urban area canopy cover in relation to the four regional character zones	33
Figure 16:	The size and canopy cover of Wales' 220 urban areas	34
Figure 17:	Western Valleys towns	36
Figure 18:	Heads of the Valleys towns	38
Figure 19:	Southern Valleys towns	40
Figure 20:	South Coast towns	43
Figure 21:	West and South-West Coastal towns	45
Figure 22:	North Coast towns	47
Figure 23:	North-East towns	49
Figure 24:	North Wales Hinterland towns	51
Figure 25:	Mid-Wales Hinterland towns	53
Figure 26:	South Wales Hinterland towns	55
Figure 27:	Cardiff - the distinctive green corridor of the river Taff	62
Figure 28:	Distribution of 12 land-use categories (2013) across the 220 urban areas of Wales	65
Figure 29:	2013 urban canopy cover percentage breakdown per land-use	66
Figure 30:	Hectarage of canopy cover within each land-use	66
Figure 31:	Contrasting formal open space	67
Figure 32:	Contrasting cemetery landscapes	68
Figure 33:	Contrasting commercial areas	69
Figure 34:	High-density housing in Canton, Cardiff	69
Figure 35:	The 2013 national urban canopy cover percentage	70
Figure 36:	Extent of woodland canopy as a component of total cover within Wales' towns	71
Figure 37:	Land-use distribution of woodland (NFI) and amenity canopy cover	71



List of Figures (continued)

Figure 38: Cardiff East Communities First cluster area. Distribution and extent of woodland	73
Figure 39: Tondu, Bridgend - tree loss between 2006 and 2009	75
Figure 40: Wales' main towns where >40% of wards have <10% cover	86
Figure 41: Swansea - ward by ward distribution of canopy cover	87
Figure 42: Welsh Index of Multiple Deprivation, 2011	89
Figure 43: Canopy cover distribution across the 575 '1-570' WIMD wards	90
Figure 44: Canopy cover distribution across the 1,166 '571-1896' WIMD wards.	90
Figure 45: Rhyl West 1 ward with only 1% canopy cover	97
Figure 46: WIMD wards, and associated canopy cover, in the Caia Park area of Wrexham	98
Figure 47: Levels of PM ₁₀ pollution in relation to urban areas and transport corridors	101
Figure 48: An aerial view of Port Talbot with the Tata steel works	102
Figure 49: Contrasting canopy cover - the wards of Margam and Tai Bach in relation to Port Talbot and Neath	103
Figure 50: Flint - large tracts of grass around the flats offering opportunities for tree cover	106
Figure 51: Cardiff canopy cover and green areas with potential to explore new planting	110
Figure 52: Cardiff's existing tree cover per land-use	111
Figure 53: Cardiff's potential canopy cover per land-use	111
Figure 54: Oblique aerial of Cardiff Bay study area	112
Figure 55: Cardiff Bay 1-190 WIMD wards showing existing and potential cover	113
Figure 56: Pontcanna, Cardiff - town house gardens with space for trees, tree-lined streets	120
Figure 57: Contrasting urban fringes to towns	121
Figure 58: Abertillery - a South Wales Valleys community with a higher than average canopy cover of 27%	122
Figure 59: Oxford Street, Swansea - generous canopy cover providing an attractive place to shop	129
Figure 60: The long-lived, large-canopied London Plane, a lasting legacy from the Victorian era	129
Figure 61: Canon Street, Aberdare - trees offering a beneficial ingredient to the urban landscape	129
Figure 62: Urban town and fringe LSOAs	132
Figure 63: 3m street tree (centre) at 1:1,750 and 1:875 scales	135
Figure 64: Thematic map of small, medium and large canopy sizes	136
Figure 65: Quality resolution helps to distinguish >3.0m crowns	137
Figure 66: Visibility of trees not in leaf (points are captured trees)	137
Figure 67: Aerial photography flight path maps for 2006, 2009 and 2013/14	138
Figure 68: Shadow and cloud compromising reliable canopy capture	139
Figure 69: Examples of automatic residential classification	144
Figure 70: US example - Cumberland, Maryland	145



List of Tables

Table 1: Acronyms and Abbreviations	9
Table 2: A breakdown of Wales' urban areas by size category and population	22
Table 3: Western Valleys - Town canopy cover	37
Table 4: Heads of the Valleys - Town canopy cover	39
Table 5: Southern Valleys- Town canopy cover	41
Table 6: South Coast - Town canopy cover	44
Table 7: West and South West Coast - Town canopy cover	46
Table 8: North Coast - Town canopy cover	48
Table 9: North-East - Town canopy cover	50
Table 10: North Wales Hinterland - Town canopy cover	52
Table 11: Mid-Wales Hinterland - Town canopy cover	54
Table 12: South-Wales Hinterland - Town canopy cover	56
Table 13: Canopy cover comparison: Wales and England 'Top 20'	57
Table 14: Canopy cover comparison: Wales and England 'Bottom 20'	58
Table 15: Canopy cover comparison: Wales and the world	59
Table 16: American Forest's tree canopy goals	60
Table 17: Portland canopy cover targets	60
Table 18: Canopy cover within each land-use for the 220 towns	65
Table 19: Contrasting 'woodland' cover within Communities First cluster areas	72
Table 20: Number of trees in Wales' urban areas	74
Table 21: Urban areas showing loss of 200+ large trees over seven years	76
Table 22: 'Top 20' urban areas of canopy cover and amenity tree loss	77
Table 23: County canopy cover and tree loss - favourable counties	78
Table 24: County canopy cover and tree loss - counties with specific issues	79
Table 25: County canopy cover and tree loss - counties with greatest concerns	81
Table 26: Distribution of wards as per the Welsh Index of Multiple Deprivation 2011	88
Table 27: The 'Top 20' most canopied wards in Wales	91
Table 28: The 'Bottom 20' least canopied wards in Wales	92
Table 29: Canopy cover of Wales' most deprived wards	93
Table 30: Canopy cover in Communities First cluster areas	94
Table 31: North Denbighshire cluster area	97
Table 32: The potential within the 27 pilot towns to increase canopy cover	108
Table 33: Number of wards (WIMD 1-570 categories only) within the 27 pilot urban areas	109
Table 34: Cardiff Bay 1-190 WIMD wards; appraisal of ward character	114
Table 35: Potential canopy cover per land-use	115
Table 36: Land-use categories and descriptions	141



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Acronyms and Abbreviations

AP	Aerial Photography
CIRIA	Construction Industry Research and Information Association
FCW	Forestry Commission Wales
LSOA	Lower Super Output Areas
NFI	National Forest Inventory
NRW	Natural Resources Wales
ONS	Office of National Statistics
PCC	Potential Canopy Cover
RCAHMW	Royal Commission on the Ancient and Historic Monuments of Wales
RMSI	RMSI Private Limited
TCWTC	Tree Cover in Wales' Towns and Cities
TDAG	Trees and Design Action Group
TPO	Tree Preservation Order
WG	Welsh Government
WIMD	Welsh Index of Multiple Deprivation

Table 1: Acronyms and Abbreviations



Figure 1: Blaenavon has 20% cover despite being a relatively elevated Valleys town.
Note the contrasting tree-less areas of terraced housing and the wooded surrounds to the church and ex-mine owner's property.
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Figure 2: Planned housing estates - Hubberston, Milford Haven (below), Prestatyn (above). Both are in coastal locations, built in the same period and similarly laid out with generous communal and garden green space. However, the contrast in the extent of tree cover is striking.
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Executive Summary

Trees: until now an uncharted resource for Welsh towns and cities

Trees are amongst the most versatile natural assets planners, policy makers, businesses and communities can use to cost-effectively raise the quality of Welsh towns and cities.

In spite of this potential, until now, very little has been known about Wales' urban tree resource - its extent, location and whether current provisions are adequate to effectively support the sustainable growth, health and well-being of Welsh urban communities.

The Tree Cover in Wales' Towns and Cities (TCWTC) study was designed to help address this gap and provide decision-makers around the country with the baseline information they need to strategically plan and manage Wales' urban tree resource.

The TCWTC study approach

Because it is mostly through their crown spread that trees deliver benefits, the TCWTC study focuses on tree canopy cover (rather than counting individual numbers of trees). This was mapped through a desk-based analysis of 2006, 2009 and 2013 aerial photographs for 220 urban areas as defined by the Office of National Statistics' settlement-based approach.

Wales is the first country in the world to undertake a complete canopy cover study of all its urban areas

The findings of non-woodland 'amenity' trees were complemented by existing datasets on urban woodland (>0.5 hectares), using National Forest Inventory data. The analysis conducted at multiple scales (county, town and ward-level) also considered the relation between canopy cover and local levels of deprivation.

A powerful and versatile natural asset for the urban environment:

- Trees help create attractive towns, encouraging inward investment and increasing property values as well as improving energy efficiency of buildings

'Customers are prepared to pay more for parking and goods (9-12% for some products) in landscaped shopping areas'¹

- Trees can improve health and well-being by removing pollutants from the air, encouraging exercise and greater community cohesion, lowering crime levels and connecting people with nature

'Children living in areas with more street trees have lower prevalence of asthma'²

- Trees counter the extremes of climate change, reducing flooding through intercepting rainfall and slowing stormwater run-off, moderating temperature within the built environment and storing carbon

'Every 5% increase in tree cover reduced water run-off by 2%'³

¹ Wolf, K., (1998) *Trees in Business Districts – Positive Effects on Consumer Behaviour*. University of Washington College of Forest Resources

² Lovasi, G., Quinn, J., Neckerman, K., Perzanowski, M., Rundle, A., (2007) *Children living in areas with more street trees have lower prevalence of asthma*. *Journal of Epidemiology and Community Health* 62(7), pp 647-9

³ Nisbet, T., Thomas, H., (2006) *The role of woodland in flood control: a landscape perspective*. *Forest Research*



A portrait of Wales' urban tree canopy

Wales' mean urban tree cover was estimated at 16.3% for 2013

Compared with the tree canopy observed in other towns and cities around the world, this is a mid-range figure. If Wales is to position itself on the world stage of sustainability, this suggests scope for improvement.

High differences from town to town

Behind national figures, landscape character influences the noticeable differences that exist:

- 24 of South Wales Valleys urban areas have cover in excess of 20%, such as Treharris (30%) and Abertillery (27%).
- Coastal towns often, but not exclusively, have very low cover. Examples include Rhyl and Porthcawl (6%), Holyhead (7%) and Port Talbot (8%).

Within similar environments, whether within the South Wales Valleys or along the coast, local landscape and social influences are at play accounting for a further contrast in canopy cover. Both the highest and lowest levels of urban tree cover in Wales can be found in small southern former mining towns: Trimsaran (33.9%) and Fochriw (2.8%). The north coast towns of Rhyl (6%) and Colwyn Bay (18%) are only 10 miles apart.

Cardiff, Wales' capital city with over 11% of the country's population, has a lower than national average canopy cover.

One third urban woodland, two thirds amenity trees

Urban woodlands represent 35% of Wales' urban canopy cover. The rest is made up of so-called 'amenity' non-woodland trees, those individual and groups of trees growing along streets, gardens, car parks and other urban public and private open spaces.

Distribution of canopy amongst land uses tells a great deal about urban tree stewardship

Public open space hosts 53% of all tree cover in our communities despite making up only 22% of urban land. 21% of graveyards and cemeteries are covered by tree canopy.

Just 1% of all tree cover is found in areas of high-density housing, and it's these areas that often experience the highest levels of deprivation. Private residential gardens make up 35% of Wales' urban areas and provide 20% of all our towns' tree cover.

The tree cover within gardens themselves is a more modest 11%. These low-density residential properties, low on woodland cover (7%) however are the main home for Wales' amenity trees - 28%.

This underlines the responsibility of homeowners, and the importance of the good use and management of tree preservation orders to the upkeep of the Welsh urban forest. It also highlights the responsibility of developers and planners as part of the development process to ensure our housing areas are all adequately canopied.

Transport routes - including verges and pavements - make up 16% of urban land but they have tree cover of only 9%. Motorised traffic causes much of the urban air and surface water pollution, which trees have the ability to remove.

Canopy cover levels observed in schools and hospital grounds suggest opportunities to increase tree cover with obvious health, well-being and learning benefits.



2006-2013 tree loss

When comparing the canopy capture findings from 2006 until 2013, 7,000 large trees appear to have been lost. This suggests a ongoing erosion of Wales' Victorian and Edwardian tree legacy.

Use of an improved aerial image definition for the 2009 canopy capture led to an artificial increase in the canopy figures, as smaller trees that had not previously been accounted for were being better captured. In spite of this, 56 towns still showed evidence of canopy loss.

What is most alarming is the comparison between the 2009 and 2013 imagery of similar resolution - 159 towns are now showing evidence of canopy loss, 72% of our towns.

Tree cover in deprived areas tends to be lower and relatively less rich in amenity trees

Whilst variation exists, 51% of more affluent wards have cover greater than 15% compared to 37% for less well-off wards. In the 10 deprived wards of Cardiff's Butetown, Riverside and Grangetown 'Communities First' cluster area, all have less than 8% tree cover.

There is however great variation in tree cover within Wales' top 10 most deprived wards, from as little as 2% in Rhyl West 2 and 3% in Rhymney's Twyn Carno 1, to 19% in Merthyr Vale and 15% in the Rhondda's Tylorstown 1.

Where high tree cover and high level of deprivation coexist, this seems to be associated with local urban woodland being present rather than amenity trees, e.g. woods provide 47% to 66% of all cover in 7 of the 9 Pentwyn and Llanrumney wards, Cardiff. Woods of this nature can sometimes be unmanaged and inaccessible. In contrast, with woodland entirely absent in these two Llanrumney wards, amenity trees contribute only 7% to overall cover.

Potential for tree cover

'Green land' sites (soil, grass and shrub areas) were assessed for potential planting, piloting one major town in each local authority.

If all 'green land' sites identified were planted, with the right trees in the right places, cover in towns could potentially increase by 35-52%.

Knowing where trees might be planted enables planners to set realistic canopy cover targets. Many North American and Australian cities have comprehensive tree strategies with tree canopy cover goals. Portland in Oregon, with a similar climate to Wales, intends to increase its cover by 7% from its current level of 26%. Bristol City Council has set an aspirational goal of increasing canopy cover from 14% to 30%.

If Welsh towns with lower cover aimed for 20% (the UK Forest Standard woodland definition) in the medium term - we could have a nation of woodland towns!



The way ahead

Having good evidence is important. Taking action based on that evidence is crucial. The study highlights significant opportunities to enhance Wales' urban tree resource. This is how we can work together to make the most of what we now know:

WHAT WE CAN ALL DO:

Share and build the evidence

What gets measured gets managed. The study has addressed a significant information gap. It's crucial that we continue to share findings and continue the research:

- 1 Use and share the data
- 2 Build on the data to add qualitative information e.g. developing a greater understanding of tree species, their condition and value, surveying the extent of young trees and determining public / private ownership of trees

NATURAL RESOURCES WALES WILL:

- 1 Make all data available on the Lle website for download
- 2 Undertake further survey updates using the latest aerial photography
- 3 Gather feedback on the study to improve methodology
- 4 Explore collaborative approaches to data collection and sharing
- 5 Promote and publish best practice case studies

Adopt a strategic approach to managing our urban trees

The study has identified significant discrepancies in canopy cover levels between and within individual towns. International best practice shows that the best way to ensure all urban communities achieve adequate canopy cover is to:

- 3 Develop and adopt local Tree Strategies – particularly in less canopied areas
- 4 Set local tree canopy cover targets to drive and monitor progress
- 6 Develop an enabling programme – supporting local authorities with least canopy cover and most tree loss
- 7 Encourage and celebrate local success

Supporting sustainable urban tree management

Significant rates of tree loss have been identified. It's crucial that we:

- 5 Review the effectiveness and use of existing tools and legislation for tree care and preservation
- 6 Ensure that the potential of grant programmes is maximised to support Wales' urban treescape.
- 8 Support the Welsh Government's review of existing tools and legislation for tree care and preservation and their use.



Sharing and disseminating results

Re-launching both this updated report and the accompanying summary is NRW's next logical step in sharing the most recent key findings from this work.

The report and summary are available online at the Natural Resources Wales' website.

Data sharing

The report and summary are supplemented by:

- Visiting the County Local Evidence Packages from the Infobase Cymru website, to identify those towns assessed for their canopy cover.
- Accessing the Welsh Government and Natural Resources Wales Lle geo-portal website for the study datasets in GIS and tabular formats.

Availability of 22 County Supplements

County reports, providing canopy cover highlights, suggested actions with potential target wards, plus a town-by-town data breakdown and analysis, are available from: urbantrees@naturalresourceswales.gov.uk



Figure 3: Ferndale, Rhondda Fach. Typical Valleys housing layout with little space for trees, though within the urban boundary canopy cover is 19%. © NRW

1. Introduction

The 'Tree Cover in Wales' Towns and Cities' study is the first nationwide study of a whole country's urban area to be undertaken anywhere in the world. Start here to understand the context, objectives, audience, and future prospects of this work:

- 1.1 Why a 'Tree Cover in Wales' Towns and Cities' study?
- 1.2 Who is this study for?
- 1.3 How was the study developed? An overview
- 1.4 A world first, revealing opportunities for sustainable growth



1.1 Why a 'Tree Cover in Wales' Towns and Cities' study?

Urban trees, a shared responsibility

Responsibility for urban trees has traditionally been vested with the Local Planning Authorities. This is often cross-departmental depending on:

- Whether trees fall within council-controlled land (highways, schools, parks, etc.) or beyond.
- What aspect of tree work is involved: design & implementation, planning conditions & enforcement, cyclical maintenance, health & safety checks, etc.

Urban tree cover also falls under the auspices of a wide range of other landowners such as Registered Social Landlords and other public bodies e.g. hospitals who manage trees within their estates. Most urban land is under private ownership, of which gardens form a significant proportion (35%). Tree Preservation Order (TPOs) legislation is available to Local Planning Authorities to protect trees of high amenity benefit and these tend to be issued for trees on private land.

Growing pressures on urban trees

The pressures on urban trees are considerable and the reasons for tree removal are varied. Both professionals and the wider public share a responsibility for tree loss, as illustrated in Figure 4. Drivers for removal include:

- An aging tree population, leading to growing numbers of dying and dangerous trees;
- Increased threats from diseases, often related to specific species;
- Lack of understanding of the benefits trees bring to society, and of available solutions to better integrate them into urban infrastructure when dealing with issues such as subsidence, pavement heave, blocked drains, loss of light and slippery paths due to leaf and fruit drop;
- Demand for new building development and work to the utilities infrastructure;
- 'Right tree right place' approach not being adhered to at planting, compromising the tree's future prospects.

Concerns on growing tree loss are well documented in England in the Government-sponsored *Trees in Towns II*⁴ and the Mayor of London's 2007 *Chainsaw Massacre*⁵. Both studies highlighted that where the Victorian legacy of large-canopied trees planted in parks, gardens and streets is being lost, it is often being replaced, if at all, by small, short-lived trees. Small trees often appear as suitable, less challenging alternative species for hard urban environments.

This trend goes against an increasing and compelling body of research on the benefits of large species trees for the overall well-being of an urban population – particularly important in assisting with adaptation to climate change. This was well documented by CIRIA, the built environment's research body, in *The Benefits of Large Species Trees in Urban Landscapes*⁶.

⁴ Britt, C., Johnston, M., (2008) *Trees in Towns II – a new survey of urban trees in England and their condition and management*. Department for Communities and Local Government

⁵ Mayor of London, Environment Committee, (2007) *Chainsaw Massacre, a review of London's street trees*. Greater London Authority

⁶ Armour, T., Job, M., Canavan, R., (2012) *The Benefits of Large Species Trees in Urban Landscapes – costing, design and management guide: C712*. CIRIA



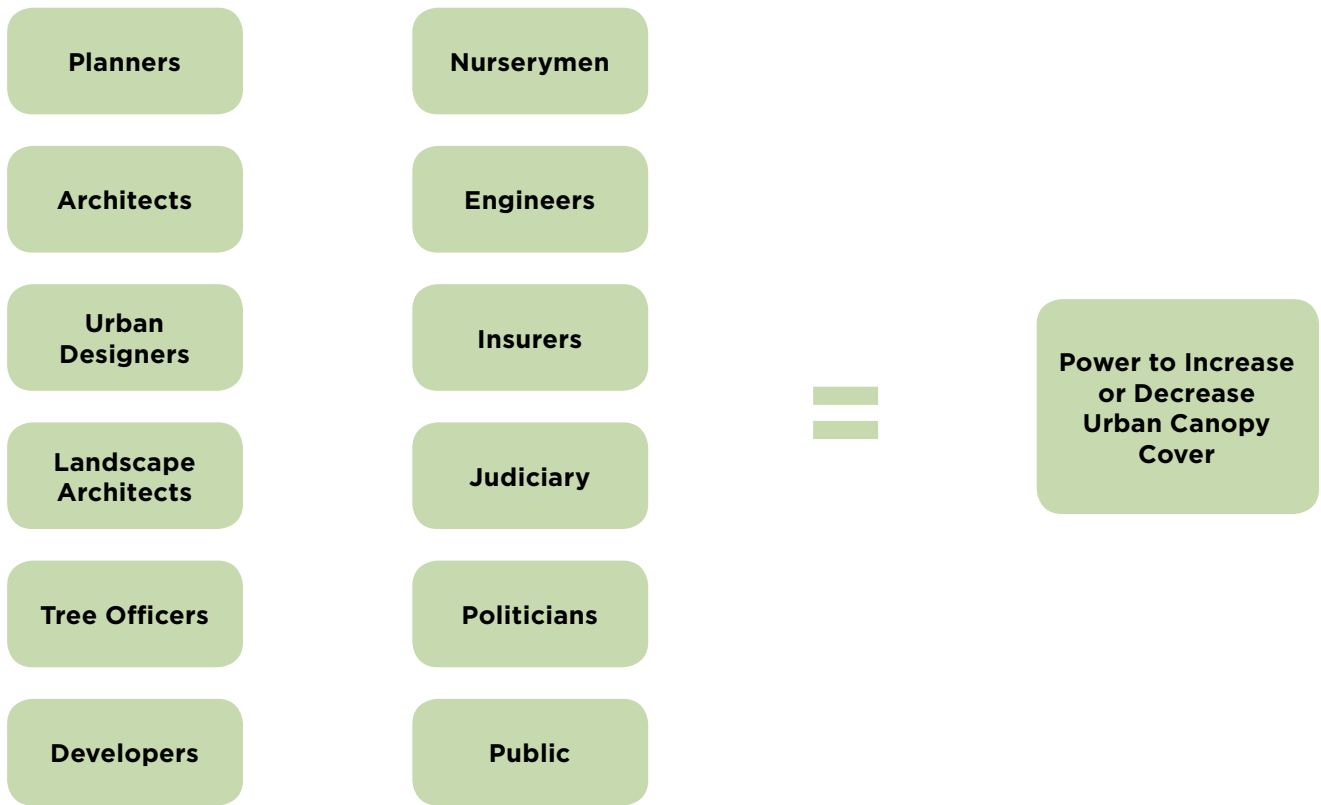


Figure 4: The urban tree cover is a collective responsibility. Adapted from © Jeremy Barrell

Taking a national pro-active approach

In 2009, the Welsh Government’s *Woodlands for Wales*⁷ strategy highlighted the need for a pro-active national approach to the management and expansion of urban woodland and trees. In response, Forestry Commission Wales (FCW) undertook a scoping and research exercise to better understand the issues affecting urban trees across Wales and to identify where FCW could best contribute. This showed that local authorities lack a full picture of the canopy cover in their towns.

Urban tree canopy cover, or the amount and distribution of leaf area as seen from the air, is the driving force behind the ability of urban trees to bring benefits to communities. As canopy cover increases, so do the benefits afforded by the leaf area: climate control and energy savings; improvement of air, soil and water quality; mitigation of stormwater run-off; provision of wildlife habitat; increased property values; and community vitality.

Understanding tree canopy cover is fundamental to all that underpins the good management of trees in towns and cities. The English Government’s 2008 national survey and audit *Trees in Towns II* concluded that “without this information, it is impossible to develop a meaningful tree strategy that can drive the tree programme forward”. ‘Tree strategies’ feature as one of the 10 priority action targets recommended by the report. ‘Know your tree resources’ also features as the first of 12 key principles of good practice, presented in the Trees and Design Action Group’s (TDAG) *Trees in the Townscape, A Guide for Decision Makers*⁸.

⁷ The Welsh Assembly Government’s Strategy for Woodlands and Trees, (2009) *Woodlands for Wales* - on the Welsh Government website

⁸ Jaluzot A., James, S., Pauli, M., (2012) *Trees in the Townscape, A Guide for Decision Makers*. Trees and Design Action Group - on the TDAG website



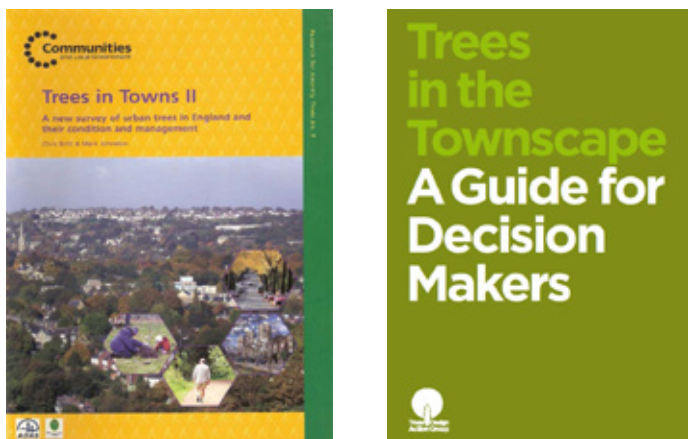


Figure 5: Two milestone documents; England's Department for Communities and Local Government's *Trees in Towns II* survey as to the condition and management of urban trees in England (© HMSO) and TDAG's *Trees in the Townscape, A Guide for Decision Makers*.

Filling a knowledge gap to empower strategic action

To enable a better understanding and management of the country's urban tree resource, FCW launched the *Tree Cover in Wales' Towns and Cities* (TCWTC) study based on a consistent approach to mapping and measuring tree canopy cover within all urban areas in Wales. This was continued by Natural Resources Wales and offered the prospect to:

- Provide Local Planning Authorities and their partners, including the Welsh Government and its Agencies, with a solid foundation to take a strategic approach to urban tree management;
- Enhance understanding of Wales' recent trends in urban canopy cover evolution and offer a baseline for future national monitoring.

The study presents an updated version of those initial findings.

1.2 Who is this study for?

The TCWTC study makes a significant contribution to building understanding and capacity for effective national coordination of urban green infrastructure delivery. Its findings will be of interest to both policy makers and practitioners, particularly those in the Welsh Government, Natural Resources Wales, local authorities, Registered Social Landlords and other significant land owners in urban areas, e.g. Welsh Water, and non-governmental bodies.

The Welsh Government

The Welsh Government has made sustainable development its central organising principle. It is committed to:

- Improving the economic, social and environmental well-being of people and communities, so as to achieve better quality of life now and in the future.
- Promoting fair, safe and sustainable communities, social justice and equal opportunities for all; and,
- Supporting the management of Wales' natural and cultural environment, using a fair share of resources, and sustaining the Welsh cultural legacy.

Better provision and management of urban trees will contribute to deliver all three objectives the Welsh Government has set for the nation.

This study provides the Welsh Government with the evidence needed to review and optimise both national policy and governmental grant allocation criteria. It will help to ensure that the contribution urban trees can make to building a Sustainable Wales is fully realised.



Natural Resources Wales (NRW)

The Welsh Government's Well-being of Future Generations (Wales) Act 2015 puts in place seven well-being goals and five ways of working that public bodies must apply in adhering to the sustainable development principle. The well-being goals are:

1. A prosperous Wales
2. A resilient Wales
3. A healthier Wales
4. A more equal Wales
5. A Wales of cohesive communities
6. A Wales of vibrant culture and thriving Welsh language
7. A globally responsible Wales.

Alongside this sits the Environment (Wales) Act 2016, in which NRW's purpose is defined along with the principles of sustainable management of natural resources. With NRW leading on developing Area Statements and having representation on Public Services Boards, there is a real opportunity to ensure that urban green infrastructure and trees are at the heart of Wellbeing Plans, with the multiple benefits they deliver fully recognised and championed.

The urban environment was one of four key priority work areas the Welsh Government asked NRW to focus on during its first year of operation. The TCWTC study establishes sound evidence and guidance for NRW's urban forestry programme for Wales' towns and cities. The TCWTC study:

- Provides a baseline to ensure progress and changes over time can be monitored
- Highlights where efforts and resources are most needed
- Identifies where 'quick wins' can be realised
- Recommends key actions for NRW and its partners for capacity building and for more effective urban forestry management across Wales

Local authorities

The TCWTC study offers local planning authorities across the country the evidence they need to take a strategic approach to the planning and management of their local tree resource. Specifically, the TCWTC provides local authorities with:

- A comprehensive baseline of both public and private canopy cover in their urban areas, which can be freely downloaded in GIS format for further analysis and manipulation in light of local information and priorities
- A set of benchmarks against which they can compare their local figures, to assist with setting their own future tree cover goals and define priorities
- Examples of methodologies (e.g. how to identify potential opportunities and 'easy wins' for new tree planting) to help inform the development of their local tree programme.

This places local planning authorities across Wales in an unprecedented favourable position to convene their local partners to build robust tree strategies and to ensure trees are an effective part of the green infrastructure, enabling local sustainable development.

Registered Social Landlords and other significant landowners in urban areas

Registered Social Landlords are significant owners and managers of green and open space on people's doorsteps in urban areas. In some areas they might manage and own more publicly accessible green space than the local authority⁹. Registered Social Landlords are therefore key agents for the management and growth of the Welsh urban tree resource.

⁹ Improving Open Spaces with Social Landlords - on Neighbourhoods Green website

¹⁰ Tree Management Toolkit - on Neighbourhoods Green website



The TCWTC study provides Registered Social Landlords and other significant urban landowners with strong community links (e.g. health boards / grounds of healthcare facilities) with a GIS baseline of their current tree resources within urban areas, available upon request from NRW. As for local authorities, this information provides a rich basis to work with their tenants and other partners on the development of a tree strategy¹⁰ grounded in a long-term and community-benefit generating strategy.

Welsh Water

Welsh Water is increasingly adopting sustainable solutions – as demonstrated in the exemplar Llanelli RainScape project¹¹ to reduce the risk of flooding and sewer spillages. The international best practices which Welsh Water has been emulating suggest that canopy cover and the underground environment associated with tree roots can be effective tools to incorporate in a wider strategy towards reducing stormwater run-off. The datasets developed, made available through the TCWTC, provide Welsh Water with a basis to continue breaking new ground in the UK in designing sustainable approaches to drainage and sewer spillage issues.

Community organisations

The TCWTC study offers local community organisations the information they need to take an active part in the strategic planning of their local tree resource. The present report, together with county canopy cover reports, available from NRW, makes this information easy to assimilate and use by everyone.



Figure 6: Aberystwyth University - The power of trees to transform a landscape. The National Library (left) in 1947 with open fields behind. The 2008 photograph (right) of the University Campus, behind the Library, shows a landscape well-endowed with maturing trees. The University's landscape master-plan was designed and implemented as part of an integral scheme with the buildings in the 60s. © Crown Copyright: RCAHMW

¹¹ RainScape Llanelli - on the Dŵr Cymru website



1.3 How was the study developed? An overview

Defining the scope of the TCWTC study: Wales' towns and cities

80% of the Welsh population live in towns and cities. By focusing on the urban environment the TCWTC study provides insight into how trees contribute to the quality of those places people use and experience the most.

For the purpose of urban canopy cover mapping, 'urban' areas were based on the Rural and Urban Area Classification methodology adopted by the Office for National Statistics. Included in the study were settlements falling within the urban (less sparse/sparse) and the town and fringe (less sparse) categories. The exact boundaries to these urban areas were then determined using land-use rules as explained in Appendix A2.2.

The selection of 220 'urban areas' identified based on these criteria resulted in a considerable size-spread from Cardiff (8,552ha) to Pontrhydyfen (20ha), with a large majority of medium and small towns. As shown in Table 2, 63% of towns fall in the <250ha size class, with only 9% >1,000ha. The minimum population size was 1,500, with towns falling within the 'rural sparse' category being excluded.

Urban Area Size (ha) Category:

	0 - 5%	5.1 - 10%	15.1 - 20%	20.1-25%	>25.1%	
Urban Size Category (ha)	No. of Urban Areas	% of Urban Areas	Total Area (ha)	% of Urban Total	Population	% of Urban Total
>5000	2	1%	14,333	17%	522,813	21%
1001 - 5000	18	8%	30,704	36%	826,320	33%
501 - 1000	18	8%	10,986	13%	289,700	12%
251 - 500	44	20%	15,437	18%	425,379	17%
0 - 250	138	63%	14,871	17%	432,496	17%
TOTAL	220	100%	86,331	100%	2,496,708	100%

Table 2: A breakdown of Wales' urban areas by size category and population.

As shown in Figure 8, this selection includes:

- Wales' largest conurbations: Cardiff, Swansea and Newport
- Wales' legacy of industrial towns: Pontypool to Gwendraeth in the Valleys, Flint and Wrexham in the Northeast, the Caernarfon hinterland, and the communities in and around Llanelli and Port Talbot
- Wales' maritime and coastal towns: such as Barry, Pembroke Dock, Aberystwyth, Holyhead, Bangor, and the north Wales coastal towns from Llandudno to Prestatyn. Many of these developed as Victorian seaside destinations, others functioned as dockland and harbour towns
- Wales' market towns: including Monmouth, Brecon to Carmarthen in the south, Builth Wells, Machynlleth and Welshpool in mid-Wales and Ruthin, Bala and Llangefni in the north.

Wales is strongly based on communities, often adjoining as in the Valleys. However, the urban area definition used meant that where there was a continual built environment this was counted as one entity. One example of this is in Rhondda Fawr where the urban area includes all towns in the valley from Trehafod to Blaenrhondda, as partly shown in Figure 7.



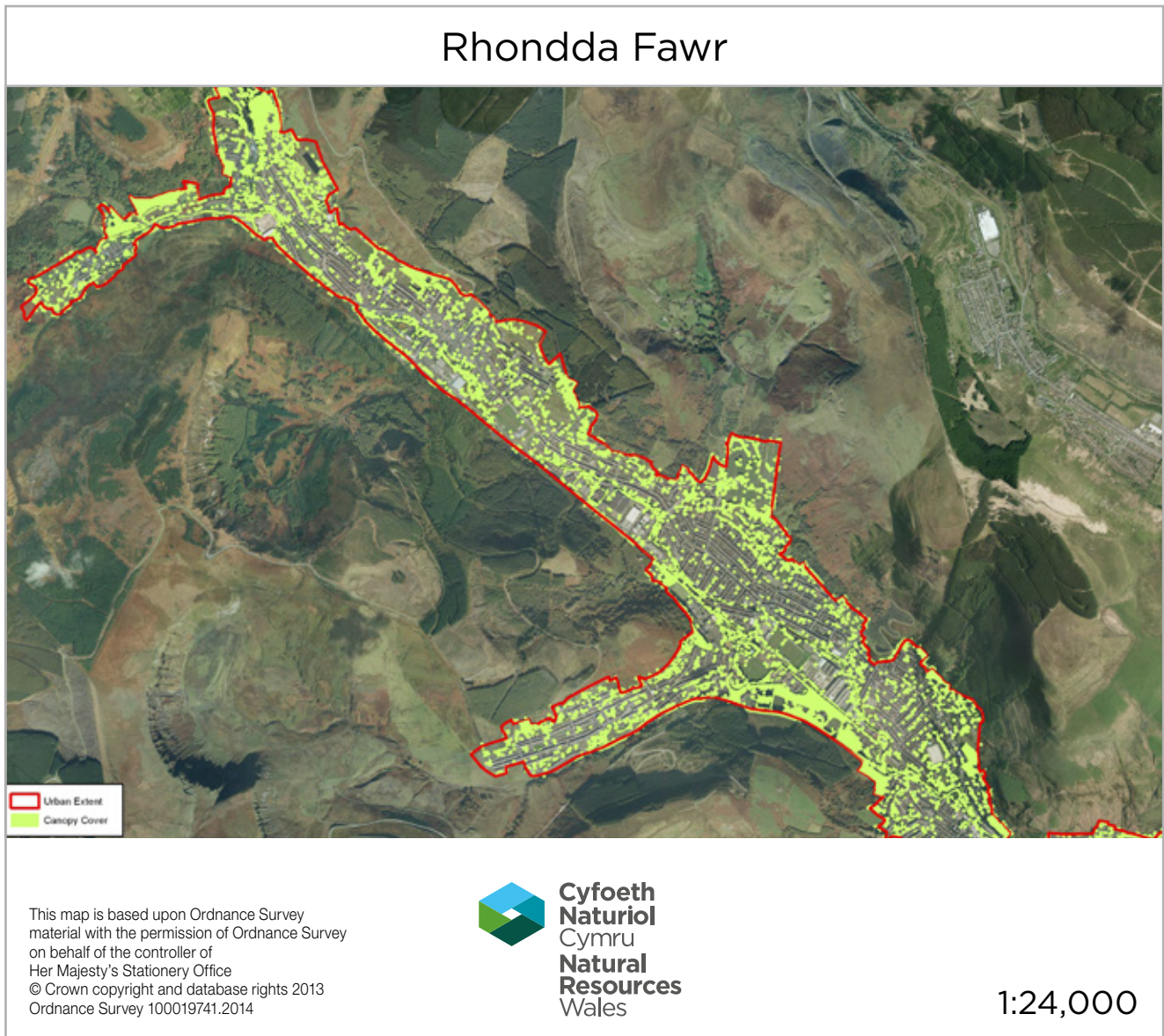


Figure 7: Top end of Rhondda Fawr (Ton Pentre to Blaenrhondda) with urban extent highlighted tight up against the built environment. The Welsh Government's 'largest urban forest in Europe', managed by NRW, is not included within the urban canopy cover study (See Appendix A2.1).



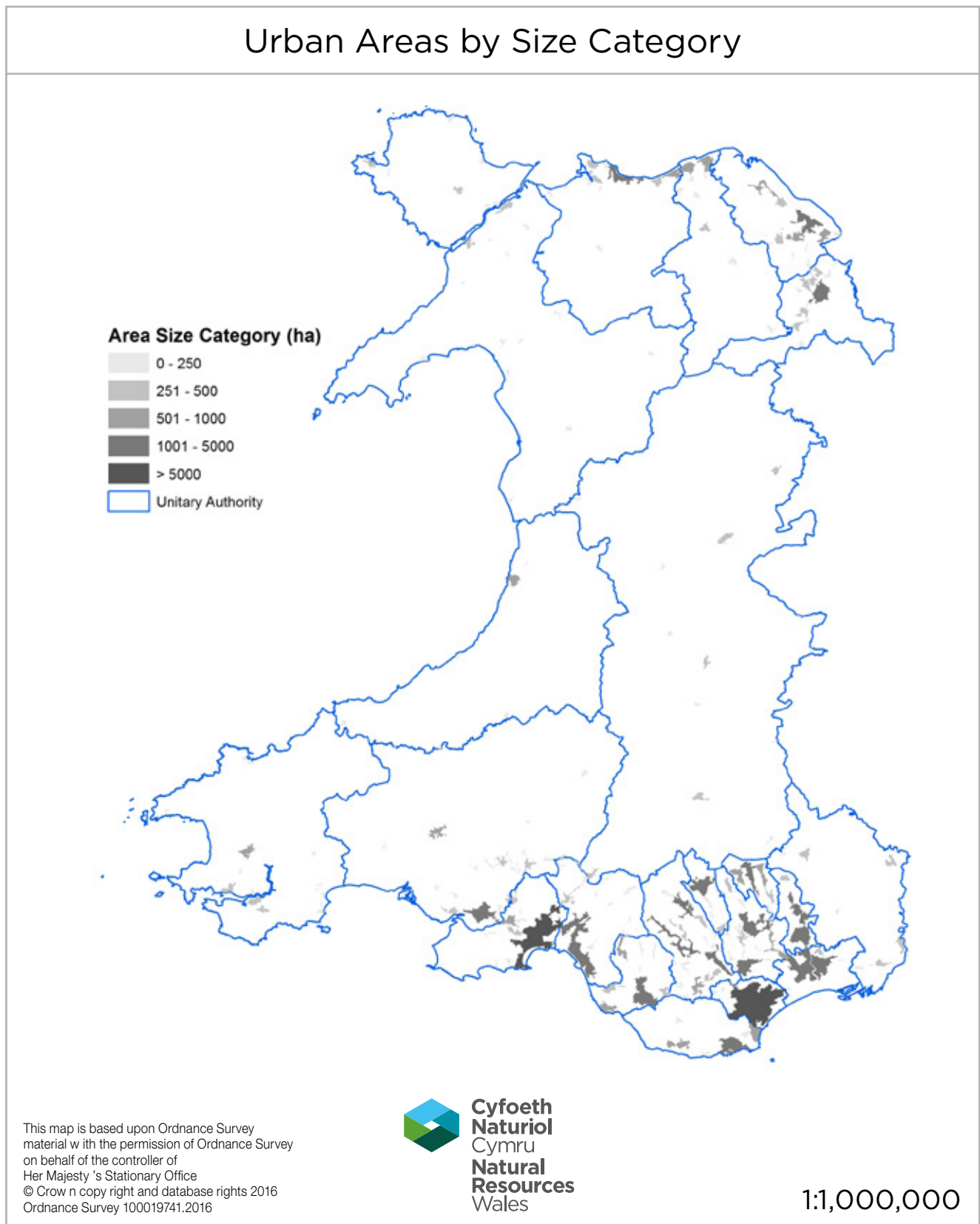


Figure 8: Urban areas by size category



Starting with a pilot (Phase 1)

In 2010, FCW launched a pilot project to use aerial photograph interpretation to determine the extent of urban canopy cover in Wales' 40 largest urban areas.

Data capture was based on the Welsh Government's 2006 aerial photography. With a resolution of 40cm, the 2006 aerial was able to reliably map trees (points and polygons) of 3.0 metre or more in diameter. This meant that young, fastigate, heavily pollarded or pruned older trees were likely not to be recorded. These omissions were deemed acceptable as these trees arguably do not contribute significantly to the overall percentage canopy cover.

Data from the National Forest Inventory (NFI), i.e. woods over 0.5 hectares, were added to the overall final picture. There is an element of the NFI data that does align with the NRW methodology: 1) young planted 'woods' that are less than 3.0m crown diameter and 2) 20% cover plus 'woods' that do not, by definition provide 100% canopy cover (see Appendix A2.2.3).

The findings primarily focused on town-level percentage and hectareage cover but also included a canopy cover breakdown across 12 land-use classes. This was supplemented by information on tree size numbers, density and, in the case of polygons, whether the stands were broadleaf, conifer, or mixed.

Rolling out the methodology to all Wales (Phase 2)

Building on Phase 1, FCW commissioned completion of the survey in 2012 based on the same methodology, for all of Wales' 220 'urban' areas. The data capture was undertaken by RMSI, using aerials from both 2006 and 2009. The goal was to ascertain whether, despite only a three-year interval, any loss of tree cover had occurred. Anecdotal evidence, plus an FCW-led pilot mapping comparison for Aberystwyth, had suggested incremental loss.

Besides providing town-wide canopy cover data, Phase 2 of the work also drilled down to a ward-level with a particular focus on areas of multiple deprivation (based on the Wales Index of Multiple Deprivation - WIMD).

An assessment of potential target areas for tree planting was also carried out for one pilot town per Local and National Park Authority. This used OS MasterMap to map areas potentially suitable for additional tree planting that could help increase the local tree canopy cover (see Section 5).

Re-running the all Wales canopy cover mapping (Phase 3)

AECOM were commissioned in 2016 to undertake a re-survey utilising 2013-14 aerial photography and supplying data as per Phase 2, minus the potential target areas for planting exercise. Boundaries for 12 towns in South Wales were extended to include urban areas not included previously. 2006 and 2009 aerial photography for these areas were also assessed so as to provide three comparable datasets across the three time-frames.

Quality assurance throughout the three phases was always potentially going to be a challenge. Ensuring consistency of data capture and interpretation was essential. Having dedicated staff responsible for scrutiny was invaluable in ensuring accurate and reliable information.

Sharing and disseminating results

Re-launching both this updated report and the accompanying summary is NRW's next logical step in sharing the most recent key findings from this work.

The report and summary are available online at the Natural Resources Wales' website.

Data sharing

The report and summary are supplemented by:

- Visiting the County Local Evidence Packages from the Infobase Cymru website, to identify those towns assessed for their canopy cover.
- Accessing the Welsh Government and Natural Resources Wales Lle geo-portal website for the study datasets in GIS and tabular formats.

Availability of 22 County Supplements

County reports, providing canopy cover highlights, suggested actions with potential target wards, plus a town-by-town data breakdown and analysis, are available from: urbantrees@naturalresourceswales.gov.uk



1.4 A world first, revealing opportunities for sustainable growth

The TCWTC study is the first nationwide canopy cover study of a whole country's urban area to be undertaken anywhere in the world. Other canopy cover mapping initiatives around the world have, however, influenced it and provide some inspirational pointers as to where it could go next:

Canopy cover mapping in England

Immediately comparable to the TCWTC study is England's *Trees in Towns II* survey carried out in 2005 and published in 2008. Canopy cover was only one dimension of this highly comprehensive study of the condition and management of urban trees. The canopy cover analysis focused on 140 towns, divided evenly across a full range of population sizes, and was derived from sample plots within each town.

In addition, between 2006 and 2012 a number of cities or metropolitan areas, including Greater Manchester, Torbay and Bristol, conducted a combination of manual and automated GIS mapping to determine their tree populations. Manchester focussed on identifying areas of low tree cover and deprivation so as to target communities for planting. The approach also allowed for capture of tree height, which the TCWTC study didn't undertake. The audit results also provided the basis for setting a canopy cover increase target in 'Manchester: A Certain Future'¹², the city's strategy to manage climate change.

City-wide canopy cover mapping in the USA

Urban tree management has gained considerable momentum in the United States of America. Thanks to active methodological support from the US Department of Agriculture Forestry Service, cities all across the country, including Burlington VA, New York NY, Baltimore MD, Chicago IL, Seattle WA, Portland OR and San Francisco CA, have mapped their canopy cover, set land-use specific canopy cover targets, and enabled a full suite of targeted actions to maintain and increase a functional tree cover.

Inspired by US work on 'Potential Canopy Cover' this Welsh study is offering a snapshot of this approach intended to identify potential target areas for new tree planting. The study has not, however, been able to identify potential 'grey' land for retrofit planting due to the lack of detail in the OS MasterMap dataset. Although these 'demanding' environs are those usually in the greatest need of green infrastructure, tree planting within a hard landscape is also more challenging. Identifying treeless green areas provides valuable insight into where 'easy wins' might be realised.

Building on canopy cover mapping: crowd sourcing and benefits estimating (i-Tree Eco)

The US Department of Agriculture's Forest Service developed the i-Tree Eco approach in 2006 for ascertaining ecosystem benefits and values of urban tree populations. This has now been adapted and applied internationally, with studies undertaken in Chinese, Italian, Canadian, Spanish, Chilean and Australian cities.

Forest Research and Treeconomics have pioneered the approach in the UK. First piloted in Torbay (2011)¹³, the Victoria Business Improvement District in Westminster (2012)¹⁴, Edinburgh (2013), studies have since been carried out in Wrexham and Glasgow (2014) and the Tawe catchment, Bridgend and London in 2015.

San Francisco's Urban Forest Map¹⁵ project is an initiative involving government, businesses and residents in mapping every tree. Existing tree databases are available in the public domain for individuals to input tree information, and from this it calculates and displays environmental benefits that trees provide in terms of energy savings, reductions in greenhouse gases, water management and air quality improvement.

¹² Manchester: A Certain Future website

¹³ Treeconomics & Forest Research, (2011) *Torbay's Urban Forest, Assessing urban forest effects and values*.

A report on the findings from the UK i-Tree Eco pilot project - on the Torbay Council and Treeconomics websites

¹⁴ Treeconomics & Victoria BID, (2012) *Green Benefits in Victoria Business Improvement District*. An i-Tree Eco, CAVAT and G.I. Valuation Study - on the Victoria BID and Treeconomics websites

¹⁵ San Francisco Urban Forest Map - on the Urban Forest Map website



Based on the above US citizen science approach to mapping trees, the Open University and Forest Research launched Treezilla's 'Monster Map'¹⁶ in June 2013. A University of East Anglia student research project¹⁷ has since utilised Treezilla to map trees in Aberystwyth with the support of Greener Aberystwyth Group (GAG)¹⁸. From the 600 trees measured, and with the 25,000 trees the TCWTC study identified, the project estimated that the town's trees are worth £3.3m in ecosystem benefits (an annual value plus carbon stored to date).

Developments in Wales and potential next steps for TCWTC

At the October 2012 'National Urban Tree Workshop'¹⁹ in Newport, organised by FCW and hosted by Peter Davies (the then Sustainable Futures Commissioner for Wales), a key action was to set up a pilot 'i-Tree Eco' study. That resulted in the 2014 Wrexham i-Tree Eco study and, along with the original TCWTC findings, were both invaluable in informing and influencing Wrexham County Borough Council's current 2016-2026 tree strategy. In 2015 two further studies were undertaken and reported upon - Swansea and the Tawe catchment plus Bridgend County Borough.

As a taster from the findings, the annual ecosystem services provided by Swansea and the Tawe catchment's trees are valued at an estimated £1.72 million with carbon stored to date worth £23 million. Such headline figures are powerful and persuasive tools in arguing the case for trees.

These i-Tree Eco studies will also provide a reference for all Welsh local authorities, the Welsh Government and their partners, on:

- the value trees can bring to a local area;
- how to factor trees in cost/benefits analysis that are traditionally used to guide decision-making on infrastructure investment.

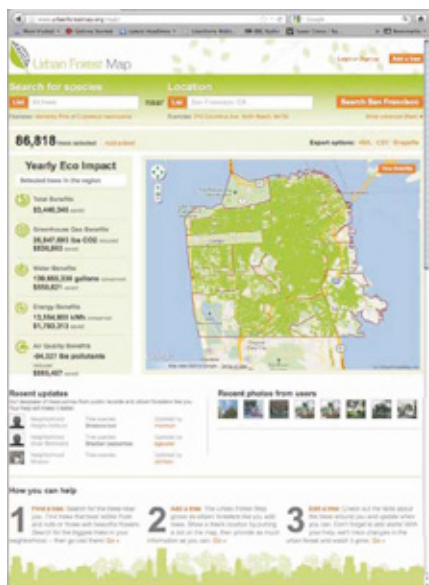


Figure 9: San Francisco Urban Forest Map

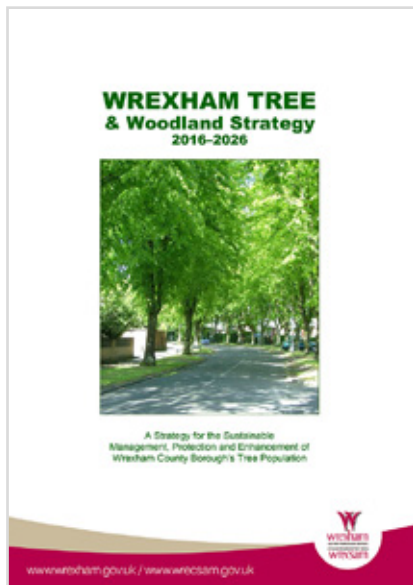


Figure 10: The latest Wrexham tree and woodland strategy 2016-2026²⁰, along with previous versions are leading the way in Wales in demonstrating the need for tree strategies. This updated strategy, rather than considering purely council trees, now provides a comprehensive approach for the vision and management of both private and public trees © WCBC

¹⁶ Open University, (2013) *Treezilla; the monster map of trees* - on the Treezilla website

¹⁷ ap Dafydd, G., (2014) *Monetising the ecosystem benefits that urban trees provide to society*. University of East Anglia, unpublished

¹⁸ Greener Aberystwyth Group website

¹⁹ Forestry Commission Wales, National Urban Tree Workshop, (2012)

²⁰ Wrexham County Borough Council, (2016) *Tree and Woodland Strategy 2016-2026* - on the Wrexham County Borough Council website



2. National, county and town canopy cover findings

This section presents headline findings on canopy cover extent.



This section presents headline findings on canopy cover extent.

Facts, figures and conclusions are provided in the following sequence:

- 2.1 National urban canopy cover
- 2.2 County canopy cover comparisons
- 2.3 Town canopy cover comparisons
- 2.4 International comparisons
- 2.5 Summary: actionable findings

Section 2 Highlights

- Wales' mean urban canopy cover in 2013 was estimated at 16.3% - down from 2009's 17.0%.
- 13 of the 22 counties have an overall town coverage of below the national mean. The counties of Denbighshire, Anglesey, the Vale of Glamorgan, Pembrokeshire and Conwy, all with coastal towns, record cover of 11-14%.
- Canopy cover in towns ranges from 33.9% to as low as 2.8%. Total cover varies dramatically across the country - from just 6% in Rhyl and Porthcawl, 7% in Holyhead and Port Talbot, to 30% in Treharris and 27% in Abertillery.
- Town size has little effect on mean canopy area. By contrast, regional landscape character does: there is higher cover in the South Wales Valleys communities and noticeably lower cover in most, but not all, coastal towns.
- Wales' urban area tree cover figures fall within the canopy ranges identified around the world. Where Welsh towns and cities are behind, however, is in setting canopy cover goals - this is considered good practice and widely adopted in North America and Australia.

2.1 National urban canopy cover

Mean urban canopy cover: 16.3%

Wales' mean urban canopy cover was estimated at 16.3% for 2013. Wales' total urban area was measured at 86,331 hectares. Of this, 14,097 hectares were covered by trees.

Across the urban areas canopy cover was found to range from 33.9% in Trimsaran to 2.8% in Fochriw. Both are former Valley mining communities falling into the smallest 0-250ha town size category (analysis of canopy cover and town size has shown no significant correlation - see 2.2 for more details).

Comparisons between canopy cover figures derived from the 2006 and 2009 aerals showed an increase of 2,068ha (+14.1%). It is difficult to envisage that amount of cover being recruited within three years. The main explanation is due to the improved 2009 aerial photographic resolution aided canopy capture (see Appendix A2.2.2 for further explanation).

Comparing findings between the 2009 and 2013 aerial photography of the same resolution lends itself to greater robustness. From 14,636ha in 2009 (17.0%) there has been a decline in canopy over the four years - a total of 539ha across Wales.

2.2 County canopy cover comparisons

County-scale urban canopy cover: highs and lows

All of the 22 counties have towns with canopy cover above and below the national average. When urban tree cover is calculated at county scale, 13 counties are below the 16.3% national average. The lowest percentage counties are all associated with the coastal belt: Denbighshire, Anglesey, the Vale of Glamorgan, Pembrokeshire and Conwy.

Six out of the nine counties featuring a mean urban tree cover above national average fall within the South Wales Valleys, with Torfaen on 23% and both Blaenau Gwent and Merthyr on over 20%.



County Canopy Cover

Below the 16.3% National Average

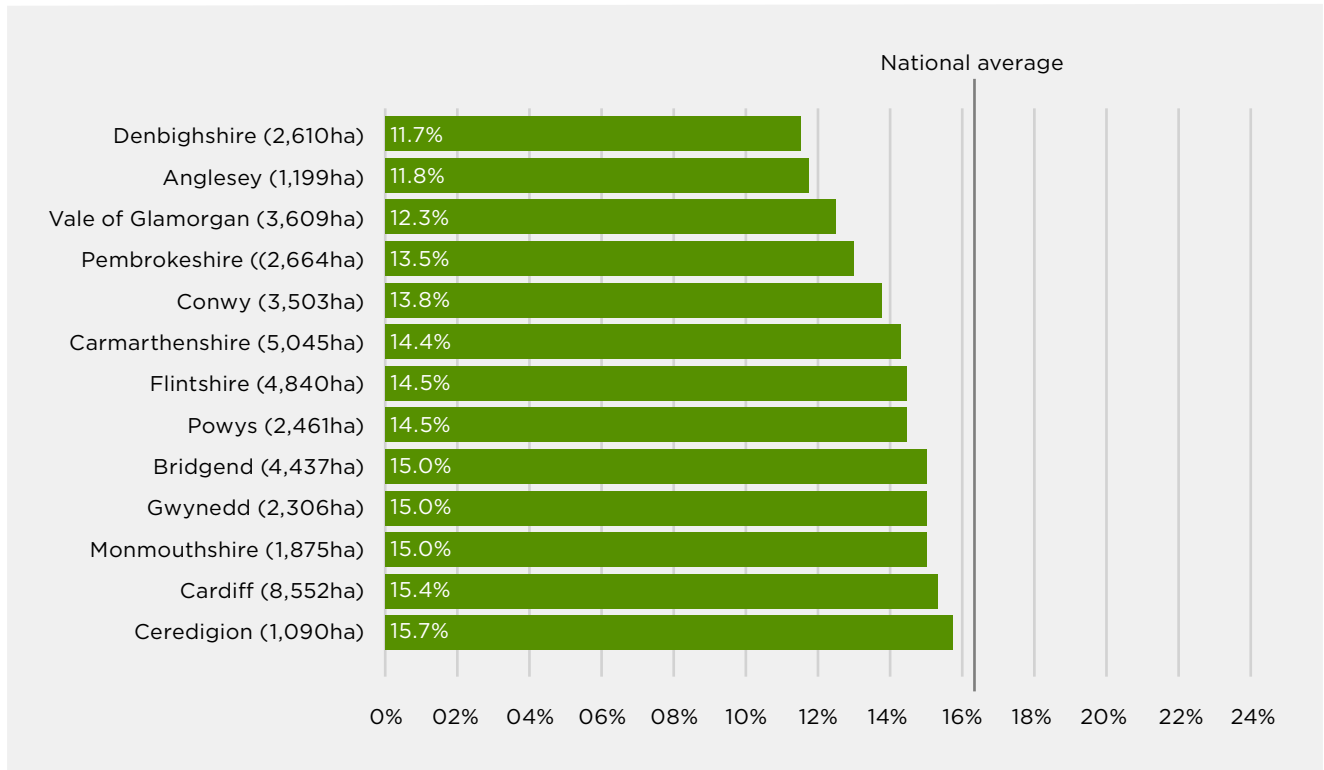


Figure 11: County canopy cover - below the national average (Urban extent of counties highlighted in hectares)

County Canopy Cover

Above the 16.3% National Average

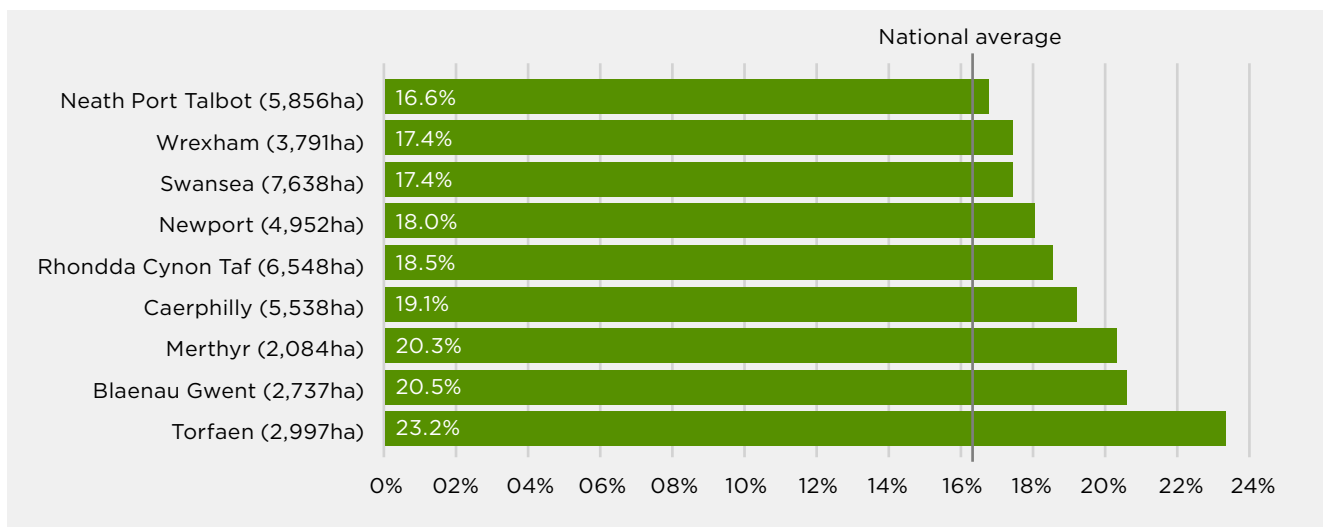


Figure 12: County canopy cover - above the national average (Urban extent of counties highlighted in hectares)





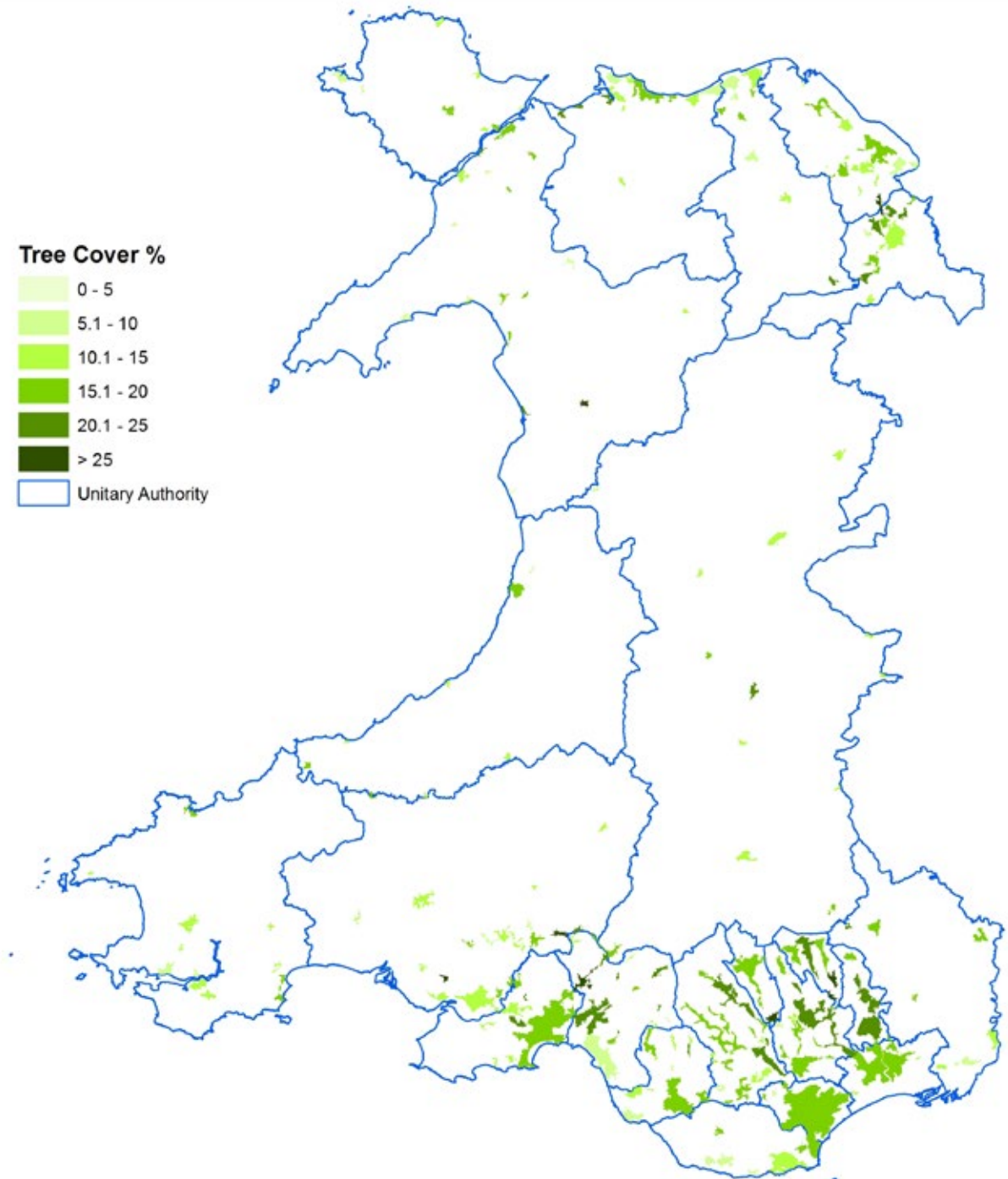
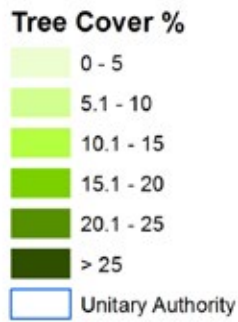
Figure 13: High canopy cover example - Treharris (30%).



Figure 14: Low canopy cover example - Rhyl (5.5%).



Urban Canopy Cover Percentage - 2013



This map is based upon Ordnance Survey material with the permission of Ordnance Survey on behalf of the controller of Her Majesty's Stationary Office © Crown copyright and database rights 2016 Ordnance Survey 100019741.2016

**Cyfoeth
Naturiol
Cymru
Natural
Resources
Wales**

1:1,000,000

Figure 15: 2013 urban area canopy cover in relation to the four regional character zones



2.3 Town canopy cover comparisons

Urban canopy cover is influenced by the landscape context: the traditionally wooded South Wales Valley communities have the highest urban tree cover, while coastal communities feature heavily amongst the lowest urban canopy coverage identified.

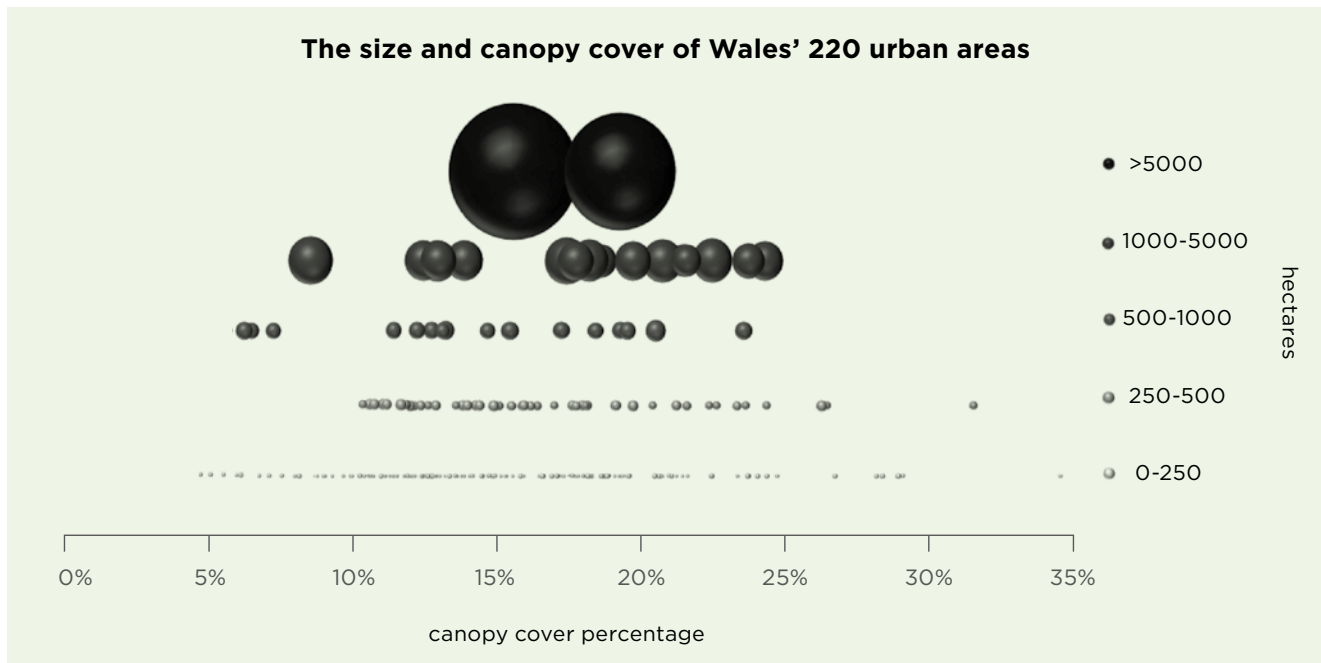


Figure 16: The size and canopy cover of Wales' 220 urban areas

Comparing urban canopy cover between towns located within similar environs helps to highlight both well provided towns and those with low cover, and where action might be needed. To facilitate such context-specific analysis, four broad regional landscape character zones were considered.

The following 10 tables for the 220 urban areas are split into their respective broad character areas.

- **Urban areas of the South Wales Valleys - 80 towns**
 - Table 3: Western Valleys
 - Table 4: Heads of the Valleys
 - Table 5: Southern Valleys
- **Coastal and seaboard towns - 74 towns**
 - Table 6: South Coast
 - Table 7: West and South West Coast
 - Table 8: North Coast
- **Towns of the North-East - 21 towns**
 - Table 9: North East
- **Hinterland communities - 45 towns**
 - Table 10: North Wales Hinterland
 - Table 11: Mid-Wales Hinterland
 - Table 12: South Wales Hinterland



The urban areas are listed in order of size (hectarage), highlighted in line with the grey colour-coding depicted below:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Population size is indicated but, whilst based on ONS figures, these are not exact as the TCWTC urban extents drawn up for this study do not entirely align with ONS town boundaries. The important link between how many people reside in a given community and the degree to which canopy cover influences their lives is, of course, fundamental. This is of particular interest in relation to high population densities, where frequently this would be associated with communities facing high levels of deprivation.

Canopy cover is highlighted with green colour-coding across the following 5 percentage category intervals:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban areas of the South Wales Valleys: highs and lows

The Valleys are characterised by a series of river corridors with post-industrial settlements often linked together and confined to valley bottoms and their immediate slopes. The narrow, steep-sided valleys of the east e.g. the Ebbw, give way to broader valleys further west e.g. the Gwendraeth. Similarly, the upper ends of the Valleys tend to be narrower and more elevated in nature, broadening out into the lower reaches en route to the south coast.

Forestry is frequently a dominant component in the wider landscape, to such an extent, that the Valleys have often been labelled as having the largest 'urban forest' in Europe. This 'forest', however, does not form part of this study.

- 1: In spite of tightly laid out terraced housing and compact town centres, a majority of Valleys communities, 51 out of 80, benefit from above national average tree cover. Twenty-four towns have over 20% tree cover, with over a third of the 'Heads of the Valleys' towns recording a canopy of between 20% and 32%. Six of the national 'Top 10' towns lie in the Valleys. Larger communities with over 20% are Neath, Pontardawe, Pontypridd, Aberdare, Mountain Ash, Treharris, Ebbw Vale, Abertillery, Bargoed / Blackwood / Newbridge, Risca / Crosskeys / Abercarn, Cwmbran and Pontypool.
- 2: To reinforce the fact that the wider 'forest' is excluded (see Appendix 2.1) the urban boundaries, determined in order to map and measure canopy cover, do not extend beyond a 20 meter buffer from the built environment (see Figure 6). The exception is where the urban land-use rules dictate, e.g. where over one third of a golf course or quarry lies alongside the built land (see Appendix 2.1). As a result, the 'forest' surrounding the Valley communities only minimally accounts for the high tree cover rate identified.
- 3: What is striking is the consistently high level of canopy cover across the majority of the South Wales Valley towns. This is even the case in the upper, more elevated reaches of the Heads of the Valleys. With the exception of the Neath and Tawe, the heads of the Western Valleys do show a tapering off to below average cover. Only scattered small communities on the most exposed tops, such as Seven Sisters, Fochriw and Abertyswg, have noticeably low cover. Interestingly, in the Southern Valleys where the river valleys broaden out, 39% of the urban areas fall below the national canopy cover average. Is this due, in part, to land being more easily developed?
- 4: Areas of woodland represent 40% of the total cover identified. These are interspersed within the built environment primarily in river bottoms, as well as on residual steep-sided slopes and post-industrial land that has undergone reclamation planting or has regenerated naturally.
- 5: The Valleys include some of the most deprived communities within Wales. The combination of acute social needs with high canopy cover levels, mostly in the form of urban woodland, raises concerns related to the quality rather than to quantity. For those towns with high levels of provision, the critical questions to investigate are: how functional are the large expanses of urban woodland found within the local built environment? Are there opportunities to generate greater community benefits?
- 6: Population density in the Valleys, particularly within those compact steep-sided valleys, is well above the national urban average of 3,000 people / km². Of the larger urban areas, communities such as Maesteg, those in the Rhondda Fawr and Fach, Mountain Ash, Risca and Crosskeys all display between 4,000 - 6,000 people / km². The importance of trees and accessible green-space to neighbourhoods is all the more critical where high levels of density and deprivation occur.



Western Valleys (Carmarthenshire, Powys, Neath Port Talbot, Bridgend):

Figure 17: Towns in the Western Valleys: Neath (left) – 23.7% and Pontardawe (right) – 25.2%. © Crown Copyright: RCAHMW

Highs:

- The major towns of Neath (23.7%) and Bridgend (17.4%) have cover above the national average
- **Swansea valley communities, in particular Pontardawe (25.2%) provide the most canopy cover of all the Western Valleys followed closely by the Neath valley**
- The Ogwr, Dulas, Aman and Gwendraeth valley towns are far more variable in their tree cover. Trimsaran, with 33.9%, is Wales' highest canopied community (which includes two heavily wooded areas). Other high canopy towns are Glanamau (28.9%), Ogmores Valley (22.8%) and Crynant (20.4%)

Lows:

- Of the 10 'urbanised' valleys the Llynfi has consistently below average canopy cover, though Maesteg, its main settlement, has 15.6%
- Likewise the cluster of four communities above the upper Gwendraeth (bordering with the Loughor watershed) have limited cover of between 10-15%
- Whilst half the urban areas are above the national average, in comparison with the 'Heads of the Valleys' towns a third are over 20%
- Only four towns fall below 10%: Bettws (5.4%) – largely dominated by its high density housing estate; Blaengwynfi (7.3%) – surrounded by forestry in the upper Afan; and Seven Sisters and Llandybïe both just below 10% - the former lying at the elevated top end of the Dulas valley



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
5	Bridgend (& Tondu / Sarn)	Bridgend	46,757	2,188	380	17.4%
7	Neath (& Skewen / Tonna)	Neath Port Talbot	50,658	1,914	453	23.7%
34	Maesteg (& Nantyffyllon / Caerau)	Bridgend	18,888	546	85	15.6%
39	Pontardawe (& Swansea Valley)	Neath Port Talbot	12,333	489	123	25.2%
60	Pontarddulais /Hendy	Swansea	9,073	349	60	17.1%
61	Ammanford	Carmarthenshire	7,945	346	53	15.2%
62	Pencoed	Bridgend	9,166	336	50	15.0%
66	Crosshands / Cefneithin	Carmarthenshire	4,141	318	44	13.9%
72	Ystradgynlais	Powys	8,092	294	54	18.4%
84	Glyn-neath	Neath Port Talbot	4,278	245	56	22.8%
91	Glanaman	Carmarthenshire	4,384	203	59	28.9%
95	Tycroes / Capel Hendre / Saron	Carmarthenshire	4,619	177	25	14.2%
107	Cwmafan	Neath Port Talbot	5,336	154	28	17.9%
117	Tumble / Drefach	Carmarthenshire	4,302	145	14	9.9%
118	Ystalyfera	Neath Port Talbot	3,019	144	31	21.6%
122	Gwaun-cae-gurwen	Neath Port Talbot	3,084	138	16	11.5%
128	Pontycymer	Bridgend	4,288	128	19	14.8%
135	Brynamman	Carmarthenshire	2,608	117	24	20.7%
142	Pontyberem	Carmarthenshire	1,695	107	18	16.7%
144	Trimsaran	Carmarthenshire	1,584	107	36	33.9%
146	Llandybie	Carmarthenshire	2,813	106	10	9.7%
154	Cwmtwrch Uchaf / Cwmllynfell	Neath Port Talbot	1,405	99	19	19.4%
161	Seven Sisters	Neath Port Talbot	2,123	90	9	9.9%
169	Ogmore Valley	Bridgend	3,117	85	19	22.8%
179	Resolven	Neath Port Talbot	2,068	74	12	16.5%
185	Penygroes	Carmarthenshire	5,717	68	7	10.0%
188	Croeserw / Cymer	Neath Port Talbot	2,113	67	8	12.6%
191	Price Town / Nant y Moel	Bridgend	2,344	65	8	11.9%
202	Crynant	Neath Port Talbot	1,602	53	11	20.4%
207	Pontlliw	Swansea	1,645	46	10	21.7%
209	Bettws	Bridgend	2,253	45	2	5.4%
213	Glyncorrwg	Neath Port Talbot	1,096	40	8	20.3%
214	Pont-Rhyd-y-Cyff	Bridgend	1,505	38	5	13.1%
216	Blaengwynfi	Neath Port Talbot	1,362	28	2	7.3%
220	Pontrhydyfen	Neath Port Talbot	830	20	5	22.9%

Table 3: Western Valleys - Town canopy cover



Heads of the Valleys (Rhondda Cynon Taf, Merthyr, Caerphilly, Blaenau Gwent, Torfaen)



Figure 18: Heads of the Valleys towns: Merthyr Tydfil (left) – 19.0% and New Tredegar (right) – 24.9%. © Crown Copyright: RCAHMW

Highs:

- **Treharris (30%), with the wooded corridor of the Taf, is Wales' second most canopied town, followed in 5th place by Aberbeeg/Llanhilleth (27.3%) with Abertillery (26.5%) lying 6th**
- **All the large 500ha plus urban areas have cover in excess of 18%. The most canopied are Aberdare (21.9%) and Bargoed / Blackwood / Newbridge (21.1%), with the least being Rhondda Fawr (18.1%) and Tredegar (18.5%)**
- **All except four of the 20 urban areas have cover over 15%**

Lows:

- Abertysswg and Fochriw, the two small elevated communities adjacent to Rhymney (16.5%), have as little as 6.3% and 2.8% respectively
- In contrast to neighbouring Treharris, Nelson has only 8.1%
- Swffryd, despite its wooded surrounds, has only 10.9% cover



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
6	Bargoed / Blackwood / Newbridge	Caerphilly	55,383	2,011	425	21.1%
12	Rhondda Fawr	Rhondda Cynon Taf	58,904	1,538	278	18.1%
13	Merthyr Tydfil	Merthyr Tydfil	43,820	1,490	283	19.0%
18	Aberdare	Rhondda Cynon Taf	29,748	1,026	224	21.9%
19	Ebbw Vale (& Cwm)	Blaenau Gwent	22,390	1,022	207	20.3%
26	Tredegar	Blaenau Gwent	14,855	657	121	18.5%
29	Brynawr / Nantyglo / Blaina	Blaenau Gwent	14,973	605	116	19.2%
58	Ferndale (& Maerdy)	Rhondda Cynon Taf	7,338	351	68	19.3%
63	Mountain Ash	Rhondda Cynon Taf	11,230	332	78	23.4%
68	Rhymney	Caerphilly	7,075	308	51	16.5%
73	Abertillery	Blaenau Gwent	10,946	292	78	26.5%
77	Treharris	Merthyr Tydfil	7,705	275	83	30.2%
81	Blaenavon	Torfaen	5,647	252	50	19.8%
86	Hirwaun	Rhondda Cynon Taf	7,247	229	40	17.3%
88	Abercanaid / Troedyrhiw	Merthyr Tydfil	5,060	224	42	18.8%
106	New Tredegar	Caerphilly	4,208	154	38	24.9%
133	Aberbeeg / Llanhilleth	Blaenau Gwent	2,990	119	33	27.3%
145	Nelson	Caerphilly	4,647	106	9	8.1%
156	Aberfan / Merthyr Vale	Merthyr Tydfil	3,547	95	15	15.8%
210	Swffryd	Blaenau Gwent	1,834	42	5	10.9%
217	Abertysswg	Caerphilly	1,462	27	2	6.3%
218	Fochriw	Caerphilly	1,250	26	1	2.8%

Table 4: Heads of the Valleys - Town canopy cover



Southern Valleys (Rhondda Cynon Taf, Caerphilly, Torfaen)



Figure 19: Southern Valleys towns: Ystrad Mynach (left) - 17.4% and Pontypridd (right) - 21.4%. © Crown Copyright: RCAHMW

Highs:

- **Of Wales' twenty-one >1,000 hectare towns Cwmbran, with a population of 47,000, has the highest level of cover at 23.9%.** One likely explanation for this is down to its 'New Town' status from 1950 onwards, where high levels of landscape planning went into the town's expansion
- The large towns of Pontypool and Pontypridd are both endowed with over 20%
- The string of communities lying within the lower Ebbw valley (Risca / Crosskeys / Abercarn) have a high overall cover of 24.1%

Lows:

- A few communities on the fringes of the Valleys have only 9%-11% cover e.g. Brynna / Llanharan, Beddau / Church Village and Pentyrch



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
11	Cwmbran	Torfaen	46,915	1542	368	23.9%
15	Caerphilly	Caerphilly	41,402	1,266	213	16.8%
16	Pontypool (& Abersychan)	Torfaen	28,334	1,203	277	23.0%
20	Pontypridd (& Treforest / Nantgarw)	Rhondda Cynon Taf	30,457	1,004	215	21.4%
23	Risca / Crosskeys / Abercarn	Caerphilly	21,375	694	168	24.1%
31	Llantrisant / Pontyclun	Rhondda Cynon Taf	14,422	605	103	17.0%
42	Beddau / Church Village	Rhondda Cynon Taf	8,236	470	55	11.7%
52	Ystrad Mynach / Hengoed	Caerphilly	12,834	392	68	17.4%
88	Tonyrefail	Rhondda Cynon Taf	9,317	224	35	15.8%
95	Penpedairheol / Gelligaer	Caerphilly	6,370	176	20	11.3%
104	Abercynon	Rhondda Cynon Taf	5,983	158	30	18.9%
105	Abertridwr / Senghenydd	Caerphilly	6,504	156	24	15.2%
120	Brynna / Llanharan	Rhondda Cynon Taf	6,686	141	14	9.8%
125	Gilfach Goch	Rhondda Cynon Taf	4,395	132	16	12.2%
159	Llanharry	Rhondda Cynon Taf	3,035	92	16	17.2%
160	Taff's Well	Rhondda Cynon Taf	5,567	91	17	18.2%
171	Ynysybwl	Rhondda Cynon Taf	3,503	84	15	17.5%
175	Llanbradach	Caerphilly	3,746	83	16	19.2%
180	Glyncoch	Rhondda Cynon Taf	4,020	71	9	12.4%
182	Machen	Caerphilly	2,362	70	12	16.5%
183	Cwmfelinfach / Ynysddu	Caerphilly	2,342	69	12	16.9%
189	Pentyrch	Cardiff	2,287	66	6	9.1%
192	Creigiau	Cardiff	2,380	65	12	18.5%

Table 5: Southern Valleys - Town canopy cover



Coastal and Seaboard Towns: highs and lows

Exposure to a maritime environment, with often strong, salt-laden winds, is not particularly conducive to the growth and realisation of wide-spreading canopies. For this study it is logical to group together all towns that are influenced by coastal and estuarine conditions. Geographically this has been divided between the south, west and south-west, and north coasts.

These are often communities with ports, harbours and / or a Victorian seaside town legacy.

- 1: As many as 51 out of the 74 coastal towns have a below average urban tree cover. Whilst the larger towns such as Port Talbot (8.2%), Rhyl (5.5%) and Porthcawl (6.2%) stand out as having particularly low cover, there are numerous other major and smaller towns that could be focussed upon to increase cover.
- 2: On the south coast, apart from Newport, Swansea and Penarth, virtually all towns are below the national average. The north coast fares marginally better, with a number of respectably canopied towns, but the extreme low cover towns are far more prevalent. The west and south-west coast towns have a 50/50 split above and below the 16.3% average.
- 3: It does not always follow that a coastal location implies low cover and can't aspire to greater canopy cover. While Rhyl and Llandudno have 5.5% and 7.7% respectively, neighbouring seaside towns fare rather differently: Colwyn Bay's tree cover is 17.9%, Conwy 22.2% and Llanfairfechan 23.7%. Amongst other high canopy cover towns (18%-23%) around the Welsh coastline are Holywell / Bagillt, Penmaenmawr, Bangor, Menai Bridge, Y Felinheli, Porthmadog, Barmouth, Aberystwyth, Goodwick, Swansea (notably the Mumbles) and Newport. This demonstrates that trees can be practically established, in the right location, within the built maritime environment. The establishment of a robust canopy network within these exposed towns can only help to ameliorate the environment and provide more comfortable living conditions.



South Coast (Monmouthshire, Newport, Cardiff, Vale of Glamorgan, Bridgend, Neath Port Talbot, Swansea, Carmarthenshire)



Figure 20: South Coast towns: Barry (left) – 11.3% and Swansea (right) – 18.0%. © Crown Copyright: RCHAMW

Highs:

- Of Wales' three major cities, both Swansea and Newport have just above national average cover with Cardiff marginally below
- The only other above-average towns are those set back from the sea in tidal estuarine locations – Caerleon (17.7%), Gowerton / Waunarlwydd (21.5%) and Llangennech (16.9%)
- For a sizeable coastal town Penarth demonstrates what can be achieved with its cover on 17.4%

Lows:

- **Only 6 of the 26 towns have above average cover**
- **Two coastal towns have particularly low cover, Porthcawl (6.2%) and Rhose (6.6%). The latter does not include the airport land**
- **Port Talbot, which includes the steel works, stands out noticeably in its size class as only having 8.2%**
- **Large towns such as Llanelli with 12.7% (and neighbouring Gorseinon on 12.4%) and Barry with 11.3% would benefit from a greater urban canopy.** Barry was one of the Welsh Government's seven Regeneration Areas and Llanelli has acute water management issues that increased tree cover could help to alleviate
- Other towns with relatively low canopy of 8%-12% are Rogiet, Caldicot, Marshfield, Llantwit Major, Southgate, Penclawdd / Crofty and Kidwelly



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
1	Cardiff	Cardiff	335,145	8,421	1,302	15.5%
2	Swansea	Swansea	187,668	5,912	1,066	18.0%
3	Newport	Newport	128,060	4,571	830	18.2%
4	Port Talbot	Neath Port Talbot	37,276	2,301	188	8.2%
8	Llanelli	Carmarthenshire	43,878	1,768	224	12.7%
9	Barry	Vale of Glamorgan	54,673	1,707	193	11.3%
22	Penarth	Vale of Glamorgan	27,226	712	124	17.4%
24	Llantwit Major	Vale of Glamorgan	8,427	682	54	7.9%
35	Porthcawl	Bridgend	15,672	541	33	6.2%
37	Gorseinon (& Loughor)	Swansea	15,757	519	64	12.4%
43	Pyle / North Cornelly	Bridgend	15,005	465	62	13.4%
46	Chepstow	Monmouthshire	12,350	419	63	15.0%
64	Burry Port / Pembrey	Carmarthenshire	8,310	332	45	13.5%
65	Gowerton / Waunarlwydd	Swansea	8,183	325	70	21.5%
67	Caldicot	Monmouthshire	11,200	312	27	8.7%
75	Caerleon / Ponthir	Newport	8,747	283	50	17.7%
112	Penllergaer	Swansea	2,868	151	19	12.5%
114	Llangennech / Brynhyfryd	Carmarthenshire	4,324	148	25	16.9%
123	Rhoose	Vale of Glamorgan	6,160	136	9	6.6%
126	Bishopston	Swansea	3,500	132	18	13.7%
130	Penclawdd / Crofty	Swansea	2,947	122	14	11.7%
152	Kidwelly	Carmarthenshire	2,782	102	12	11.9%
177	Southgate	Swansea	2,004	82	10	12.0%
194	Marshfield	Newport	2,319	61	7	11.5%
206	Rogiet	Monmouthshire	1,813	46	4	8.4%
215	Underwood	Newport	1,976	37	4	10.8%

Table 6: South Coast - Town canopy cover



West and South-West Coast (Pembrokeshire, Ceredigion, Gwynedd)



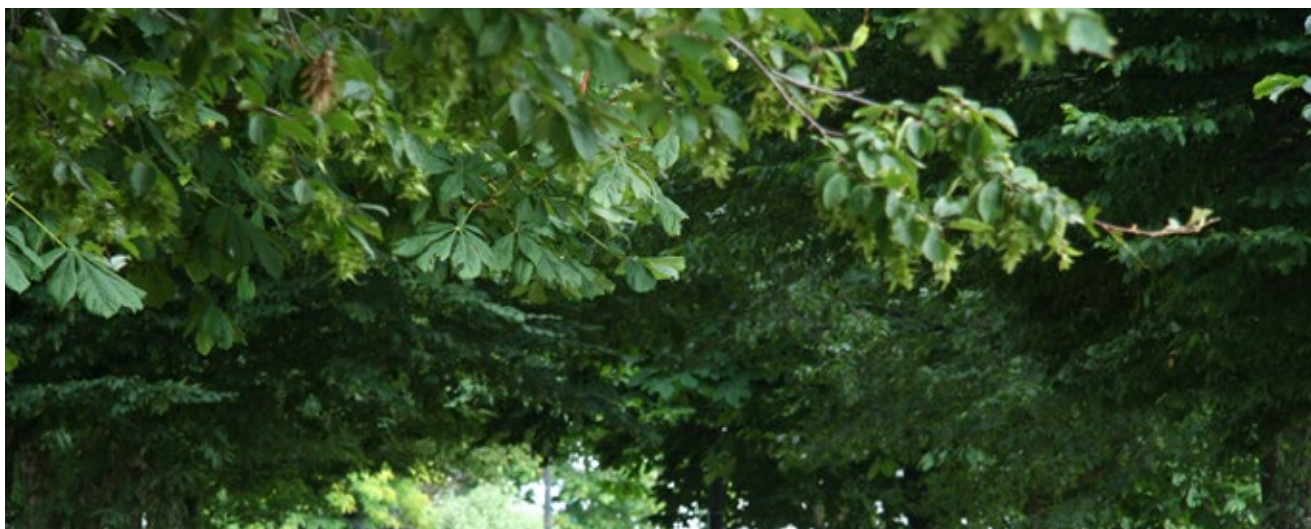
Figure 21: West and South-West Coastal towns: Milford Haven (left) - 9.5% and Aberystwyth (right) - 18.1%. © Crown Copyright: RCHAMW

Highs:

- Almost a half of these Cardigan Bay and Pembrokeshire towns display canopy cover above the national average
- **Relatively high canopy cover towns are Barmouth (22.7%), Porthmadog (19.1%), Penrhyndeudraeth (18.3%), Aberystwyth (18.1%) and Goodwick (18.1%)**

Lows:

- **Twyn (4.7%) is the second least canopied town in Wales, with Pwllheli on only 7.8%**
- Other towns with low canopy of 9%-13% are Criccieth, Aberaeron, St Davids, Milford Haven and Neyland. The other Cleddau estuary towns of Pembroke and Pembroke Dock have only modest cover of around the 13-14% mark



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
33	Aberystwyth	Ceredigion	18,093	568	103	18.1%
44	Pembroke Dock	Pembrokeshire	9,753	443	62	14.1%
48	Milford Haven	Pembrokeshire	13,582	405	38	9.5%
79	Pembroke	Pembrokeshire	7,552	260	34	12.9%
94	Pwllheli	Gwynedd	4,076	180	14	7.8%
97	Tenby	Pembrokeshire	4,696	169	28	16.6%
101	Saundersfoot	Pembrokeshire	2,767	161	28	17.4%
110	Porthmadog	Gwynedd	2,981	152	29	19.1%
115	Tywyn	Gwynedd	3,097	148	7	4.7%
119	Cardigan	Ceredigion	4,184	142	22	15.5%
121	Fishguard	Pembrokeshire	3,419	141	22	15.9%
134	Harlech	Gwynedd	1,762	118	20	16.9%
138	Neyland	Pembrokeshire	3,708	113	11	9.7%
155	Barmouth	Gwynedd	2,315	97	22	22.7%
162	Goodwick	Pembrokeshire	1,720	88	16	18.1%
165	Aberaeron	Ceredigion	1,422	86	10	11.6%
176	Criccieth	Gwynedd	1,753	83	11	13.3%
181	Penrhyndeudraeth	Gwynedd	1,546	71	13	18.3%
196	St David's	Pembrokeshire	1,408	58	7	12.7%
201	Aberporth	Ceredigion	1,241	54	8	14.8%

Table 7: West and South West Coast - Town canopy cover



North Coast (Gwynedd, Anglesey, Conwy, Denbighshire, Flintshire)

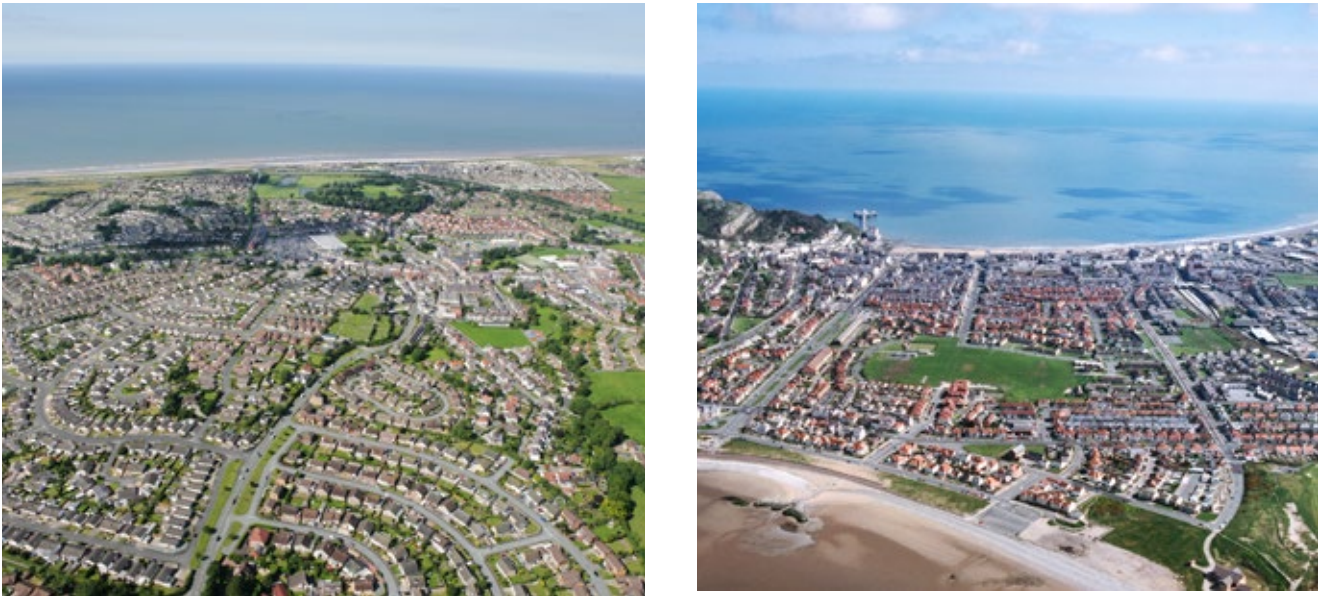


Figure 22: North Coast towns: Abergele (left) - 11.6% and Llandudno (right) -7.7%. © Crown Copyright: RCHAMW

Highs:

- **Of 28 towns only Llanfairfechan (23.7%), Penmaenmawr (22.6%), Conwy (22.3%), Y Felinheli (21.7%), Menai Bridge (19.3%), Holywell / Bagilt (19%), Bangor (18%), Colwyn Bay (17.9%) and Dyserth (16.7%) have above the national canopy cover average**
- Interestingly towns within a short distance of each other e.g. Rhyl vs. Colwyn Bay and Bangor vs. Caernarfon, show distinctly differing canopy cover

Lows:

- **19 out of the 28 coastal towns fall below the national average**
- **Rhyl (5.5%), Towyn / Kinmael Bay (6.4%) - with a strong caravan park component, Holyhead (6.8%), Rhuddlan (7.2%), Mostyn (7.3%) and Llandudno (7.7%) all feature in the top 20 of least canopied towns in Wales**
- Other towns with less than 13% are Abergele, Tywyn / Deganwy / Llandudno Junction, Caernarfon, Penrhyn Bay, Amlwch, Benllech, Llanfairpwllgwyngyll, Valley and Beaumaris
- Anglesey, Denbighshire and Gwynedd towns all fell within the North Wales Coast and Môn a Menai Strategic Regeneration Areas. As of 2014-2016 the Welsh Government is refocussing its regeneration priorities through the 'Vibrant and Viable' framework, of which north coast towns such as Colwyn Bay, Bangor, Caernarfon and Holyhead are beneficiaries



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
10	Connah's Quay	Flintshire	33,549	1,582	249	15.7%
17	Colwyn Bay	Conwy	29,405	1,100	197	17.9%
21	Prestatyn	Denbighshire	19,495	729	96	13.2%
25	Rhyl	Denbighshire	25,149	659	36	5.5%
28	Holywell / Bagillt	Flintshire	9,808	621	118	19.0%
38	Towyn / Kinmel Bay	Conwy	9,497	512	33	6.4%
41	Bangor	Gwynedd	17,988	472	85	18.0%
51	Flint	Flintshire	14,907	394	56	14.2%
53	Llandudno	Conwy	15,371	392	30	7.7%
55	Abergele	Conwy	9,208	362	42	11.6%
56	Tywyn / Deganwy / Llandudno Junction	Conwy	10,658	354	40	11.3%
59	Holyhead	Anglesey	11,431	351	24	6.8%
71	Caernarfon	Gwynedd	9,493	296	36	12.2%
91	Conwy	Conwy	3,873	203	45	22.2%
98	Penrhyn Bay	Conwy	4,432	168	20	11.9%
103	Amlwch	Anglesey	3,211	159	19	11.9%
109	Llanfairfechan	Conwy	3,637	152	36	23.7%
129	Rhuddlan	Denbighshire	3,709	125	9	7.2%
132	Menai Bridge	Anglesey	4,958	119	23	19.3%
143	Benllech	Anglesey	2,236	107	12	11.2%
158	Penmaenmawr	Conwy	2,535	93	21	22.6%
168	Llanfairpwllgwyngyll	Anglesey	3,107	85	11	12.9%
173	Dyserth	Denbighshire	2,269	84	14	16.7%
184	Y Felinheli	Gwynedd	2,284	69	15	21.7%
186	Valley	Anglesey	2,361	68	6	8.8%
199	Mostyn	Flintshire	1,606	55	4	7.3%
200	Llansantffraid	Conwy	1,735	54	8	14.8%
203	Beaumaris	Anglesey	1,370	51	5	9.8%

Table 8: North Coast - Town canopy cover



Towns of the North-East (Flintshire and Wrexham): highs and lows

The post-industrial and now highly urbanised character of the North-East justified its distinct landscape character region in terms of this study.

- 1: A number of the high canopied towns are ex-mining, milling, brick, chemical and steel works towns, arguably with similar well-canopied characteristics to those communities in the South Wales Valleys.
- 2: In contrast there are a few communities, on land bordering the river Dee, that are particularly low on tree cover. Broughton can be explained by the inclusion of the airfield.
- 3: Wrexham, the 'capital' of the North-East, and the other major towns of Connah's Quay (included within the North-Wales coastal section) and Buckley, could well focus on increasing canopy cover from their current 12%-16% levels.



Figure 23: North-East towns: Wrexham (left) - 14.1% and Cefn Mawr (right) - 24.4%. © Crown Copyright: RCAHMW

Highs:

- Nearly half the 21 towns in the North-East have higher than average cover
- **On 29.7%, Caergwrle is the 3rd most canopied town in Wales (the highest outside the Valleys)**
- **The Wrexham County Borough towns of Llay (25%), Gresford (24.5%), Cefnmawr (24.4%) and Brymbo (21.2%) all demonstrate high coverage**

Lows:

- **Wrexham is North Wales' principal town and, with a modest cover of 14.1%, should be aspiring to increase this. Buckley is also a large town on only 12.4%**
- **Four urban areas stand out for their particularly low cover - Broughton (5.3%), Saltney (5.5%), Coedpoeth (7.5%) and Gwernaffield (9.5%)**
- Leeswood, Soughton, Penyffordd and Chirk's canopy cover ranges between 10% and 14%



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
14	Wrexham	Wrexham	44,711	1,471	207	14.1%
30	Buckley	Flintshire	19,639	605	75	12.4%
36	Broughton	Flintshire	5,974	533	28	5.3%
45	Brymbo	Wrexham	3,981	419	89	21.2%
50	Mold	Flintshire	10,058	398	61	15.3%
57	Rhosllanerchrugog / Penycae	Wrexham	13,501	352	55	15.6%
69	Cefnmawr	Wrexham	7,051	303	74	24.4%
74	Llay	Wrexham	4,681	288	72	25.0%
78	Gwersyllt	Wrexham	10,677	268	47	17.5%
86	Caergwrle	Flintshire	4,284	239	71	29.7%
93	Gresford	Wrexham	5,010	192	47	24.5%
97	Chirk	Wrexham	4,007	172	24	14.0%
100	Saltney	Flintshire	4,769	163	9	5.5%
131	Coedpoeth	Wrexham	5,723	120	9	7.5%
150	Ruabon	Wrexham	3,357	103	17	16.5%
151	Rossett	Wrexham	2,007	103	18	17.5%
170	Penyffordd	Flintshire	3,554	84	10	11.9%
197	Leeswood	Flintshire	2,282	58	6	10.3%
208	Soughton	Flintshire	1,710	46	5	10.9%
212	Gwernymynydd / Cadole	Flintshire	1,141	41	8	19.5%
219	Gwernaffield	Flintshire	905	21	2	9.5%

Table 9: North-East - Town canopy cover



Hinterland Communities: highs and lows

These towns lie beyond the coastal belt and outside the main urbanised areas of the Valleys and the North-East. They are predominantly rural in nature, though the slate quarrying communities of Gwynedd have characteristics common to the other two other post-industrial regions. Population density of towns, in contrast to the Valleys, is mainly below the national urban average of 3,000 / km².

- 1: Whilst almost two-thirds of all these predominantly market towns fall below the national average of 16.3%, there is a relative consistency of cover in the 11%-15% range. Apart from two towns, Mid-Wales' communities are all below average cover.
- 2: Of 45 towns only six have cover less than 10%, and all except two are in North Wales. This possibly is related to a combination of altitude and past slate-mining influences.
- 3: Several of the main market towns are well down on tree cover and should consider increasing canopy. None, however, come close to the 9% cover for Denbigh. Considering this town is surrounded by low-lying agricultural land, with very little surrounding woodland and limited public access to the countryside, plus having some less advantaged neighbourhoods, surely this is an exemplar town in terms of a 'call to arms'?
- 4: As for low-cover towns, 20%+ towns are also few and far between. The high cover of Llangollen, Dolgellau and Gilwern is possibly related to their strong river and canal corridors, whilst in the case of Llandrindod Wells this may be influenced by its Victorian Spa town heritage.

North Wales (Denbighshire, Conwy, Anglesey, Gwynedd)



Figure 24: North Wales Hinterland towns: Llangollen (left) - 25% and Denbigh (right) - 9%. © Crown Copyright: RCAHMW

Highs:

- **Two towns stand out with high canopy cover, Dolgellau (26%) and Llangollen (25%), both featuring in Wales' 'Top 10'**
- Llanberis, Bodelwyddan and St Asaph are the three other above-average canopied towns

Lows:

- **Considering its size as a market town, Denbigh has only 9% cover**
- **Other communities reflecting poor cover are Blaenau Ffestiniog (7.1%), Llanrug (7.8%) and Penygroes (8.2%)**
- On less than 12% Llanrwst, Bala and Ruthin are hardly well-endowed with tree cover either



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
70	Denbigh	Denbighshire	8,514	301	27	9.0%
81	Llangefni	Anglesey	4,864	259	42	16.2%
84	Ruthin	Denbighshire	5,461	247	29	11.7%
99	St Asaph	Denbighshire	3,355	165	29	17.6%
111	Llangollen	Denbighshire	3,466	152	38	25.0%
113	Dolgellau	Gwynedd	2,688	150	39	26.0%
116	Bodelwyddan	Denbighshire	1,794	148	27	18.2%
136	Bethesda	Gwynedd	3,799	115	18	15.7%
139	Blaenau Ffestiniog	Gwynedd	3,662	112	8	7.1%
140	Llanrwst	Conwy	3,323	112	13	11.6%
166	Bala	Gwynedd	1,974	86	10	11.6%
198	Llanberis	Gwynedd	1,844	57	11	19.3%
204	Llanrug	Gwynedd	1,916	51	4	7.8%
205	Penygroes	Gwynedd	1,793	49	4	8.2%

Table 10: North Wales Hinterland - Town canopy cover



Mid-Wales (Powys, Ceredigion, Carmarthenshire)



Figure 25: Mid-Wales Hinterland towns: Llandrindod (left) - 21.4% and Welshpool (right) - 11.8%. © Crown Copyright: RCAHMW

Highs:

- **Llandrindod Wells, with 21.4%, is the most canopied town in mid-Wales, with Newcastle Emlyn (16.8%) the only other above-average cover town**

Lows:

- **The remaining 12 towns have lower than average cover. Rhayader is just below on 15.4%**
- Both Machynlleth (7.7%) and Bow St (9.5%) fall below 10%. Nine towns fall between 10% and 15%



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
40	Newtown	Powys	11,357	475	66	13.8%
78	Llandrindod Wells	Powys	5,309	268	57	21.4%
82	Welshpool	Powys	5,948	251	30	11.8%
127	Lampeter	Ceredigion	2,970	131	17	13.0%
141	Knighton	Powys	3,007	109	13	12.2%
147	Builth Wells	Powys	2,829	105	14	13.5%
148	Rhayader	Powys	1,824	105	16	15.4%
149	Llanidloes	Powys	2,929	104	12	11.8%
157	Newcastle Emlyn	Carmarthenshire	1,883	93	16	16.8%
172	Presteigne	Powys	2,056	84	9	11.2%
174	Machynlleth	Powys	2,235	84	6	7.7%
187	Llandysul	Ceredigion	1,484	67	7	10.4%
195	Hay-on-Wye	Powys	1,954	61	7	11.8%
211	Bow Street	Ceredigion	1,572	42	4	9.5%

Table 11: Mid-Wales Hinterland - Town canopy cover



South Wales (Pembrokeshire, Carmarthenshire, Powys, Monmouthshire, Vale of Glamorgan)



Figure 26: South Wales Hinterland towns: Carmarthen (left) - 12.4% and Abergavenny (right) - 17.5%.
© Crown Copyright: RCAHMW

Highs:

- **Of 17 towns, Gilwern (20.3%) is the only one with 'high' cover.** Five others are above average, including the market towns of Abergavenny and Monmouth

Lows:

- **Johnston has less than 11%**
- The market towns of Brecon and Carmarthen, have only 12%-13%



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Area Size Rank	Urban Area	County	Population ONS 2011 Census	Urban Area (ha)	Total Cover '13 (ha)	Total Cover '13 (%)
27	Carmarthen	Carmarthenshire	15,854	624	78	12.4%
32	Haverfordwest	Pembrokeshire	14,596	574	81	14.2%
47	Brecon	Powys	8,250	407	53	12.9%
49	Abergavenny	Monmouthshire	13,423	400	70	17.5%
54	Monmouth	Monmouthshire	10,110	379	64	17.0%
89	Murch	Vale of Glamorgan	7,490	212	36	17.0%
102	Cowbridge	Vale of Glamorgan	3,804	160	27	16.9%
108	Magor	Monmouthshire	5,914	152	23	15.0%
124	Llandovery	Carmarthenshire	2,458	135	19	14.4%
137	Crickhowell / Llangattock	Powys	2,725	114	18	15.6%
153	Kilgetty / Begelly / Pentlepoir	Pembrokeshire	3,179	101	13	12.5%
163	St Clears	Carmarthenshire	1,989	87	10	11.6%
164	Usk	Monmouthshire	2,834	87	14	16.4%
167	Narberth	Pembrokeshire	2,265	85	13	14.9%
178	Gilwern	Monmouthshire	2,263	80	16	20.3%
190	Johnston	Pembrokeshire	1,941	66	7	10.9%
193	Llandeilo	Carmarthenshire	1,795	62	8	12.7%

Table 12: South Wales Hinterland - Town canopy cover



2.4 International comparisons

Comparisons with canopy cover identified in other parts of the world provide a useful context to analyse and draw conclusions from the analysis provided above.

Wales and England

The canopy cover findings from England's *Trees in Towns II* study, whilst not covering all towns, do offer an interesting basis for comparison with Wales' urban canopy cover results.

Canopy cover comparison: Wales and England 'Top 20'

Canopy Cover Size Classes:

		0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
Rank	Wales Towns (Top 20)	% cover 2013		England Towns (Top 20) *	% cover 2005		
1	Trimsaran	33.9		Heathfield (E. Sussex)	29.3		
2	Treharris	30.2		Windermere (Cumbria)	26.0		
3	Caergwrle	29.7		Knowle/Bentley Heath (W. Midlands)	21.2		
4	Glanaman	28.9		Chigwell (Essex)	18.2		
5	Aberbeeg / Llanhilleth	27.3		Budleigh Salterton (Devon)	18.5		
6	Abertillery	26.5		Tavistock (Devon)	17.4		
7	Dolgellau	26.0		Hythe (Kent)	17.2		
8	Pontardawe (& Swansea Valley)	25.2		Poole (Dorset)	17.1		
9	Llangollen	25.0		Truro (Cornwall)	16.4		
10	Llay	25.0		Midhurst (W. Sussex)	16.0		
11	New Tredegar	24.9		Huddersfield (W. Yorks)	15.9		
12	Gresford	24.5		Tadley (Hants)	15.2		
13	Cefnmawr	24.4		Princes Risborough (Bucks)	15.0		
14	Risca / Crosskeys / Abercarn	24.1		Whaley Bridge (Derbyshire)	14.7		
15	Cwmbran	23.9		Sheffield (S. Yorks)	14.6		
16	Neath (& Skewen / Tonna)	23.7		Oxford (Oxfordshire)	13.8		
17	Llanfairfechan	23.7		Christchurch (Dorset)	13.3		
18	Mountain Ash	23.4		Bristol (Bristol)	13.0		
19	Pontypool (& Abersychan)	23.0		Crawley (W. Sussex)	12.5		
20	Pontrhydyfen	22.9		West Kingsdown (Kent)	12.5		

Table 13: Canopy cover comparison: Wales and England 'Top 20' (* Source: Britt and Johnston, 2008)

As highlighted previously the South Wales Valley towns display the greatest canopy cover. The majority of England's towns with the greatest canopy cover are also in the south.



Canopy cover comparison: Wales and England 'Bottom 20'.

Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Rank	Wales Towns (Bottom 20)	% cover 2013	England Towns (Bottom 20) *	% cover 2005
1	Fochriw	2.8	Blackpool (Lancs)	1.2
2	Tywyn	4.7	Peterlee (Durham)	1.3
3	Broughton	5.3	Skelton (Redcar & Cleveland)	1.3
4	Bettws	5.4	Barnard Castle (Durham)	1.3
5	Rhyl	5.5	Dearne (S. Yorks)	1.6
6	Saltney	5.5	Shildon (Durham)	1.6
7	Porthcawl	6.2	Ashington (Northumberland)	2.0
8	Abertyswg	6.3	Amble (Northumberland)	2.1
9	Towyn / Kinnel Bay	6.4	Redcar (Teeside)	2.4
10	Rhosee	6.6	Hartlepool (Teeside)	2.6
11	Holyhead	6.8	Ilkeston (Leics)	2.8
12	Blaenau Ffestiniog	7.1	Stockton-on-Tees (Teeside)	2.9
13	Rhuddlan	7.2	Langley Park (Durham)	2.9
14	Mostyn	7.3	Wirksworth (Derby)	3.0
15	Blaengwynfi	7.3	Stoke-on-Trent (Staffs)	3.1
16	Coedpoeth	7.5	Hemsworth (W. Yorks)	3.1
17	Llandudno	7.7	Newport (Shropshire)	3.1
18	Machynlleth	7.7	Bishop Auckland (Durham)	3.3
19	Pwllheli	7.8	Sudbury (Teeside)	3.4
20	Llanrug	7.8	Rushall (W. Midlands)	3.4

Table 14: Canopy cover comparison: Wales and England 'Bottom 20' (* Source: Britt and Johnston, 2008)

In terms of geographical location, there are seaside towns as for Wales, e.g. Blackpool and Hartlepool, where canopy cover is noticeably low. However, there is distinct concentration of 'Bottom 20' towns in North-East England. Some towns are on the coast but many can be characterised as being post-industrial and located within relatively open agricultural landscapes. This is in stark contrast to the post-industrial South Wales and Pennine Valleys (e.g. Huddersfield), where the nature of the landscape offers greater scope for tree cover.



Wales and the World

Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Rank	City	Country	% Cover
1	Brisbane	Queensland, Australia	46.0%
2	Atlanta	Georgia, USA	36.7%
3	Portland	Oregon, USA	26.0%
4	Barcelona	Catalunya, Spain	25.2%
5	Seattle	Washington, USA	23.0%
6	Melbourne	Victoria, Australia	22.0%
7	New York	New York, USA	20.9%
8	Toronto	Ontario, Canada	20.5%
9	Leipzig	Saxony, Germany	19.0%
10	Newport	Wales	18.2%
11	Swansea	Wales	18.0%
12	Chicago	Illinois, USA	17.2%
13	Edinburgh	Scotland	17.0%
14	Cardiff	Wales	15.5%
15	Sydney	New South Wales, Australia	15.5%
16	Sheffield	England	15.0%
17	Bristol	England	14.0%
18	San Francisco	California, USA	11.9%
19	Udine	Friuli-Venezia Giulia, Italy	10.0%
20	Calgary	Alberta, Canada	7.2%

Table 15: Canopy cover comparison: Wales and the world.

The world's cities canopy cover table shows Wales lying in the mid-range.

When focussing on areas with a comparable climate, Wales' largest cities of Cardiff, Swansea and Newport compare favourably to English towns (e.g. Bristol). However they do not feature as extensive a tree cover as some North American cities with a similar climate to Wales such as Seattle (23%) or Portland (26%).

In most international urban canopy cover studies reviewed, the mapping of existing tree cover levels and distribution has been used to set future targets. This is regarded as good practice by the US Conference of Mayors, the US Department of Agriculture Forest Service, and many non-for-profit organisations including the Arbor Day Foundation (US-based), American Forest (US-based), the National Urban Forest Association (Australia-based) and the Trees and Design Action Group (UK-based).



In the US, American Forests²¹ offers some general guidelines for canopy goals based on climate conditions and zoning / land-use categories:

Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
Metropolitan Areas East					
Average tree cover counting all zones					40%
Suburban residential zones					50%
Urban residential zones					25%
Central business district					15%
Metropolitan Areas in the South-West and Dry West					
Average tree cover counting all zones					25%
Suburban residential zones					35%
Urban residential zones					18%
Central business district					9%

Table 16: American Forests' Tree Canopy Goals

American Forests stresses, however, that each community must first inventory its tree canopy cover and then set specific goals based upon its unique combination of climate, geography, land-use and political context.

For example, Portland is aiming to increase its canopy cover from current levels (26%) to 33%. To achieve this, land-use specific targets have been set as follows:

LAND USE	CURRENT CANOPY	TARGET CANOPY
Residential	30%	35-40%
Commercial / Industrial	7%	15%
Parks / Open Spaces	28%	30%
Rights of Way	17%	35%
Citywide	26%	33%

Table 17: Portland canopy cover targets²²

²¹Urban forests on American Forests protecting and restoring forests website

²²Portland canopy cover targets - on the Portland Plan website



2.5 Summary: actionable findings

Setting canopy cover targets

The review of experiences on the international stage demonstrates that adopting canopy cover targets helps to drive urban tree management. The national findings on mean canopy cover provide a useful benchmark for local planning authorities across the country to use in support of their local planning efforts.

Under the UK Forest Standard, 20% tree cover constitutes woodland. This could be applied to urban areas as to whether they attain 'woodland town' status.

Priority towns for adoption of a strategic approach to canopy cover increase

As demonstrated in the synopsis of benefits provided in Appendix 1, trees are a critical component of the green infrastructure required to provide for healthy and sustainable living in urban environments.

Those largest and densest urban population centres with markedly below average canopy cover are therefore a legitimate priority for concerted and strategic action to increase cover.

Apart from the number of people affected by low tree canopy provision, other factors to consider when identifying canopy cover needs include deprivation, air quality and flood issues.

- Port Talbot (8%) combines both a significant urban population, with a very low tree cover, as well as air quality issues in Margam and Tai Bach. The 'Coed Talbot Trees' project is one of several initiatives to deal with the PM₁₀ particulate pollution problem (see Section 4.3). Other significant urban population centres with low tree cover (12-14%) are Wrexham, Llanelli and Barry.
- Amongst coastal towns Rhyl stands out in terms of very low cover (5.5%), town size and high presence of top category WIMD wards. Other coastal towns for attention would include Towyn, Llandudno, Deganwy, Holyhead, Milford Haven, Porthcawl and Llantwit Major.
- Most of the low cover South Wales Valley towns are modest in size and are often well provided for in quantitative terms, both within and beyond town limits. In these communities, particularly when affected by high levels of deprivation, the quality of existing provision merits special attention.
- In the North-East, the sizeable towns of Buckley, Mold and Rhosllannerchrugog (13-16%) merit action along with smaller communities on 5-8% such as Broughton, Coedpoeth and Saltney.
- The hinterland towns are medium to small and within their countryside setting may not appear a priority for attention. However it would appear that, where linked to major trunk roads, many of these towns record high levels of PM₁₀ pollution. Increased tree cover would contribute to reducing this unhealthy situation. Haverfordwest, the largest town, has a modest 14% cover. Denbigh has only 9%. The latter is an interesting example of where, because of its rural setting, there may appear no need for targeted action. However, surrounded by the open agricultural landscape of the Vale of Clwyd, there is scant woodland cover beyond the urban area. The old slate mining communities of Gwynedd, e.g. Blaenau Ffestiniog, are low on cover and arguably merit tree planting.



The ward-level analysis provides further insight where targeted tree planting might be needed. This is addressed in Section 4.

This study clearly shows that these towns would benefit from strategic tree cover management and canopy increase initiatives:

- 1) Along the North Wales coast, in particular Rhyl and Holyhead
- 2) The South Wales towns of Port Talbot, Llanelli and Barry

These towns are also strongly linked to the WIMD ward canopy cover findings highlighted in Section 4.

To facilitate the development of tree strategies, NRW is considering:

- Developing an enabling programme – supporting those local planning authorities in less canopied areas, particularly those where evidence of tree loss has been identified;
- Encouraging and celebrating local success – recognising good practice and results.

Optimising funding tools facilitating delivery

The strategic delivery of the canopy cover objectives set for a local area will be greatly facilitated if existing funding streams supporting the delivery of a high quality environment and infrastructure across urban Wales integrate tree-related measures as an eligible expenditure. For example: Vibrant and Viable Places, Coastal Communities Fund, Business Improvement District Fund Wales, Regional Transport Consortia Grant, Safe Routes in Communities, etc.

In line with this, NRW will ensure that its own grant schemes are open to urban tree and woodland proposals as far as possible.



Figure 27: Cardiff - The distinctive green corridor of the River Taff, including Sophia Gardens and Bute Park, leading right into the city centre. © Crown Copyright: RCAHMW

3. Distribution, composition and change of canopy cover

This section focuses on the urban forest's distribution, composition and changes to canopy cover.



This section focuses on the urban forest's distribution, composition and changes to canopy cover. It considers:

- 3.1 Urban canopy cover distribution across land-uses
- 3.2 Balance between urban woodlands and amenity trees
- 3.3 Monitoring the extent of urban tree canopy over time – losses and gains
- 3.4 Tree types (conifers, broadleaf, mixed)
- 3.5 Summary: actionable findings

Section 3 highlights

- Public open space hosts 53% of all tree cover in our communities despite making up only 22% of urban land. 21% of graveyards and cemeteries are covered by tree canopy.
- Just 1% of all tree cover is found in areas of high-density housing, often those experiencing the highest levels of deprivation. Private residential gardens make up 35% of Wales' urban areas and provide 20% of all our towns' tree cover.
- Transport routes, including verges and pavements, make up 16% of urban land but they have tree cover of only 9%.
- Urban woods represent 35% of canopy cover, with 65% made up of amenity trees. Woods make up 50% of cover in 12 towns across the Valleys. 81% of all woods fall within the open space land-use categories. 29% of all amenity trees lie within private gardens.
- High tree cover at the local ward level can often be attributed to areas of woodland. In the case of seven of Cardiff's nine Pentwyn and Llanrumney wards, woods contribute 47% to 66% to the overall canopy. Amenity tree cover in the two non-wooded Llanrumney wards is as low as 6 and 9%.
- Some 7,000 large amenity trees were lost between 2006 and 2013. 20 hectares of urban woodland have been lost in three years.
- 159 of Wales' 220 towns have lost canopy cover between 2009 and 2013 with all counties except two showing urban tree canopy loss.
- Analysis provided of both canopy cover and tree size and woodland losses points to the need for further investigative actions and ground-truthing to verify concerns over canopy and large tree decline.

3.1 Urban canopy cover distribution across land-uses

To provide insight into the key contributors and stewards of Wales' urban tree resource, analysis was conducted to identify canopy cover distribution across 12 land-use categories drawing from OS MasterMap and PointX data.

Land Use Category	Total Land-use: hectares	TCWTC 2013 Canopy Cover: hectares
Commercial Areas (COM)	8820.75	1090.73
Education (EDU)	3029.15	370.62
Hospitals (HOS)	495.31	88.56
Burial (BUR)	681.56	142.78
Remnant Countryside (FLD)	1055.63	180.39
Formal Open Space (OSF)	9572.36	2251.63
Informal Open Space (OSI)	8308.55	3899.09
Woodland (WOD)	1285.64	1285.64
High Density Residential (RHD)	4628.55	123.26
Low Density Residential (RLD)	25276.45	2652.60
Transport Corridors (TRN)	13915.09	1318.15
Un-Classified Land-Use (UNC)	9262.12	741.41
TOTAL	86331.15	14144.85

Table 18: Canopy cover within each land-use for the 220 towns.
 Note: 9,262ha of urban area unable to be allocated to land-use categories using MasterMap and PointX data. This is 11% of the urban area, meriting further analysis in future

Wales Land-Use 2013

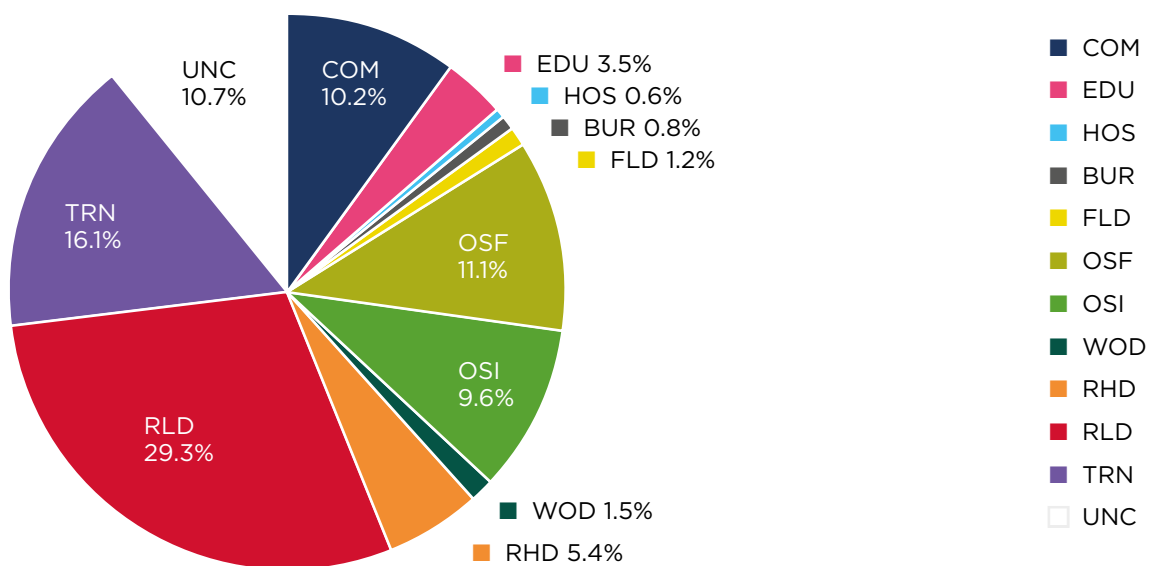


Figure 28: Distribution of the 12 land-use categories (2013) across the 220 urban areas of Wales



Wales Canopy Cover per Land-Use 2013

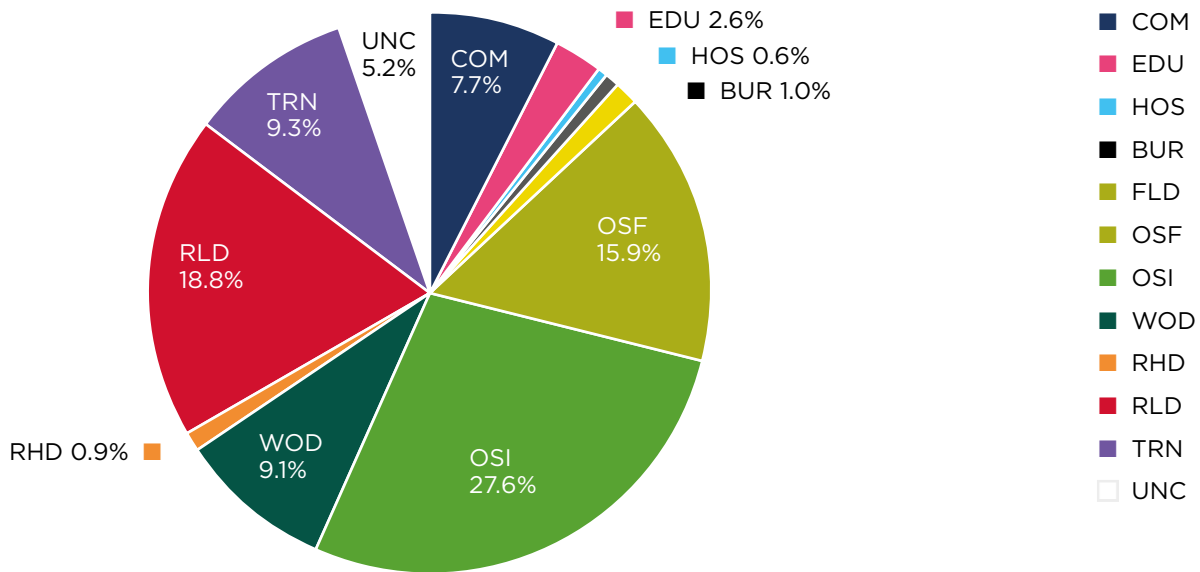


Figure 29: 2013 urban canopy cover percentage breakdown per land-use.

Percentage of Canopy Cover per Land-Use

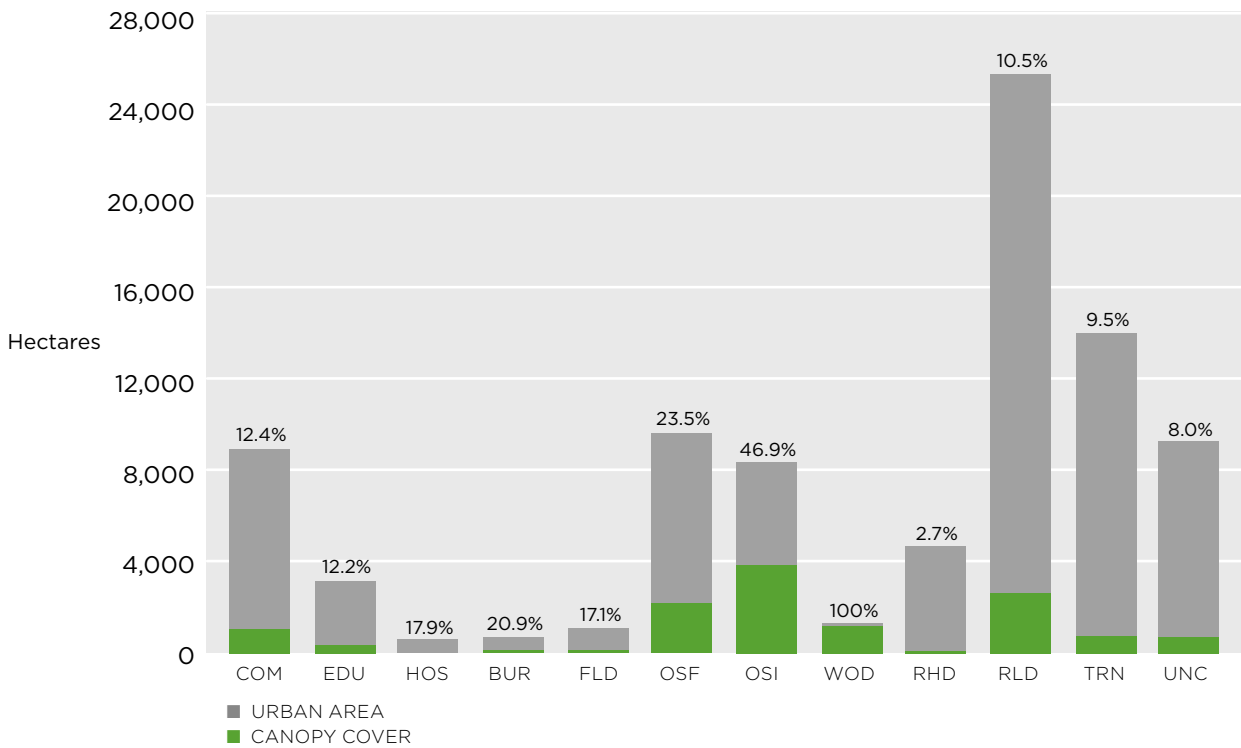


Figure 30: Hectareage of canopy cover within each land-use. (Also expressed as % of total land-use area).



The proportion of each land-use within Wales' urban areas is shown in Figure 28. This contrasts with Figure 29 which shows the contribution each land-use makes towards Wales' total urban canopy figure. Understandably, open space (including additional woodland) contributes significantly (53%) to Wales' 14,145 hectares of urban canopy, and notably low-density residential is home to 20%. Figure 30 provides insight into the two key factors underpinning this distribution: total land area and average canopy cover per land-use. This shows contrasting relative contributions: open spaces feature the highest average canopy cover (16% in formal OS and 28% in informal OS) while high-density residential areas and transport corridors contribute a low level of canopy cover (respectively 1% and 9%).

Informal & Formal Open Space (OSI & OSF) mean tree cover: 47% & 24%



Figure 31: Contrasting formal open space – the surrounds to Newport civic centre (left) and public open space at Bellevue Park, Parciau, Wrexham (right). © Crown Copyright: RCAHMW

Informal and formal open space combine to host nearly half (44%) of Wales' urban canopy cover. Informal open space provides 28% of this, the largest land-use contributor of the 11.

Woodland (WOD) mean tree cover: 100%

This category picks up NFI woodland that does not fall within any of the other 10 land-use classes. 1,286 hectares of additional woodland forms part of the unallocated 11,548 hectares. Arguably very similar in definition to informal open space, this woodland land-use contributes 9%.

Remnant Countryside (FLD), Burial (BUR), Education (EDU) and Hospital (HOS) grounds mean tree cover: 12-21%

These ancillary land-uses are not major contributors to Wales' overall urban canopy coverage. However, in relative terms within the context of a town centre, the church graveyard, for example, can offer a huge and historic tree presence. On average, as much as 21% of burial land is covered by trees.

Health-care land contributes 0.6% to Wales' overall urban cover, but 18% of hospital land is tree canopy. Whilst higher than Wales' average, canopy lags some way behind the coverage reached within public open space. This points to the value of investigating opportunities to increase tree cover within the grounds of health care facilities that would offer valuable well-being and restorative benefits (see 'Trees for Health' box on the following page).





Figure 32: Contrasting cemetery landscapes: Cathays, Cardiff (left) and Trealaw, Rhondda (right).
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Trees for health: Learning from Scotland and England

Since 2009 Forestry Commission Scotland and its national health advisor have been actively working with NHS Scotland to target hospital grounds, undertaking new planting, managing existing woods and creating better access, e.g. the Ninewells Hospital, Dundee. NHS Forest has delivered similar projects in England. The new Ysbyty Ystrad Fawr, Caerphilly, delivered a community-based planting initiative in 2011. Clearly there is considerable scope elsewhere in Wales across Health Trusts' grounds.

Towns with university and college campuses boost the extent of the canopy cover associated with education land, e.g. Aberystwyth. 3,029 hectares across Wales fall within this land-use category, of which 12% is tree canopy. Valuable playing fields are a major feature of school grounds but opportunities do exist to enhance tree cover on under-utilised tracts of grass around parking and circulation spaces – thus providing a much enhanced environment for learning (views from the classroom, opportunities for more natural play, sheltering from wind and rain for greater comfort, etc.). Opportunities to create natural outdoor classrooms, featuring tree cover, seem under-exploited.

Depending on a town's character and the configuration of the urban area, remnant countryside (FLD) can feature quite prominently e.g. Brymbo, Wrexham.

Commercial areas (COM) mean tree cover: 12%

Commercial land-uses – including retail, manufacturing, office and other business-dominated areas – contribute 8% of Wales' urban tree coverage. Further analysis is required to ascertain where the main bulk of cover is. It is likely that cover is low not only on industrial sites but also in town centre retail areas. Despite the huge land-take for out-of-town shopping areas and associated car-parking, there is generally an element of tree cover, albeit often sparse (frequently small in stature and <3.0m diameter) within the scale of the development. Possibly this points to where the majority of the 12% tree cover is located across commercial areas.





Figure 33: Contrasting commercial areas: Ebbw Vale steel works, now demolished and in the process of being transformed under the banner of 'The Works' (left) and a foreground mix of commercial uses in Newport (right).
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Residential Low-Density neighbourhoods (RLD) mean tree cover: 11%

Low-density residential areas are the custodians of nearly a quarter (19%) of Wales' urban tree cover. Low-density housing is also by far the largest land-use, accounting for 25,276 hectares, and partially explains this contribution to urban cover. The mean canopy cover is however only 11%.

This underlines the role of residents' understanding of and goodwill towards urban trees for the future retention and potential expansion of Wales' trees. It also points to the importance of the good use and management of tree preservation orders by local planning authorities; in particular, their residential street tree planting management programmes.

Transport corridors (TRN) mean tree cover: 8%

Transport corridors include all major trunk road thoroughfares and associated land-take and the town's transport system, including the majority of residential streets.

Transport corridors contribute 8% of Wales' overall urban canopy coverage. Given the limited land availability for trees, this seems to demonstrate that landscaping to relief road improvement schemes over the last 25 years has made a positive contribution to tree cover within urban areas. However, as a component of transport routes, cover is also only 8% - the second lowest mean cover across all 12 land-uses considered.

Residential High-Density (RHD) mean tree cover: 3%

High-density housing areas contribute only 1% to Wales' tree cover. Average canopy cover within such communities is also very low (3%). Yet, high-density housing neighbourhoods are where most of the urban population live. Valley towns and Cardiff itself stand out as having high-density communities (>4,000 people / km²). Drilling down further and examining high-density housing at ward level would provide valuable data as to where lack of tree cover is most prevalent.



Figure 34: High-density housing in Canton, Cardiff.
© Crown Copyright: RCAHMW

Depending on the type of housing development, these are also often our most deprived communities. As high-density suggests, space for trees and green space is often at a premium, with only modest rear and, where available, front gardens. Areas around housing are often challenging. A hard-landscaped environment is often not suitable for trees. Social housing sites arguably offer more potential with their swathes of mown grass but, within this study, these are classified as 'open space formal'. However, despite the constraints and expense involved, improving the immediate surrounds of these communities, and within the gardens where possible, is surely a priority.

3.2 Balance between urban woodland and amenity trees

The 2014 National Forest Inventory (NFI) shows that urban woodland amounts to 4,918 hectares. The TCWTC aerial photographic interpretation concluded that other types of urban trees (groups and individuals) contribute an additional 9,180 hectares of canopy cover. Arguably 'wooded' and 'amenity' (non-woodland) canopy cover are quite distinct both in character and the benefits they offer society.

Wales' Urban Canopy Cover % - 2013
National Average - 16.3%

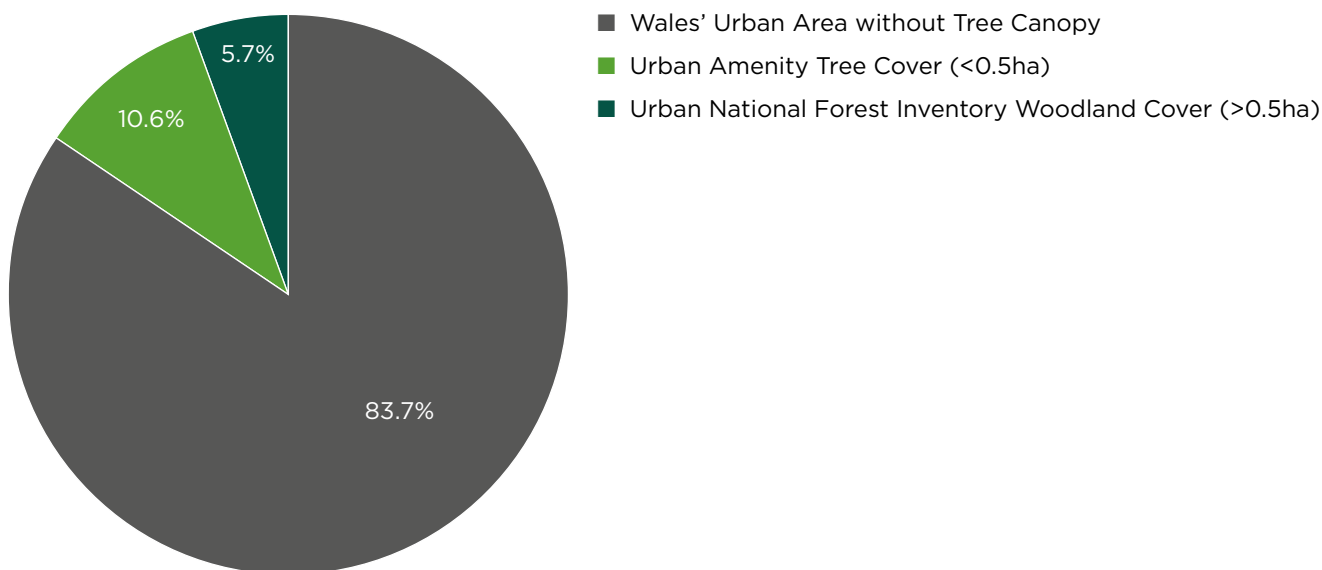


Figure 35: The 2013 national urban canopy cover percentage

Nationally, woodland (NFI) makes up 35% of the overall canopy of urban areas. This similarly ranges from 30-35% in the four main town-size categories, but within the smaller 0-250 hectare towns this reduces to 21%.

The woodland component contributes 20-21% of total cover equally across the four 0-40% canopy classes. 43 urban areas have woodland providing in excess of 40% total canopy cover, of which 18 host as much as 50-60%.

Urban areas with high woodland (NFI) cover

Explaining the higher cover of Valley towns in South Wales, urban woodland is often a higher than average contributor to tree canopy. Woodland in 12 urban areas across the Valleys makes up, on average, 50% of all tree cover. Abertillery contains as much as 66% woodland cover. Major towns such as Neath and Pontypool possess 52% and 51% woodland respectively within their built environment.

Almost all the other highly 'wooded' towns, six in total, are in North-East Wales, e.g. Holywell (43%), Cefnmawr (49%) and Caergwrle (58%).



Extent of Woodland across Wales' 220 Towns

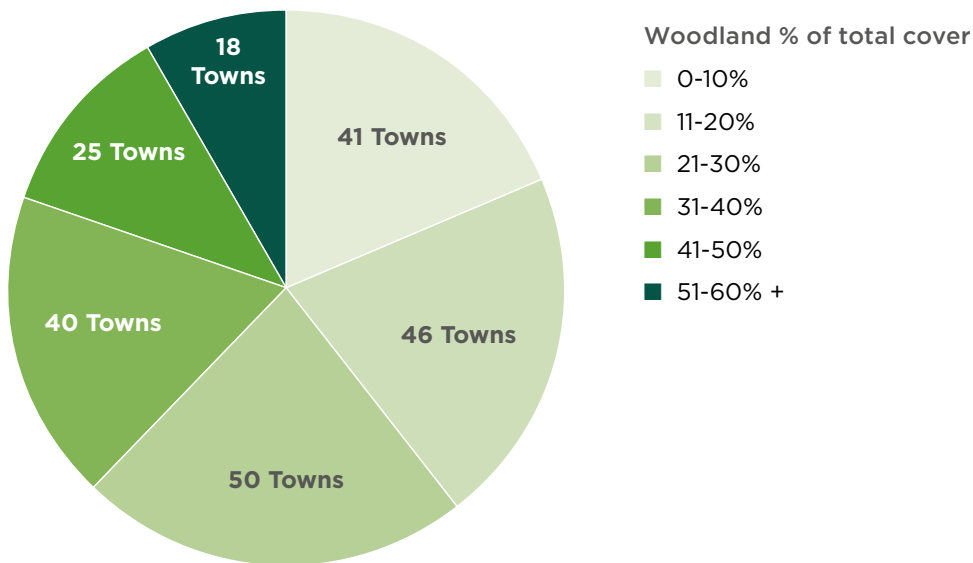


Figure 36: Extent of woodland canopy as a component of total cover within Wales' towns

Urban areas with low woodland (NFI) cover

Reflecting the generally low cover of coastal towns, woodland is mainly well below average in contributing to canopy cover. Woodland cover contributes 19%, 20% and 21% to the major towns of Llanelli, Barry and Rhyl respectively. Towns low on woodland are Towyn and Kinmel Bay (7%), Pembroke (7%) and Tywyn, Deganwy and Llandudno Junction (8%).

However, some coastal towns are capable of sustaining a high 'wooded' component, e.g. Barmouth (65%), Aberystwyth (50%) and Colwyn Bay (39%).

Seventy small towns (half of the 0-250 hectare category) have less than 20% 'wooded' cover, with half of those under 10%.

Land-use distribution of woodland vs. amenity canopy

Comparison of Amenity and Woodland Trees 2013

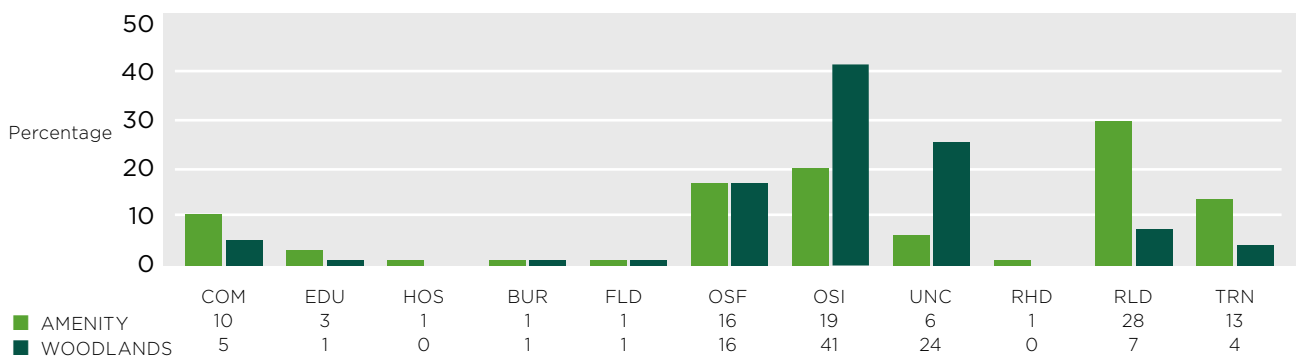


Figure 37: Land-use distribution of woodland (NFI) and amenity canopy cover (expressed as percentage of cover type).



Figure 37 highlights that woodland within informal open space provides 41% of all the wooded cover across the land-uses, contributing twice as much canopy as do amenity trees within this land-use. Woodland not allocated to the 10 other land-uses accounts for 24%, with formal open-space woods contributing 16%, a 50/50 split with amenity trees in these formal parkland settings. A modest woodland 5%-7% presence features in commercial and low-density residential areas. Of the other six land-uses, only transport corridors (4%) contribute over 1% of woodland to Wales' urban areas.

Amenity trees come to the fore in low-density residential areas, hosting 28% of Wales' urban non-woodland cover. Informal and formal open space register 19% and 16% cover respectively. The two other main land-uses, transport (13%) and commercial (10%) provide modest contributions, with education, 3% of the urban area total, hosting 3% of urban amenity cover.

The significant quantity of individual and groups of trees, present within private gardens and contributing to the overall 'amenity' of Wales' towns, merits highlighting. Whilst only a modest 13% total tree-cover exists within this overall large land-use holding (35% of towns), their 20% 'wooded' and 'amenity' contribution rests in the care of individual householders. This highlights the importance of raising awareness amongst the public of the benefits of trees to us all and of exploring avenues to safeguard this societal resource.

Wards with high and low woodland (NFI) cover - making the distinction between 'wooded' and 'amenity' tree cover

Overall ward-by-ward findings are explored in Section 4 but their woodland vs. amenity character is discussed here.

The extremes of 'wooded' cover become even more pronounced in specific wards. Focusing on disadvantaged Communities First cluster areas, Table 19 highlights wards that are mainly well above the national average of 16.3%. What comes across strongly however is the extent to which this is comprised of woodland canopy.

Cluster Area Wards (LSOA)	Urban Area	'Wooded' %	'Amenity' Tree %	Total Canopy %
High 'Wooded' Wards				
Ystradgynlais 1	Ystradgynlais	81%	19%	18.3%
St. Cadocs and Penygarn	Pontypool (& Abersychan)	81%	19%	46.2%
Caerau 4	Cardiff	77%	23%	33.6%
Bonymaen 4	Swansea	74%	26%	40.8%
Greenmeadow 1	Cwmbran	74%	26%	39.5%
Cwmtillery 2	Abertillery	73%	27%	29.5%
Low 'Wooded' Wards				
Butetown, Riverside, Grangetown	Cardiff	0%	100%	4.5%
St. Dials 1&2	Cwmbran	0%	100%	16.8%
Splott 1, 2, 3	Cardiff	0%	100%	12.4%
Adamsdown	Cardiff	0%	100%	5.2%
Swansea North West	Swansea	0%	100%	7.3%
Fairwater 5	Cardiff	0%	100%	15.0%

Table 19: Contrasting 'woodland' cover within Communities First cluster area wards.



However, by their very nature woods are likely to be contributing tree cover in quantity, but only in very specific areas rather than being spread evenly across where people live and work. Potentially woodlands offer significant health and well-being benefits for local communities. Unfortunately, in all too many instances these 'wooded' areas are not managed, are inaccessible and while they continue to deliver a range of ecosystem services, they are currently of limited value to people.

This is often in contrast to the remaining canopy cover which is generally spread throughout communities. In many respects, because of their 'on the doorstep' presence this 'amenity' cover offers a greater range of benefits to urban living. Due to their location and proximity to people and buildings, these groups and individual trees undergo a more rigorous management regime. Where carried out properly, to professional standards, this cover delivers a quality neighbourhood treescape.

In light of this distinction it is important to be aware that high canopy cover areas can actually be quite low on quality amenity treescapes. For example, in Cardiff's Caerau 4 ward, total canopy cover is a respectable 34%. However 77% of this is 'wooded' cover, largely confined to the hill-top fort site abutting the A4232. The remaining 23% is 'amenity' cover. This provides coverage to only four of the wards' 47 hectares, equating to 8%.

If the more marginally located 'wooded' areas are separated out from 'amenity' cover, then in the case of Caerau 4's 8%, this is similar to the low total percentage cover wards of Cardiff, Newport and Swansea, highlighted in Table 19 (where NFI woodland is completely absent).

Figure 38 of Cardiff East's most deprived wards shows reasonably high canopy cover in the range of 17%-37% within 5 of the Pentwyn and Llanrumney wards. The woodland canopy component of this is as much as 49%-66%. However the actual amenity tree cover in Llanrumney 4 and 7 wards is as low as 6%-8%. The contrast is explained by the combination of the wooded river corridor of the Rhymney adjoining compact housing estates with limited tree cover.

Further analysis and ground-truthing would reveal useful, detailed evidence as to the exact spatial balance between 'wooded' and 'amenity tree' areas within communities.

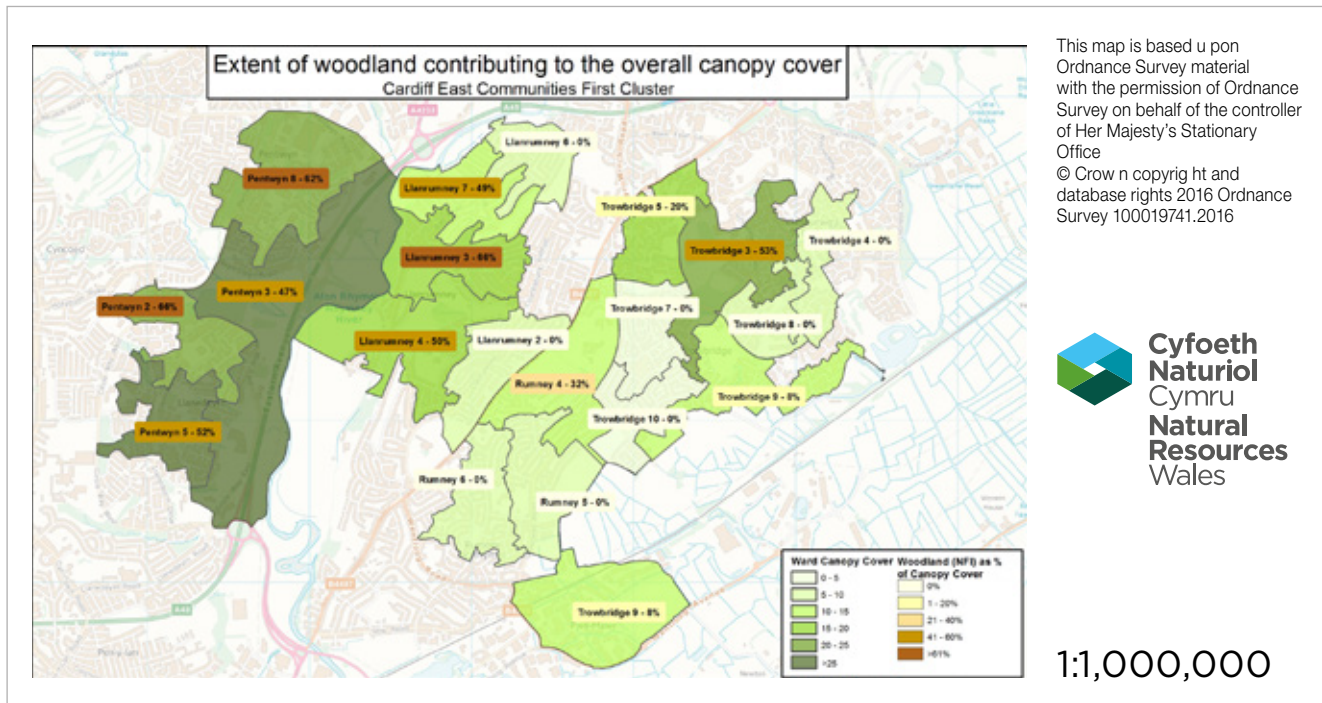


Figure 38: Cardiff East Communities First cluster area. Distribution and extent of woodland contributing to the overall canopy cover



3.3 Monitoring the extent of urban tree canopy over time - losses and gains

The national picture - canopy cover change

2013 - 16.3%
2009 - 17.0%
2006 - 14.6%

County canopy cover comparisons

2006-2009: With the 2009 improved aerial photographic resolution Wales' urban canopy cover increased by 2.4% with all counties registering gain, in particular Blaenau Gwent (+4.9%), Carmarthen (+5.2%) and the Vale of Glamorgan (+4.2%). The presence of cloud on the 2006 Llanelli aerials certainly influenced the overall Carmarthen findings. There were also counties where the canopy gain was negligible e.g. Gwynedd (0.1%), Conwy (0.3%) and Neath Port Talbot (0.3%).

2009-2013: The like for like aerial photography for 2009 and 2013 comparisons offered a different perspective of trends across Wales. Wales lost 539 hectares - 0.6% of urban canopy in four years. Elsewhere it was a decline on a modest scale, the least percentage loss was in Neath Port Talbot (0.1% - 8ha), the greatest Blaenau Gwent (1.7% - 46ha). In hectares loss was least in Anglesey (3ha) and greatest in Swansea (107ha). With Swansea it should be noted that a degree of 2009 over-zealous capture was re-calibrated in 2013.

Levels of county canopy cover loss:

0.1% - 0.5%: Bridgend, Caerphilly, Cardiff, Anglesey, NPT, Pembrokeshire, RCT,
0.5% - 1.0%: Carmarthen, Conwy, Denbigh, Gwynedd, Newport, Powys,
1.0% - 1.5%: Ceredigion, Merthyr Tydfil, Monmouth, Swansea, Vale of Glamorgan, Torfaen,
1.5% - 2.0%: Blaenau Gwent.

The only two counties to show a gain were in the North-East;

Flint: +0.7% (33ha)
Wrexham: +0.4% (15ha)

2006-2013: Comparisons over the seven years offer a picture of national gain - 1.8%, but this needs to be considered in the context of the more robust like for like 2009 and 2013 data capture. So whilst 19 counties show gains up to 4.5% (Carmarthen), Gwynedd and Conwy still show a modest loss and Monmouthshire remains static.

Balancing both the low levels of canopy, all below the national average except Wrexham and loss of cover in many of their towns, the North Wales counties remain a concern.

Town canopy loss between 2006, 2009 and 2013



Figure 39: Tondy, Bridgend - tree loss between 2006 and 2009 making way for new housing

56 urban areas showed canopy loss between 2006 and 2009 and this increased to 63 across the seven years. However when comparing the like with like aerial photography of 2009 and 2013 159 urban areas showed a decline in canopy - 72% of Welsh towns, albeit on a modest scale.

Towns in seven counties all showed loss. Counties with numerous small to medium towns, e.g. Carmarthen, Pembrokeshire, Powys and RCT all demonstrated a large majority of towns with canopy loss.

As with counties on higher levels of cover certain well-canopied towns appear susceptible to canopy loss, e.g. Dolgellau (26% from 29%), Llangollen (25% from 28%) and Llandrindod Wells (21% from 23%).

Specific town canopy cover highlights are featured in the county 'assessing canopy loss' tables 23, 24 and 25.

Change in amenity tree numbers between 2006, 2009 and 2013

Between 2006 and 2013, Wales' towns have lost 7,005 large trees, those greater than twelve metres in crown diameter (see table 20). Across these seven years there has been an overall 336,304 increase in the total number of amenity trees, the majority in the medium 6-12 metre crown category.

Year	Total Number of Amenity Trees			Total No. of Amenity Trees in 220 Urban Areas
	Large 12m+	Medium 6.0 -12m	Small 3.0 - 6.0m	
2006	34,972	658,732	1,853,006	2,546,710
2009	23,578	727,693	2,966,591	3,717,862
2013	27,967	926,262	1,928,784	2,883,014
Change in Tree Numbers 2006 - 2009	-11,393	68,961	1,113,584	1,171,152
Change in Tree Numbers 2009 - 2013	4,389	198,569	-1,037,807	-834,848
Change in Tree Numbers 2006 - 2013	-7,005	267,530	75,778	336,304

Table 20: Number of amenity trees in Wales' urban areas.

Calculating and presenting the number of trees (points and polygons - see methodology A2.2.1) has only focussed on amenity trees. Excluded from these figures are all those trees less than 3.0 metres in diameter plus NFI woodland.

Large amenity trees - The 2006 to 2009 results highlighted the loss of 10,826 of large trees, but the 2009 to 2013 period saw a recruitment of 4,389, presumably from the medium category.

Whilst the differing trend of loss and then gain between the two periods is difficult to explain, it is quite plausible that mature tree loss would occur over relatively short time-scales through felling or heavy pruning and pollarding. Between Phase 1 and 2 FCW carried out an overlay exercise of the 2006 tree data onto the 2009 aerial photographs for Aberystwyth (568 ha). This highlighted that 80 >3.0m diameter trees had been lost in this short space of time. Greener Aberystwyth Group's (GAG) survey of street trees in 2005 identified 448 trees. The re-survey in 2010 showed a loss of 48 trees, 10.7% of the street tree population. This equates to a loss of 2% per annum. It was this dramatic loss plus talking to a number of local authority tree officers that convinced FCW of the merit of monitoring change at regular intervals.

The loss of 7,000 large trees over seven years is nevertheless a cause for concern.

Small amenity trees - The 2006 to 2009 results showed an increase of 1,113,584 trees. This significant recruitment was very unlikely to be tree growth over this three year period. The credible explanation was that the higher resolution of the 2009 aerial photography accounted for trees previously 'unnoticed' being picked up and captured. Whilst adhering to the >3.0m diameter methodology, the Phase 2 contractors did state that the improved 25cm resolution could have enabled them to capture 2.0m diameter trees. With the same aerial resolution for 2009 and 2013 the findings show a sizeable reduction of small tree numbers, to the tune of 1,037,807. This is partly explained through a combination of re-calibration of over-zealous canopy capture in 2009, i.e. that of non-canopy polygons of shrubs and, genuine tree loss.



All amenity trees – as per the national figures there is fluctuation in tree numbers over the three periods and between the tree size counts. Overall there are more trees being picked up and estimated in 2009 with the 2013 counts either remaining broadly static or falling between the 2006 and 2009 figures. Conwy is the only county to consistently show a decline in numbers over each period. Caerphilly, Flintshire and Torfaen are estimated to have between 5,000 and 13,000 less trees now than in 2006 with Rhondda Cynon Taf showing a loss of 36,000 trees. These losses in Caerphilly and Conwy are arguably countered by increased woodland coverage but the other three counties also show woodland loss too.

Regular re-runs of the canopy cover mapping at the same 25cm resolution will arguably build a more comparative, consistent and robust picture of change

Urban area size category (hectares)	Overall large tree loss (2006 - 2013)
>5,000ha	
Cardiff	-244
Swansea	-280
1,000 - 5,000ha	
Bridgend (& Tondy / Sarn)	-578
Connah's Quay	-575
Wrexham	-336
Ebbw Vale (& Cwm)	-390
500 - 1,000ha	
Aberystwyth	-589
Carmarthen	-830
Haverfordwest	-212
250 - 500ha	
Flint	-472
Monmouth	-584
Pembroke Dock	-247
Pontardawe (& Swansea Valley)	-392
Rhosllanerchrugog / Penycae	-285
<250ha	
Glynneath	-713
Murch	-435
St Asaph	-347
Penpedairheol / Gelligaer	-312



Table 21: Urban areas showing loss of 200+ large trees over seven years



Woodland change between 2011 and 2014

Blaenau Gwent and Torfaen stand out as having the highest levels of woodland within urban areas – 10.3% and 10.5% respectively, contrasting with Anglesey (2.1%) and the Vale of Glamorgan (2.4%) having the least.

In the space of three years Wales' urban areas have lost an overall 20 hectares of woodland, gaining 55 hectares but losing 75 hectares. Counties showing the most loss are Caerphilly and Newport – 13 hectares, Monmouthshire (12ha) and Neath Port Talbot (10ha). This loss is often countered by 'new' woodland as in the case of Caerphilly where 21 hectares have been gained. Denbighshire, despite its 'least canopied' tag has seen an overall 8 hectare increase in woodland. These new woodlands need to be assessed against the NFI dataset as non-canopy categories exist to a modest degree in urban areas, e.g. new woodland creation.

Losses - towns displaying woodland loss are Newport (13ha), Port Talbot (8ha), Risca / Crosskeys / Abercarn (6ha), Penpedairheol / Gelligaer and Pontypool - 4 hectares, Aberdare, Caerphilly and Lanelli - 3 hectares with Bangor, Caergwrle, Gwersyllt, Llanharry, Merthyr Tydfil, Monmouth – 2 hectares. Counties showing the most loss are Caerphilly and Newport – 13 hectares, Monmouthshire (12ha) and Neath Port Talbot (10ha).

Gains - these are to be found in Bargoed / Blackwood / Newbridge (19ha), Prestatyn (8ha), Gresford, Neath and Swansea, increasing by 3 hectares with both Colwyn Bay and Wrexham gaining 2 hectares. Caerphilly County Borough and Denbighshire both show an overall gain in excess of 8 hectares. These increases need to be assessed against the NFI dataset as non-canopy categories exist to a modest degree in urban areas.

Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Aligning canopy cover and amenity tree loss

CC Rank	Urban Area	County	2013 Canopy Cover %	Urban Area - ha	Canopy Cover (CC) Loss	L/M/S Tree Loss / Gain
1	Colwyn Bay	Conwy	17.9%	1100	24.6ha	-750
2	Rhondda Fawr	Rhondda Cynon Taf	18.1%	1538	23.6ha	-31,329
3	Flint	Flintshire	14.2%	394	10.1ha	-5,110
4	Caergwrle	Flintshire	29.7%	239	9.1ha	-1,496
5	Porthcawl	Bridgend	6.2%	541	8.5ha	-2,598
6	Port Talbot	Neath Port Talbot	8.2%	2301	8.4ha	+9,895
7	Gresford	Wrexham	24.5%	192	6.6ha	-5,395
8	Monmouth	Monmouthshire	17.0%	379	6.1ha	+9,523
9	Ruthin	Denbighshire	11.7%	247	5.7ha	-4,304
10	Llangollen	Denbighshire	25.0%	152	5.3ha	-3,365
11	Pwllheli	Gwynedd	7.8%	180	5ha	-2,521
12	Mold	Flintshire	15.3%	398	4.6ha	-9,858
13	Rhuddlan	Denbighshire	7.2%	125	4.5ha	-55
14	Newtown	Powys	13.8%	475	3.7ha	-2,636
15	Dolgellau	Gwynedd	26.0%	150	3.7ha	-362
16	Menai Bridge	Isle of Anglesey	19.3%	119	3.2ha	-5,913
17	St Asaph	Denbighshire	17.6%	165	3.2ha	+3,871
18	Benllech	Isle of Anglesey	11.2%	107	3ha	-1,152
19	Usk	Monmouthshire	16.4%	87	2.9ha	+1,651
20	Aberaeron	Ceredigion	11.6%	86	2.7ha	-1,241

Table 22: 'Top 20' urban areas of canopy cover and amenity tree loss between 2006 - 2013

Assessing canopy loss - identifying concerns meriting further detailed town and county investigation

In respect of canopy cover, amenity tree and woodland loss the following six counties, whilst with room for improvement, appear to fare relatively favourably:

Counties with the least canopy cover and tree loss concerns	Confirming findings where further investigative action / ground-truthing could be targeted
Half of these counties lie in the relatively canopied South Wales Valleys. Cardiff and Newport, Wales' largest cities, are located on the South Wales coastal belt, with Wrexham championing the North. There are some specific town canopy levels that deserve attention.	
BRIDGEND	<ol style="list-style-type: none"> 1) County canopy has decreased a modest 0.4% during '09-'13. 2) Porthcawl - 7.8%, 6.4%, 6.2%. Already registering low canopy, this is the one town in the county showing a decrease - 8.5ha in 7 years. Why? 3) Between '09-'13 Maesteg appears to have lost 950 large trees, though over the 7 years there is an overall gain. So worth checking. 4) Otherwise towns showing gains over both periods - especially Valley towns, e.g. Maesteg (+2%), Pontycymer & Price Town. 5) The reported loss of 578 large trees in Bridgend occurred almost exclusively during '06-'09.
CAERPHILLY	<ol style="list-style-type: none"> 1) The canopy cover has dropped 0.5% between '09-'13, with the tree count reduction of 5,000. 2) The 3 main towns - Bargoed etc, Caerphilly, Risca etc all show minor canopy loss in '13 after the improved capture gains in '09. 3) New Tredegar, Machen, Abertridwr, Ystrad Mynach & Abertysswg have all increased cover in the '06-'09 & '09-'13 periods. 4) Apart from low canopy in the elevated small Fochriw and Abertysswg communities the >100ha town of Nelson stands out as having low cover (8.1%) a decrease of 0.8% since '09. 5) Penpedairheol / Gelligaer lost 312 large trees in '09 but no loss was then recorded in '13. 6) An extra 19.5ha of woodland (new planting?) has been identified from the '14 NFI dataset in Bargoed / Blackwood / Newbridge but elsewhere there are losses in Risca / Crosskeys / Abercarn (5.5ha), Penpedairheol / Gelligaer (4ha) and Caerphilly (2ha).
CARDIFF	<ol style="list-style-type: none"> 1) The effectiveness of improved AP resolution picked up an extra 269ha of amenity tree cover from 2006. Conversely 37ha were lost in '13 (the county coverage dropping 0.5%), possibly a re-calibration of over-zealous polygon canopy capture in '09. 2) In the context of Cardiff's size the loss of 244 large trees over 7 seven years may not be unreasonable - e.g. 35/yr. 3) A hectare of woodland has been lost between '11-'14 within the city itself.
NEATH PORT TALBOT	<ol style="list-style-type: none"> 1) Notable for the number of well-canopied towns, 47% have over 20% canopy cover ('Valley' towns) - for its size and population Neath ranks as one of Wales' most canopied large towns. The extent of county canopy (16.6%) too has remained almost stable - down 0.1% over the '09-'13 period. 2) Port Talbot's 8% cover is in stark contrast to the similar-sized Neath and has lost 13ha in '09-'13 (0.6%). 3) Almost half of NPT's towns show a decline in cover during '09-'13. 4) Notable large tree losses were identified in Pontardawe (392) and Glynneath (713) mainly from the '06-'09 period. 5) Neath showed a 3ha increase in woodland during '11-'14 but there were losses in Port Talbot (8ha) and Ystalyfera (1ha).
NEWPORT	<ol style="list-style-type: none"> 1) Of Wales' 3 cities Newport marginally has most cover (18.2%). 2) County cover declined 0.8% during '09-'13. 2) 38ha of canopy loss were identified over the '09-'13 phase - 0.8% of its tree cover. 13ha of this loss was woodland. 3) Newport's large tree population appears to have increased in terms of their contribution to canopy (+92), though between '06-'09 Caerleon seems to have lost as many as 218.
WREXHAM	<ol style="list-style-type: none"> 1) As of '13 Wrexham is the only N. Wales county above the national average. Canopy increased by 0.4% between '09-'13. 2) Along with Flint, these are the only two counties to show canopy increase both over '06-'09 & '09-'13. 3) Towns showing the most canopy increase during '09-'13 were Wrexham - 11ha (0.8%), Gresford - 2ha (1%), Cefnmawr (1.6%), Chirk - 1ha (0.8%) and Ruabon - 1ha (0.7%). 4) The low-canopied Coedpoeth (7.5%) deserves mention as its canopy has increased by 1ha (0.9%). 5) Gwersyllt has lost 2ha during '09-'14. 6) Large tree loss in Wrexham is 336 and the smaller Rhosllannerchrugog / Penycae is 285, largely occurring over the '06-'09 period.

Table 23: County canopy cover and amenity tree loss - favourable counties.

The analysed data from the following nine counties appear to highlight a number of canopy cover, tree and woodland loss issues that would be worth investigating further:

Counties with canopy cover and tree loss concerns	Confirming findings where further investigative action / ground-truthing could be targeted
The Valleys, N.E, rural hinterland and South/S.W. coastal regions are all represented by these counties. Many of the issues concern overall loss in those well-canopied counties and decline in rural and coastal towns.	
BLAENAU GWENT	<ol style="list-style-type: none"> 1) 2nd highest canopied county (down 1.6% from '09 - the highest loss of all counties). 50% Of towns display >20% canopy, BUT: 2) Between '09-'13 all towns show loss, e.g. Tredegar - 2.4% (16ha), Ebbw Vale - 1.8% (19ha), Brynmawr - 1.5% (9ha), Aberbeeg - 1.5% (2ha), 3) Abertillery shows a steady, but modest 1.4ha loss over seven years, 4) Ebbw Vale appears to have lost 390 large trees (2006-13), but has gained a hectare of woodland during '11-'14.
CARMARTHENSHIRE	<ol style="list-style-type: none"> 1) Across the county an additional 263ha was identified with 2009 AP, e.g. Llanelli went from 6% to 13% ('06-'09) due to the big cloud in centre of town. 2) '09-'13 findings suggest 84% of towns across the county are losing canopy, 0.1-1.8% (the latter being Penygroes). Llanelli lost 14ha, Carmarthen 6ha. As a consequence the county coverage has dropped 0.7%. 3) However across the '06-'13 period all towns show a total increase in cover (due to initial AP resolution). 4) If there is a concern over large tree loss that would be in Carmarthen itself - 830 in 7 years. 5) '11-'14 woodland loss has occurred in Llanelli (3ha), Brynamman (1ha) with Glanamman gaining 1.7ha.
FLINTSHIRE	<ol style="list-style-type: none"> 1) The '06-'09 Flintshire findings looked worrying - 79% of all towns showing loss. However this was tempered in '09-'13 with 36% showing loss, so still cause for concern. 11,000 less trees were counted over the 7 years. The overall county coverage however increased by 0.7%, one of only two counties to show such an improvement. 2) A closer analysis suggests most of the bigger towns are faring ok. Connah's Quay, the largest urban area, has overall increased cover by 5%, with Holywell/Bagillt & Buckley both showing a 2% increase. These towns are largely responsible for the overall county gain of 32ha in '13. 3) Flint itself however has lost 10ha cover (3%) over the 7 years (a loss in each period). 4) A well-canopied town, Caergwrle has lost 9ha (almost 4%) in this period. 5) The lowest canopied towns, Saltney and Broughton (5%) showed continued overall canopy loss, while Mostyn's 7% remains as was in 2006. 6) Intriguingly Soughton's canopy almost halved in '09, but the '13 capture restored its >10% figure from 2006. 7) Large tree loss featured strongly in Connah's Quay (575), Flint (472) and Broughton (50) - again mainly in the '06-'09 period. Curiously Connah's Quay's canopy increased by 3.6% in that period. 8) Caergwrle lost 1.8ha of woodland between '11-'14 whilst Connah's Quay gained 1.5ha.
MERTHYR	<ol style="list-style-type: none"> 1) Canopy is the 3rd highest - 20%, with cover in Treharris (30%) the 2nd highest town in Wales. 2) County canopy has however fallen 1.4% between '09 -'13, the joint 3rd highest loss of all counties. 3) The '09-'13 figures indicate that all towns lost 1%-2% canopy (Merthyr losing 19ha - 1.3%, including 2ha of woodland), despite the apparent gains in '09. 4) Abercanaid / Troedyrhiw too has lost a hectare of woodland during '11-'14.
PEMBROKESHIRE	<ol style="list-style-type: none"> 1) The 4th lowest canopied county (13.5%), with cover declining by a modest 0.2% during '09 -'13. 2) 92% of all towns show loss over the '09-'13 period. 3) The worst decline occurs in St Davids with 3.8% loss. This 2.3ha loss only leaves 7.5ha in a town with as little as 12.7% cover. 4) Haverfordwest (14%) was the one town to show a positive increase of 3.6% over the 7 years. 13ha were recruited between '09 -'13. 5) Large tree losses have occurred in Haverfordwest (212), Pembroke Dock (247), Milford Haven (138), Tenby (255) and Saundersfoot (207), mainly from the '06-'09 phase.
POWYS	<ol style="list-style-type: none"> 1) 12 of Powys' 13 towns show canopy decline over the '09-'13 period. Ystradgynlais showed a 0.3% increase. This is reflected in the 0.8% county canopy loss over this period. 2) Brecon was the only town to show loss over the two periods - albeit 2ha. 3) However those towns losing >1% of their cover between '09 -'13 should be of concern. These are Newtown (6ha.....in 4 years!), Llandrindod (3.5ha), Welshpool (2ha), Crickhowell (3ha) and Machynlleth (1.5ha)....the latter already on only 8%. 4) Large tree loss occurs, mainly in the '06-'09 period, in Brecon (172) and Ystradgynlais (197).



<p>RHONDDA CYNON TAF</p>	<ol style="list-style-type: none"> 1) 75% of RCT's towns are above the Wales average (16.3%) – mainly due to 'Valleys' communities. The top of the Cynon valley (Aberdare / Mt Ash) fair particularly well. 2) 13 (81%) of RCT's 16 towns show canopy loss over the '09-'13 period (County coverage similarly dropped by 0.5%). Most of the town loss was 'modest', but the greatest percentage losses were in Abercynon (1.3% - 2ha) and Ynysybwl (1.4% - 1ha). Considering its 1,537ha size, Rhondda Fawr, the largest urban area, lost 'only' 2ha. 3) 36,000 less trees were counted between 2006 and 2013, but taking the increased capture with '09 AP this loss is shown to be 117,355 trees during these latter 4 years! 4) Towns gaining canopy over both periods were Ferndale & Maerdy (supposedly 9.5ha), Gilfach Goch (2.5ha) & Tafs Well (2.5ha). 5) Large tree loss seems to be of most concern in Pontypridd (113) and Aberdare (143), mainly in the '06-'09 period. 6) Aberdare has also lost 3ha of woodland over the '11-'14 period, with Llanharry losing 1.7ha.
<p>TORFAEN</p>	<ol style="list-style-type: none"> 1) The highest canopy cover of all counties, albeit this fell by 1.2% from '09 (the joint 3rd highest loss of all counties). All 3 urban areas >20%. 2) Nevertheless, between '09 -'13 all 3 towns showed loss – Pontypool 17ha (1.4%), Cwmbran 18ha (1.1%) and Blaenavon 2ha (0.9%). 3) As a result the county canopy has fallen 1% during this period with a reduced tree count 13,000 over the 7 years. 4) 4ha of woodland in Pontypool has been lost between '11 -'14.
<p>SWANSEA</p>	<ol style="list-style-type: none"> 1) All towns showed a '09-'13 canopy loss except Penllergaer with 'no change'. 2) Over this period county coverage fell by 1.4% (the joint 3rd highest loss of all counties). 3) Swansea itself offers an ideal insight into how much more canopy '09 AP tended to pick up in 3 years....179ha! With the more comparable '09 & '13 AP it was notable that as much as 88ha was lost (1.5%). Swansea was a good example of where over-zealous data capture in '09, (i.e. over-use of polygons where, a: over-lapping canopy didn't truly exist or, b: <3.0m canopy existed) was re-calibrated by the '13 contractor. Therefore, as per other county towns loss has occurred but not on the 88ha scale. 4) Apart from Swansea itself, towns showing >1.0ha loss in '09-'13 are Gorseinon (8ha), Pontarddulais (2.5ha), Gowerton / Waunarlywydd (1.0ha), Bishopston (1.0ha), Penclawdd / Crofty (2ha) and Southgate (3.0ha – 3.4% of its cover). 5) 280 large trees were lost in Swansea predominantly in the '06-'09 period. 6) Swansea did recruit 3ha of new woodland during '11-'14 (new planting?), whilst Gorseinon lost 1ha.

Table 24: County canopy cover and amenity tree loss – counties with specific issues.

Data analysed from the following seven counties highlight worrying canopy / tree loss issues. Further investigation is needed to substantiate the concerns:

<p>Counties with the most canopy cover and tree loss concerns</p>	<p>Confirming findings where further investigative action / ground-truthing could be targeted</p>
<p>Counties with a coastal and rural character feature especially those in North Wales. Low existing canopy cover plus a trend of decline are reasons for concern and targeted action.</p>	
<p>CEREDIGION</p>	<ol style="list-style-type: none"> 1) County canopy has now fallen below the national average (dropping as much as 1.5% between '09 -'13, the 2nd highest loss of all counties). 2) Aberystwyth has lost 8ha between '09 -'13. Coupled with this the town lost 488 large trees in '09 and a further 101 in '13. 3) Canopy in Aberaeron (3%) & Aberporth (1%) is declining across the two periods. 4) All towns show loss from '09-'13. 5) The small community of Bow St's canopy now stands on 9.5% (overall loss of 3% in 7 years). 6) 0.8ha of woodland appears to have been lost in Cardigan during '11-'14.



CONWY	<ol style="list-style-type: none"> 1) One of only 2 counties to show less canopy cover than in '06 (down 0.8% from '09), a loss of 15ha and a reduced count of 8,000 trees. 2) Both Colwyn Bay (-2%) & Llansantffraid (-2%) show a loss over both periods. Colwyn Bay, Conwy's largest town, has lost 22ha in 7 years. 3) Llanfairfechan (+1%), Penmaenmawr (2%) and Llanrwst (0.8%) show an overall canopy increase for both periods, but all gained in the last 4 years. 4) The tree counts suggest that Llanfairfechan has lost 220 large trees, mainly in the first 3 year period, where there was a 2.2% canopy loss - only to show a 3.2% gain in '13. A closer look may offer an explanation. 5) An extra 2ha of woodland was identified in Colwyn Bay during '11-'14.
DENBIGHSHIRE	<ol style="list-style-type: none"> 1) Denbigh is now Wales' least canopied county on <12% (down 0.7% from '09), with 3 towns displaying less than 10% cover. 2) This is a county consistently losing canopy cover across its towns - 78% of towns in the '09-'13 period. 3) Llangollen (the champion in terms of a high-canopied town, -5ha), Rhuddlan (low on 7%, -5ha), Ruthin (-5ha) & St Asaph (-4ha) all show loss over each period. 4) The county's largest town, Rhyl, is notably low on cover and has lost 4ha in the last 4 year period. 5) Denbigh, now on 9%, has shown a slight recovery after a 1.1% loss in '09. 6) St Asaph has reportedly lost 347 large trees, mainly in the '06-'09 period. 7) Prestatyn gained 8ha of woodland over the '11-'14 period - presumably new planting and therefore not strictly canopy?
GWYNEDD	<ol style="list-style-type: none"> 1) One of only 2 counties to show less canopy cover than in '06 (down 0.6% from '09 and showing 7,600 less trees). 2) The county has seen a 14ha decline in canopy over the 7 years. 65% of towns show loss over this period (11 out of 17 towns), mainly of a modest 0.1-0.5% but some towns e.g. Pwllheli (3%) and Dolgellau (3%), a well-canopied town, experiencing greater loss. 3) Bangor, the largest town, did lose 9ha from its 2009 94ha. 4) The coastal towns of Harlech (-1ha) and Tywyn (-2%), the least canopied Gwynedd town on 4.7%, show a continuous canopy decline. 5) Only Porthmadog and Penegroes show a positive increase: almost 2%. 6) Large tree loss doesn't seem an issue. The county count for large trees appears low - possibly this is a reflection of coastal or elevational aspect. 7) Between '11-'14 Bangor and Caernarfon lost 2ha and 1.5ha of woodland respectively whilst Harlech gained 1ha.
MONMOUTHSHIRE	<ol style="list-style-type: none"> 1) Over the 7 years 50% of towns losing canopy - this rises to 100% when only looking at '09-'13 findings (County canopy has fallen by 1.2% between '09 -'13). 2) Of the large towns, Monmouth and Chepstow have both lost 5ha between '09 -'13, with Abergavenny losing 3ha. 3) Usk has consistently shown a decline over the 7 years - 3ha/3%. 4) Monmouth shows large tree loss (584) mainly from the '06-'09 period.
VALE of GLAMORGAN	<ol style="list-style-type: none"> 1) Vale of Glamorgan is the 3rd lowest canopied county - 12.3% and cover fell by 1.1% during '09 -'13. 2) Barry, the major urban area has only 11% and lost 20ha (1.1%) over the '09-'13 period. 3) Between '09-'13 all towns lost cover, Cowbridge the most - 2.5% (4ha), Murch - 1.6% (3.5ha) and Penarth - 1.2% (9ha) 4) Low canopy towns with loss should be of concern, in particular Llantwit Major (8%) losing 3.5ha in 4 years, and Rhoose (7%) down 0.5ha. 5) Some smaller towns appear to have lost numerous large trees - Llantwit Major (121), Murch (435) and Cowbridge (77) mainly over the '06-'09 period.
YNYNS MÔN	<ol style="list-style-type: none"> 1) Is now the 2nd least canopied county on <12% (but with only a modest 0.3% decrease during '09-'13). 2) With a low average of 11.8% this coastal county showed some positive signs over '09-'13 with only 38% towns losing canopy though across the 7 years 63% of towns have evidence of canopy decline. 3) As Anglesey's main town, Holyhead has canopy provision as low as 6.8%, with five hectares lost between '09-'13. 4) Large tree loss doesn't seem an issue. The county count for large trees is low, presumably a reflection of its coastal environment.

Table 25: County canopy cover and amenity tree loss - counties with the greatest concerns.



3.4 Distribution by amenity tree type (broadleaf, mixed and conifer)

An urban forest dominated by broadleaves

Differentiating conifers from broadleaves from the aerial photography was not reliable, due to factors such as resolution, seasonality and shadow. Whilst one can surmise that conifers may well have been under-represented in the count, their presence in towns is a fraction compared to broadleaves. The 2009 canopy cover findings (not including NFI woodland) show 7,950ha of broadleaf, 112ha of mixed and 20ha of conifer.

The exercise was not repeated in 2013.

Local exceptions

A number of South Wales Valley and coastal towns plus Swansea display a slightly higher conifer presence. This may be due, in part, to post-industrial reclamation schemes and also the suitability of certain conifers to maritime conditions. The overall low coverage of conifers does not detract from their often strong individual presence seen in parks and residential gardens.

3.5 Summary: actionable findings

Identifying landowners to promote better care and planting of trees

The distribution of Wales' urban tree resource amongst 12 land uses has demonstrated the wide range of public and private stakeholders that have a decisive impact on Wales' existing and future urban canopy cover. The strategic delivery of increasing canopy cover will be greatly facilitated if existing funding streams of respective landowners' budgets can be tapped into in order to support the delivery of a high quality environment and infrastructure across urban Wales. In doing so, this would recognise the huge contribution that trees make to ecosystem services.

Identifying quantity and quality of tree cover to improve the provision and management of trees where best aligned to communities needs

The case for distinguishing between woodland and amenity canopy cover is useful for:

- Quantity; where woodland cover increases a town's canopy but, in terms of benefits to neighbourhoods, it is often not realising its potential due to lack of management or accessibility.
- Quality; where regular tree management in parks, gardens and streets provides a cared-for appearance. These are the trees that, whilst not extensive in terms of canopy, tend to be 'on the doorstep' of where people live and work.

The presence, or not, of woodland is clearly a factor in accounting for the highs and lows of the South Wales Valley and coastal towns. The open-space land-use categories host the majority of woodland cover, with private gardens being the major provider of towns' amenity trees. Examining woodland vs. amenity cover at a ward level helps to understand that the make-up of the local landscape plays a major role in determining high and low cover. Despite the broad high and low cover distinctions between the Valleys and coasts, or affluent versus deprived areas, there are numerous specific examples where woodland significantly raises canopy levels in both localities.

Further detailed analysis and ground-truthing would usefully reveal:

- Evidence as to the exact spatial balance between 'wooded' and 'amenity tree' areas within communities;
- To what degree quantity and quality of tree cover aligns with the needs of where people live, work and play and where targeted tree planting is required.



Identifying amenity tree and woodland loss, aligning with decline in canopy cover and highlighting specific town, county concerns for further investigation

The loss of large long-lived trees is concerning. This maturing Victorian legacy, whilst at some point in need of replacement, does offer urban society the greatest benefits. The danger is that these trees are not being replaced and where they are, small, short-lived trees offering fewer overall benefits take their place.

A nationally consistent, resourced and planned approach is needed to:

- Protect and care for the Victorian legacy of large trees
- Promote planting of large canopy specimens.

Initial analysis combining tree count and canopy cover loss across counties highlights specific towns where a diminishing tree resource is apparent. The next steps for local authorities and NRW would be to:

- Undertake detailed interrogation of the survey data, ascertaining both the validity of the highlighted concerns and identifying in detail where specific loss is occurring;
- Undertake complimentary ground-truthing across towns to further understand and explain the reasons behind tree removal and their rate of loss.

Identifying legislation to protect and funding to increase tree planting opportunities

Optimising existing legislation to reduce tree loss and using current funding tools to secure planting schemes would help to address canopy cover concerns. Examples of practical next steps include:

- Reviewing the effectiveness and use of existing tools and legislation for tree preservation.
- Ensuring investments in enhancing the Wales urban treescape are an eligible expenditure for grant programmes such as Vibrant and Viable Places, Coastal Communities Fund, Business Improvement District Fund Wales, Regional Transport Consortia Grant, and Safe Routes in Communities.



4. Neighbourhood canopy cover - a focus on deprived wards

This section focuses on contrasting ward-level canopy cover, primarily considering levels of deprivation to identify where qualitative or quantitative improvements to tree cover might be needed. The role trees have to play in improving air quality in communities is introduced, highlighting the case for further in-depth analysis to ascertain where targeting is most needed.



This section focuses on contrasting ward-level canopy cover, primarily considering levels of deprivation to identify where qualitative or quantitative improvements to tree cover might be needed. The role trees have to play in improving air quality in communities is introduced, highlighting the case for further in-depth analysis to ascertain where targeting is most needed. Analysis and findings are presented as follows:

- 4.1 Best and worst canopied urban wards
- 4.2 Multiple deprivation and canopy cover
- 4.3 Air quality and canopy cover
- 4.4 Summary: actionable findings

Section 4 highlights

- Tree cover in the 'Top 20' wards ranges from 41%-68%, with half lying within the South Wales Valleys.
- Tree cover in the 'Bottom 20' wards range from 0%-2.4% and all, except one, lie within the coastal and seaboard towns.
- 65 out of 205 wards (32%) in Cardiff and all of Rhyl's 17 wards have less than 10% cover.
- 40% of all wards in the most deprived 1-570 WIMD communities have less than 10% cover, whereas in the more advantaged 571- 1896 WIMD neighbourhoods this almost halves to 25%. Conversely, where cover is greater than 15%, it is those more affluent areas (51% of wards) that benefit most compared to 37% for less well-off wards.
- This considerable variation in tree cover is exemplified within Wales' 'Top 10' most deprived wards - from as little as 2% in Rhyl West 2 and 3% in Rhymney's Twyn Carno 1, to 19% in Merthyr Vale 2 and 15% in Tylorstown 1 in the Rhondda Fach.
- If WIMD categories or 'Communities First' cluster areas are to be used to focus resources on target tree planting or tree management, a fuller ward-by-ward analysis is required to identify where cover is the lowest as well as understanding how the existing canopy is currently composed.

4.1 Best and worst canopied urban wards

There is often a strong degree of canopy cover variation within each town. By identifying tree cover per ward this section highlights those 'hot spots' of low and high.

Towns where >40% of Wards have <10% Canopy Cover

(Over 250 ha towns only - also includes Newport and Swansea with 27% and 25% of wards with <10% cover respectively)

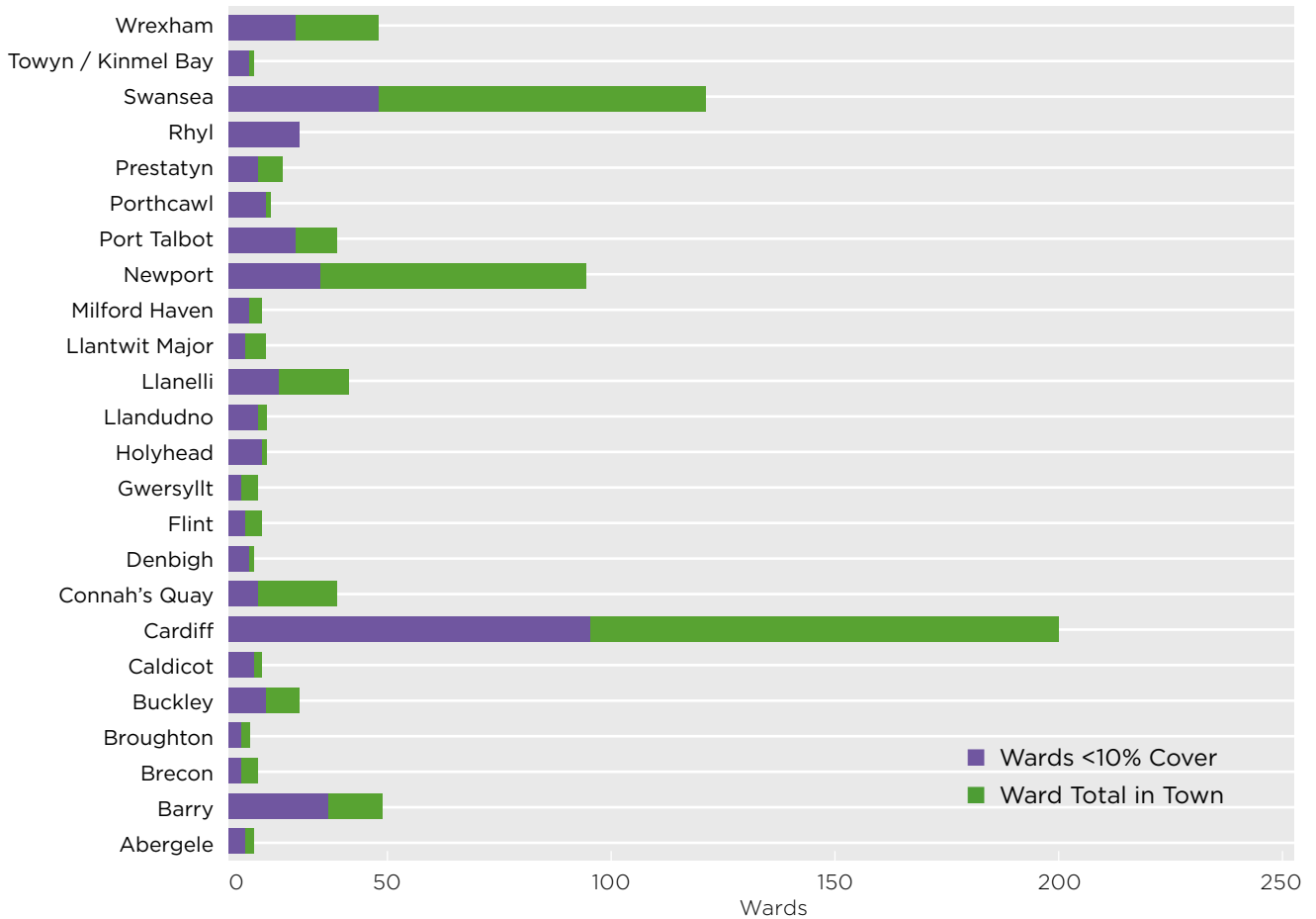


Figure 40: Wales' main towns where >40% of wards have <10% cover.

Figure 40 highlights the 24 urban areas, greater than 250 hectares in extent, where over 40% of wards have low (<10%) canopy cover. This includes:

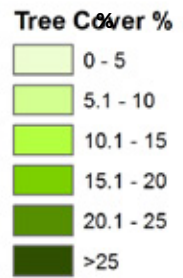
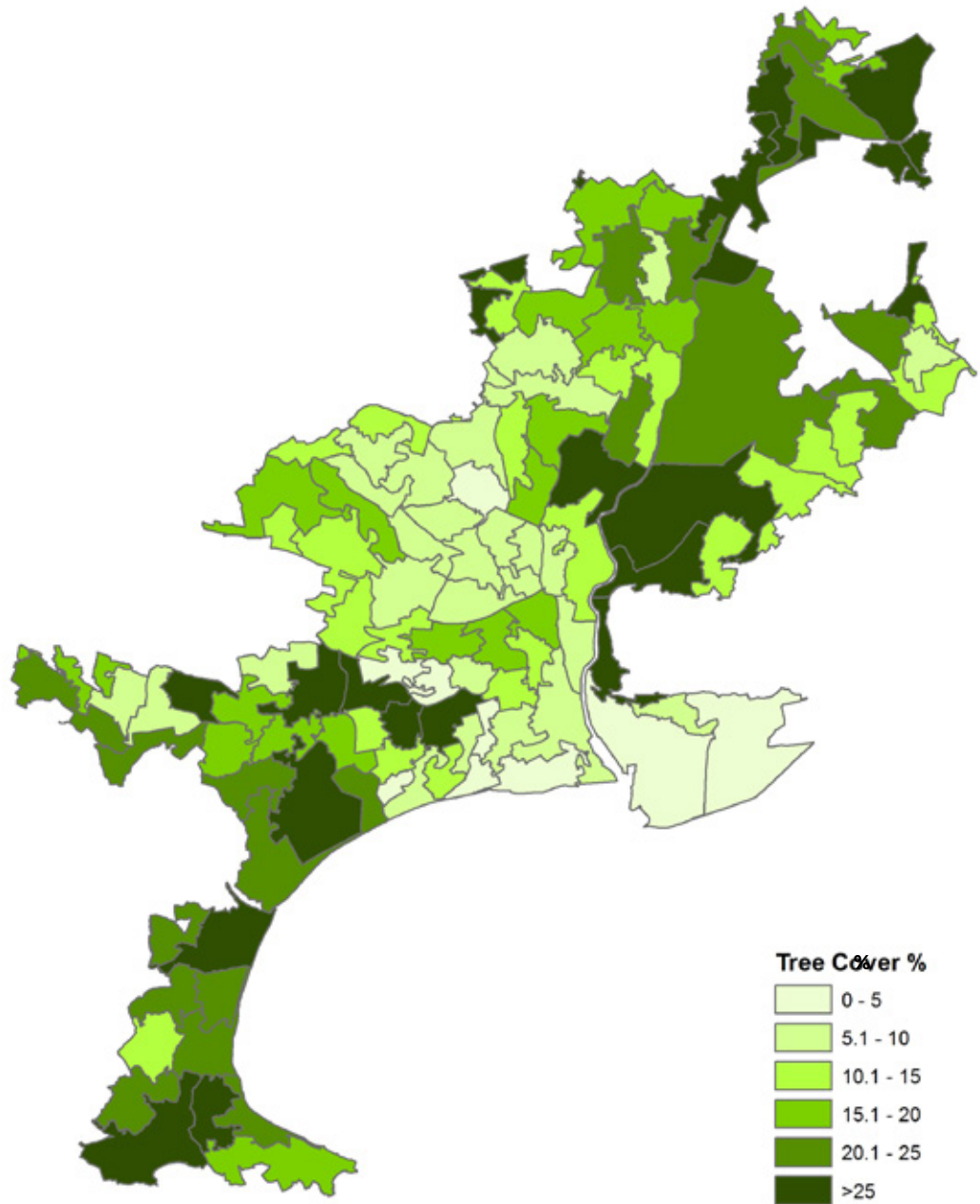
- Cardiff, where 65 out of 205 wards (32%) have less than 10% cover.
- Rhyl, where all 17 wards fall into this category.

There are another 25 small urban areas (i.e. under 250ha) that fall within this overall ward analysis of low cover. They include Nelson, Blaenau Ffestiniog, Coedpoeth, Pwllheli, Rhoose, Rhuddlan, Saltney, Tywyn and Valley where all wards, ranging from two to four in total, show <10% cover.

A majority of these urban areas have already been highlighted previously as having low cover. These ward findings provide further insight into where the most underserved areas, in terms of trees, are within each town. Cardiff is a good example. For many, the Welsh capital has the image of a green city, full of trees. Cardiff's slightly below national average cover of 15.5% hints at a not-so-green picture everywhere. The ward data sheds light on those areas, e.g. Cardiff South where cover is particularly low.



Swansea Ward by Ward Canopy Cover Breakdown



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 Ordnance Survey 100019741.2016

Cyfoeth Naturiol Cymru
Natural Resources Wales

1:75,000

Figure 41: Swansea - ward by ward distribution of canopy cover.



It is common practice in American and Australian tree strategies to spatially map the highs and lows of canopy cover across towns and cities with the equivalent of a ward-by-ward approach. Swansea (Figure 41) demonstrates contrasting canopy cover across 113 wards (Lower Super Output Areas - LSOAs). For example, the majority of the more prosperous wards in Sketty and Mumbles range from 20%-30%, as do less well-off communities to the north, e.g. in Clydach, Llansamlet and Morriston. This compares dramatically with the central town and dockland wards such as Castle and St. Thomas (5%-10%). The lower Swansea valley, where the intensity of the industrial era left an almost tree-less landscape, has been transformed in the last 40 years. However, certain communities, particularly on the western slopes, such as Penderry and Cwmbwrla, remain low on canopy cover with 7.2% and 8.1% respectively.

4.2 Multiple deprivation and canopy cover

How the Welsh Index of Multiple Deprivation (WIMD) was used

To identify where increasing canopy cover should be made a priority, the breakdown of canopy cover data at a ward level aligns itself usefully with the Welsh Index of Multiple Deprivation (WIMD²³), a ward-by-ward categorisation of the most, and least, disadvantaged communities.


No	Key		WIMD Category	Total No. of Wards	TCWTC Urban Area (Ha)
1	Most Deprived	0-10%	1 - 190	189	7,926
2		10-20%	191 - 380	189	9,081
3		20-30%	381 - 570	187	9,283
4		30-50%	571 - 950	343	18,429
5	Least Deprived	50-100%	951 - 1896	775	41,644
Total				1,683	86,363

Table 26: Distribution of wards as per the Welsh Index of Multiple Deprivation 2011. (The 2011 rankings rather than the 2014 WIMD have been retained for consistency to align with the same LSOA boundaries used for 2006, 2009 and 2013 data capture).

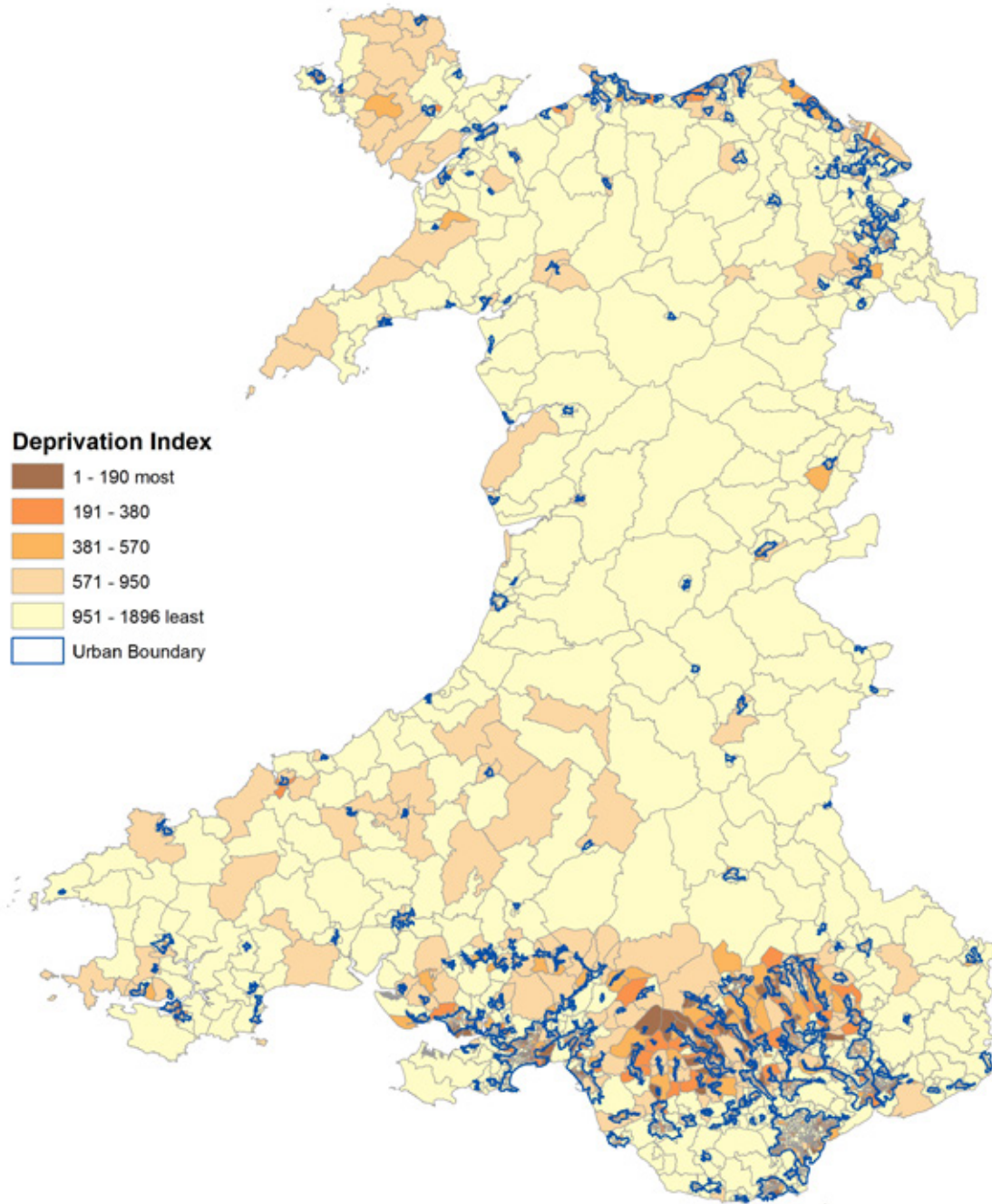
Multiple deprivation relates to the occurrence of several forms of deprivation concurrently, such as low income, poor housing, and unemployment. The WIMD data has been fundamental in assisting strategy policy formulation at national and local levels, and planning focused programmes for those communities facing greatest need. The Welsh Government's 'Communities First' programme²⁴ is designed to target communities falling within highest (i.e. most deprived) WIMD categories. Initiated in 2001, the programme has recently been modified to identify 52 cluster areas, with all counties represented except Ceredigion and Monmouthshire.

The TCWTC study has been able to analyse ward-level canopy cover in light of deprivation levels (see Tables 27 and 28). Further analysis was conducted for those wards falling within the TCWTC urban area boundary with higher levels of deprivation: Table 29 shows the canopy level of the 'Top 10' most deprived wards. Table 30 concentrates on the 52 Communities First cluster areas which contain the bulk of the 200 most disadvantaged wards.

²³ Welsh Index of Multiple Deprivation, (2011) - on the Welsh Government website

²⁴ Communities First - on the Welsh Government website

The Welsh Index of Multiple Deprivation 2011



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**Cyfoeth
Naturiol
Cymru
Natural
Resources
Wales**

1:1,000,000

Figure 42: The Welsh Index of Multiple Deprivation, 2011. This highlights the main concentrations of deprivation as being in the Valleys, the North-East especially along the North Wales coast and Wales' main towns



Canopy cover across the 1-570 WIMD wards

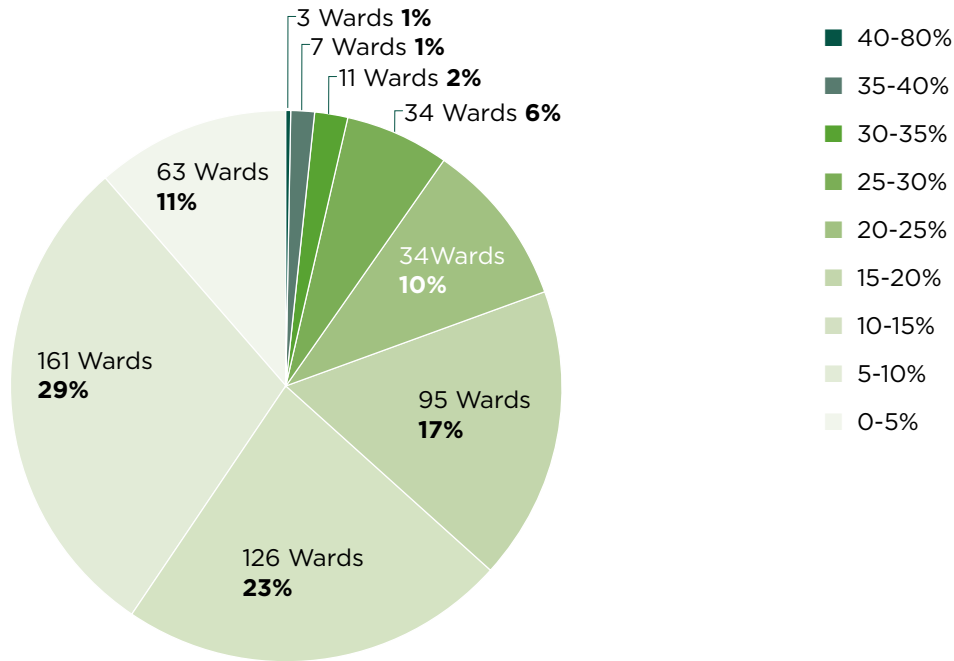


Figure 43: Canopy cover distribution across 575 '1-570' WIMD wards (72 wards, with <1.0ha falling within urban extent, were excluded).

Canopy cover across the 571-1896 WIMD wards

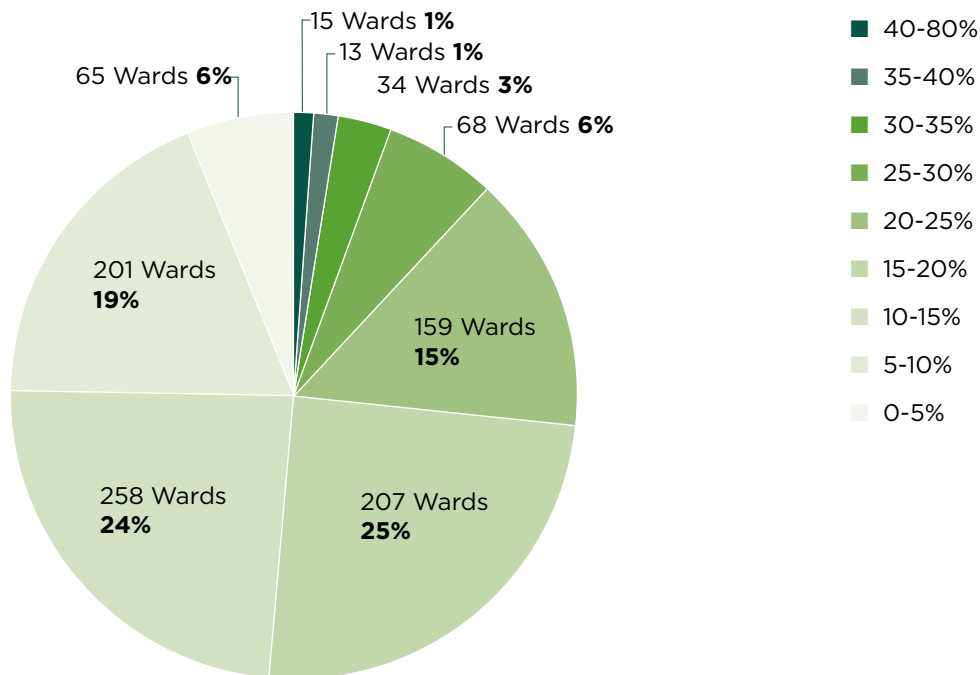


Figure 44: Canopy cover distribution across the 1,166 '571-1896' WIMD wards (35 wards, with <1.0ha falling within urban extent, were excluded).



Section 3.2 examined the distribution of woodland and amenity trees within wards and highlighted examples of high canopy cover within deprived areas, largely due to the presence of woods. Figures 43 and 44, however, confirm that, overall, deprived communities display lower levels of canopy cover than those more advantaged areas. For example, 40% of all wards in the most deprived 1-570 WIMD categories have less than 10% cover, whereas in the more advantaged 571-1896 WIMD neighbourhoods it is 25%. Conversely, where cover is greater than 15% it is those more affluent areas (51% of wards) that benefit more compared to 37% for less well-off areas.

Whilst not an unexpected conclusion, this does highlight where focused attention is needed in terms of better provision of trees and associated green-space.

'Top 20' most canopied urban wards

- In line with the town-scale findings, nearly half the towns in the 'Top 20' are in and around the South Wales Valleys.
- High levels of trees tend to be associated with those more well-to-do communities. However, the five less advantaged WIMD wards in Blaenau Gwent, Caerphilly and Torfaen demonstrate that this is not always the case.
- There are 210 of all 1,683 wards, and part-wards, of over 25% canopy cover, of which 71 have double the national average of 16.3%.

Canopy Rank	Urban Area	Ward / WIMD Category	Urban Area in Ward (ha)	Cover (ha)	Canopy Cover %
1	Swansea	Fairwood 2	5 of 526	5.0	100.0%
2	Caergwrle	Llay 1	18 of 632	12.2	67.8%
3	Wrexham	Marchwiell 1	43 of 3464	27.5	64.0%
4	Caergwrle	Gwersyllt East and South 3	10 of 152	6.0	59.6%
5	Newport	Caerleon 3	107 of 787	62.8	58.6%
6	Aberdare	Pen-y-waun 2	1 of 176	0.6	56.7%
7	Aberystwyth	Llanfarian	6 of 3352	3.4	56.1%
8	Swansea	Killay North 1	34 of 151	18.4	54.2%
9	Tredegar	Badminton 1	8 of 179	4.0	50.3%
10	Brecon	Felin-fâch	3 of 9469	1.4	46.9%
11	Pontypool (& Abersychan)	St. Cadocs and Penygarn	105 of 206	48.6	46.3%
12	Neath (& Skewen / Tonna)	Cadoxton	135 of 415	61.8	45.8%
13	Neath (& Skewen / Tonna)	Aberdulais	97 of 955	43.8	45.2%
14	Connah's Quay	Buckley Pentrobin 3	1 of 105	0.4	44.3%
15	Southgate	Gower (Swansea) 2	2 of 6122	0.9	44.1%
16	Swansea	Mayals 1	79 of 365	34.0	43.0%
17	Treharris	Treharris 2	55 of 111	23.5	42.8%
18	Bargoed / Blackwood / Newbridge	Pengam 1	81 of 87	34.6	42.7%
19	Cwmbran	Fairwater 3	36 of 36	15.3	42.6%
20	Gresford	Marford and Hoseley 1	62 of 72	25.5	41.1%

Table 27: The 'Top 20' most canopied wards in Wales (excluding those part-wards where only a minimal area is included within the urban area. The 'Urban Area in Ward [ha]' column indicates the ward area included within the study and that which falls outside).



'Bottom 20' least canopied urban wards

- All wards except Darren Valley, Fochriw lie within coastal and seaboard towns and the influence of maritime conditions. The wards in Cardiff's Cathays, Grangetown and Penllergaer's Gorseinion 1 are set back somewhat from the sea itself.
- High 1-570 WIMD wards make up just over half of those with 0-2.4% cover, indicating that low canopy cover occurs over a range of urban dimensions, be it coastal, altitude or, as will often be the case, due to the tight historic layout of the ward.
- 130 wards, and part-wards, have under 5% canopy cover.
- 499 wards, and part wards, have 5-10% cover.

Canopy Rank	Urban Area	Ward / WIMD Category	Urban Area in Ward (ha)	Cover (ha)	Canopy Cover %
1	Fochriw	Darren Valley 1	1 of 1460	0.0	0.0%
2	Port Talbot	Sandfields East 3	52 of 56	0.4	0.8%
3	Aberystwyth	Aberystwyth Rheidol 1	14 of 16	0.1	1.0%
4	Rhyl	Rhyl West 1	28 of 30	0.3	1.0%
5	Penllergaer	Gorseinion 1	4 of 179	0.0	1.2%
6	Port Talbot	Sandfields West 3	38 of 38	0.5	1.4%
7	Cardiff	Cathays 1	11 of 11	0.2	1.4%
8	Port Talbot	Aberavon 4	27 of 27	0.4	1.5%
9	Port Talbot	Sandfields West 4	56 of 62	0.9	1.6%
10	Rhyl	Rhyl West 2	33 of 33	0.6	1.8%
11	Cardiff	Grangetown 8	13 of 13	0.2	1.8%
12	Porthcawl	Rest Bay 2	88 of 172	1.6	1.9%
13	Llandudno	Mostyn (Conwy) 1	31 of 77	0.6	1.9%
14	Cardiff	Grangetown 10	10 of 10	0.2	2.0%
15	Swansea	Castle 8	19 of 20	0.4	2.1%
16	Towyn / Kinmel Bay	Kinmel Bay 1	62 of 78	1.3	2.2%
17	Prestatyn	Prestatyn North 2	62 of 62	1.3	2.2%
18	Port Talbot	Port Talbot 3	34 of 34	0.8	2.2%
19	Barry	Buttrills 1	18 of 18	0.4	2.3%
20	Porthcawl	Porthcawl West Central 1	34 of 39	0.8	2.4%

Table 28: The 'Bottom 20' least canopied wards in Wales. (Excluding those part-wards where only a minimal area is included within the urban area. The 'Urban Area in Ward [ha]' column indicates the ward area included within the study and that which falls outside).



Canopy cover of Wales' most deprived wards compared against cover of their respective urban area.

County Council	Town	% Cover	Ward	WIMD 2008	WIMD 2011	WIMD 2014	2013 (ha) Ward Cover	2013% Ward Cover
Denbighshire	Rhyl	6%	Rhyl West 2	1	1	2	0.6	2%
Caerphilly	Caerphilly	17%	St James 3	9	2	1	1.8	7%
Caerphilly	Rhymney	17%	Twyn Carno 1	8	3	7	0.9	3%
Merthyr Tydfil	Merthyr	19%	Penydarren 1	7	4	14	2	7%
Rhondda Cynon Taf	Mountain Ash	23%	Penrhiwceiber 1	10	5	15	5	18%
Swansea	Swansea	18%	Townhill 1	6	6	29	7.2	19%
Denbighshire	Rhyl	6%	Rhyl West 1	3	7	11	0.3	1%
Bridgend	Maesteg	16%	Caerau 1	12	8	6	3.8	11%
Wrexham	Wrexham	14%	Queensway1	2	9	3	2.5	9%
Rhondda Cynon Taf	Ferndale (& Maerdy)	19%	Tylorstown 1	16	10	5	8.6	15%
Cardiff	Cardiff	16%	Splott 6	51	36	4	8.9	8%
Merthyr Tydfil	Aberfan / Merthyr Vale	16%	Merthyr Vale 2	27	17	8	5.4	19%
Rhondda Cynon Taf	Hirwaun	17%	Pen-y-waun 2	12	15	9	5.3	12%
Newport	Newport	18%	Pillgwenlly 4	21	27	10	2.9	9%
Cardiff	Cardiff	16%	Butetown 2	4	68	1495	4.6	5%
Denbighshire	Rhyl	6%	Rhyl S-West2	5	12	20	8.8	4%

Table 29: Canopy cover of Wales' most deprived wards compared against cover of their respective urban area.

Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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Table 29 shows the socio-economic fortunes of wards in respect of their 2008, 2011 and 2014 WIMD rankings understandably vary. Nevertheless, across the three periods several communities consistently feature in the 'Top 10', in particular Rhyl West 2, St James (Caerphilly), Twyn Carno 1 (Rhymney) and Queensway 1 (Wrexham).

Butetown 2, now ranked 1,495, continues to show a marked improvement from its 2008 position of the 4th most deprived ward. Canopy cover however remains on a lowly 5%.

A majority of 2014's 'Top 10' most deprived wards show a markedly lower level of canopy compared to their respective towns, e.g. Twyn Carno 1's tree cover is only 3% compared with Rhymney's 17%.

There are noticeable variations in canopy cover levels in 2014's 'Top 10' most deprived wards:

- Two out of the six most deprived wards in the South Wales Valleys feature canopy cover levels comparable to the national average. Merthyr Vale 2 has higher cover (19%) than the overall 16% for Aberfan / Merthyr Vale.
- Two South Wales Valleys wards only display tree cover of 3% (Twyn Carno 1) and 7% in St James 3, Caerphilly.
- The wards in Cardiff, Newport and Wrexham also show low cover between 8%-9%.
- Rhyl (6%) as a town and its West 2 ward (2%), both display a very low level of cover.



Canopy Cover in Communities First Cluster Areas

Canopy Cover Size Classes:

		0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
County & Cluster Area	Urban Areas in Cluster (All in 1 - 570 WIMD Categories)	Wards in Cluster	Max. % Ward Cover	Min. % Ward Cover	Ave. % Ward Cover		
Anglesey							
Ynys Môn	Llangefni, Holyhead	7	12.9%	2.9%	7.1%		
Blaenau Gwent							
Ebbw Fawr	Ebbw Vale	8	35.7%	3.9%	18.6%		
North Ebbw Fach	Brynawr / Nantyglo / Blaina	7	26.5%	9.6%	19.9%		
South Ebbw Fach	Aberbeeg / Llanhilleth, Abertillery, Brynmawr / Nantyglo / Blaina, Swffryd	8 (9)	35.6%	7.7%	22.9%		
Tredegar	Tredegar	6	23.3%	7.0%	15.8%		
Bridgend							
Lower Bridgend	Bridgend, Pyle / North Cornelly	10	23.4%	6.7%	11.9%		
Mid Bridgend	Bettws, Bridgend	4 (7)	23.1%	5.4%	15.8%		
Upper Bridgend	Maesteg	8	19.8%	8.9%	12.7%		
Caerphilly							
Caerphilly Basin	Abertridwr / Senghenydd, Caerphilly	11	23.3%	6.4%	14.0%		
Mid Valleys East	Aberbeeg / Llanhilleth, Bargoed / Blackwood, Cwmfelinfach / Ynysddu, Risca / Crosskeys / Abercarn	11 (13)	42.9%	6.9%	20.4%		
Mid Valleys West	Bargoed / Blackwood, Penpedairheol / Gelligaer, Ystrad Mynach / Hengoed	13	29.0%	4.1%	14.5%		
Upper Rhymney Valley	Abertysswg, Fochriw, New Tredegar, Rhymney	10	26.8%	2.8%	14.9%		
Cardiff							
BRG	Cardiff	10	7.6%	1.8%	4.5%		
East	Cardiff	19	37.2%	3.5%	14.4%		
STAR	Cardiff	14	14.6%	2.8%	7.2%		
West	Cardiff	16	33.4%	5.2%	12.0%		
Carmarthenshire							
Carmarthenshire	Ammanford, Llanelli, Trimsaran	13	31.3%	4.1%	10.9%		
Ceredigion (No Communities First Clusters)							
Conwy							
Conwy	Abergele, Colwyn, Llandudno, Towyn / Kinmel Bay	13	26.1%	1.9%	8.4%		
Denbighshire							
West/South West & Upper Denbigh	Denbigh, Rhyl	8	10.0%	1.0%	4.4%		
Flintshire							
Flint Rural	Broughton, Connah's Quay	5 (6)	13.3%	5.2%	8.9%		
Flint Urban	Flint, Holywell / Bagillt, Mold	6	22.5%	3.1%	13.7%		
Gwynedd							
Gwynedd	Caernarfon	4 (5)	24.2%	8.7%	15.0%		



Canopy Cover in Communities First Cluster Areas (continued)

Canopy Cover Size Classes:

		0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
County & Cluster Area	Urban Areas in Cluster (All in 1-570 WIMD Categories)	Wards in Cluster		Max. % Ward Cover	Min. % Ward Cover	Ave. % Ward Cover	
Merthyr Tydfil							
Central	Merthyr	6		26.1%	9.5%	17.2%	
North	Merthyr	7		24.4%	5.4%	12.2%	
South	Abercanaid, Aberfan / Merthyr Vale, Treharris	7 (8)		36.3%	14.2%	22.3%	
Monmouthshire (No Communities First Clusters)							
Neath Port Talbot							
Afan	Blaengwynfi, Croeserw / Cymer, Cwmafan, Glynccorwg, Pontrhydyfen	7		22.4%	7.3%	14.9%	
Neath	Neath	11		32.9%	4.2%	18.1%	
Sandfields & Aberavon	Port Talbot	9		14.7%	1.4%	4.4%	
Western Valleys	Glynneath, Pontardawe, Seven Sisters, Ystalyfera, Ystradgynlais	7		32.7%	4.5%	19.0%	
Newport							
Central	Newport	8		11.8%	4.2%	6.7%	
East	Newport	12		30.4%	4.9%	15.7%	
North	Newport	7		31.7%	6.7%	19.5%	
West	Newport	6		24.8%	8.7%	16.3%	
Pembrokeshire							
Pembrokeshire	Haverfordwest, Pembroke, Pembroke Dock	6		15.7%	4.8%	9.2%	
Powys							
Western Valleys	Ystradgynlais	2		18.3%	16.7%	17.5%	
Rhondda Cynon Taf							
Lower Cynon	Abercynon, Mountain Ash	8		26.6%	9.7%	18.5%	
Mid Rhondda	Rhondda	10		36.6%	6.2%	18.0%	
Pontypridd	Glyncoch, Pontypridd, Ynysybwl	7		18.0%	9.8%	13.4%	
Porth	Rhondda, Pontypridd	10		38.1%	5.1%	16.4%	
Taf West	Gilfach Goch, Tonyrefail, Rhondda	7		17.3%	5.7%	11.6%	
Upper Cynon	Aberdare, Hirwaun	8		29.3%	12.5%	19.4%	
Upper Rhondda Fach	Ferndale (& Maerdy)	6		28.8%	8.7%	18.4%	
Upper Rhondda Fawr	Rhondda	8		29.3%	11.8%	17.1%	
Swansea							
East	Swansea	7		40.8%	2.7%	15.9%	
North East	Swansea	7		27.5%	7.7%	14.6%	
North West	Swansea	8		11.0%	3.6%	7.2%	
South	Swansea	7		16.2%	2.1%	8.5%	
West	Swansea	8		19.3%	3.5%	11.1%	



Canopy Cover in Communities First Cluster Areas (continued)

Canopy Cover Size Classes:

0-5%	5-10%	10-15%	15-20%	20-25%	>25%
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County & Cluster Area	Urban Areas in Cluster (All in 1 – 570 WIMD Categories)	Wards in Cluster	Max. % Ward Cover	Min. % Ward Cover	Ave. % Ward Cover
Torfaen					
North	Blaenavon, Pontypool	8	46.2%	4.6%	19.7%
South	Cwmbran	10	39.5%	10.3%	22.2%
Vale of Glamorgan					
Barry	Barry	10	15.8%	4.1%	8.4%
Wrexham					
Caia Park & Hightown	Wrexham	9	26.7%	4.9%	10.2%
Urban Villages	Brymbo, Cefnmawr, Gwersyllt, Llay, Rhosllaner-chrugog / Penycae	9	23.7%	8.6%	15.5%

Table 30: Canopy cover in Communities First cluster areas. ('Wards in Cluster' figure denotes those wards within the defined urban area. The figure in brackets represents the ward total of the cluster area).

N.B. The full extent of urban areas identified do not necessarily all fall within the cluster area.

Canopy cover within the urban sections of the designated cluster areas display important variations: it does not always follow that a high WIMD ward is deprived of tree cover. Twenty-seven cluster areas have wards with over 25% cover. There has been no analysis of the relative distribution of woodland and amenity trees to ascertain whether the situation identified in Townhill 1, Swansea (high canopy cover due to local accessible woodland rather than individual trees spread amongst the built environment) is also seen in these high cover cluster areas. However, as observed amongst the 'Top 10' deprived wards, the urban sections of the designated cluster areas also have many instances where cover is as low as 5% and frequently below 10%.

Focussing on where cover is low, the following cluster areas are worth highlighting:

- 8 cluster areas feature where the maximum ward cover is well below the 16.3% national average. Cardiff BRG stands out on less than 8%.
- 29 cluster areas feature where the overall average ward cover is well below the national average. Those cluster areas with less than 10% cover are Anglesey, Cardiff BRG & STAR, Conwy, Rhyl / Denbigh, Flint Rural, Sandfields & Aberavon, Newport Central, Pembrokeshire, Swansea South & North-West and Barry:
- **Cardiff BRG, Sandfields / Aberavon and Rhyl / Denbigh have a ward average of less than 5%.**
- **All cluster areas have a minimal ward cover below the national average.**
- **Wards with less than 2.0% lie within Cardiff's BRG, Port Talbot's Sandfields & Aberavon, Conwy and Rhyl / Denbigh.**

18 cluster areas display the national average canopy cover across their respective wards:

- Ebbw Fach South, Caerphilly Mid-Valleys East, Merthyr South and Cwmbran South range from 20%-26%.



Clearly, from these tables many disadvantaged areas have, working at this scale, a relatively healthy canopy cover. However, ground-truthing may reveal specific areas within wards where amenity trees are lacking e.g. town centres or housing estates, while local urban woodland creates, at ward level, the impression of a 'green' environment. In such instances investment might be needed to help both integrate amenity trees into the built environment as well as enhance the use-value of the local woodlands.

Quality matters just as much as quantity.

As demonstrated in the two examples below, if WIMD categories or 'Communities First' cluster areas are to be used as a focus to target tree planting or tree management resources, a ward-by-ward analysis is required to identify where cover is low as well as understanding how the existing canopy is currently composed.

Example 1: North Denbighshire Cluster



Figure 45: Rhyl West ward with only 2% canopy cover © Crown Copyright: RCAHMW

DENBIGH CANOPY COVER	9%
RHYL CANOPY COVER	6%
Wards (Incl. WIMD category)	Ward Cover
Denbigh Upper / Henllan 1	4%
Rhyl East 3	7%
Rhyl South East 4	3%
Rhyl South West 1	6%
Rhyl South West 2	10%
Rhyl West 1	1%
Rhyl West 2	2%
Rhyl West 3	3%

Table 31: North Denbighshire cluster area

The North Denbighshire cluster includes areas in Upper Denbigh / Henllan as well as West, South West & East Rhyl. Table 31 shows consistent low cover across the different areas included in the cluster, with ward tree cover ranging from 10% down to 1%, clearly highlighting those wards in most need of priority attention.

Example 2: WIMD Wards in the Caia Park area of Wrexham

Wrexham is Wales' 14th largest town. Its overall canopy cover was estimated at 14% for 2013, which is below the national urban tree cover average. The Caia Park area of Wrexham has for a number of years been the centre of several regeneration initiatives. This area includes Queensway 1 ward which lies 3rd in Wales' 10 most deprived communities, as well as three other wards (Queensway 2, Wynnstay, and Cartrefle 2) that fall within the 1-190 WIMD category. Also in the Caia Park area is Smithfield ward (191-380 WIMD category) as well as Cartrefle 1 and Whitegate 1 wards (both in the 381-570 WIMD category). With the exception of Hermitage 2 (26%), all of Caia Park's eight deprived wards show canopy cover levels well below the Wrexham town figure, with ward-level tree coverage ranging from 5 to 11%.



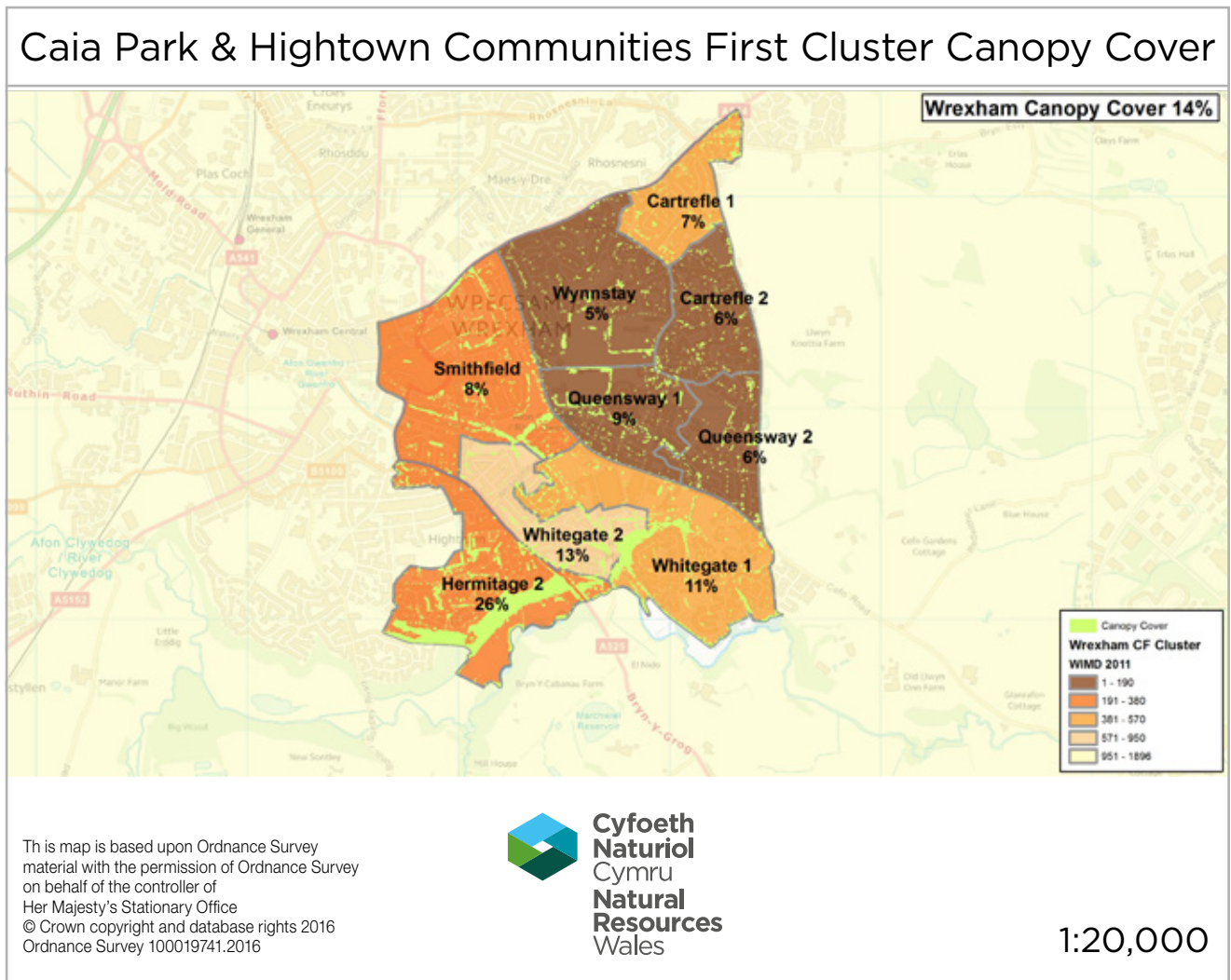


Figure 46: WIMD wards, and associated canopy cover, in the Caia Park area of Wrexham.

In 2012 the Welsh Government's 'Plant!' scheme²⁵ (a tree for every child born and adopted in Wales), with support from the local community, planted woodland areas totalling three hectares within the substantial green space areas of Caia Park. In time this targeted planting will contribute significantly to the canopy cover in Queensway ward.

²⁵ Plant! - on the Welsh Government website



4.3 Air quality and canopy cover

The beneficial role of trees in improving air quality

“Through pollution removal and other tree functions (e.g. air temperature reductions), urban trees can help improve air quality for many different air pollutants in cities, and consequently can help improve human health”²⁶.

Overall air quality has shown significant improvements since the 1970s. Emissions in Wales have decreased by 54% since 1990²⁷. However, the Department of the Environment, Food and Rural Affairs estimates that the annual economic cost from the impacts of air pollution in the UK is £9-19 billion every year. The Environmental Audit Committee (2010)²⁸ indicates air pollution reduces UK life expectancy by seven to eight months. Air quality, particularly in urban areas, is still therefore a serious concern.

The air pollutants most harmful to human health are airborne particulate matter (PM), oxides of nitrogen, and ground-level ozone (O₃). Road transport, emissions of agricultural nitrogen and the burning of fossil fuels, for instance in fuel-burning plants such as power stations, are the biggest sources of these pollutants. While this study focuses on the existing published literature relating to PM₁₀ in Wales, there is a growing body of evidence that smaller particles, such as PM_{2.5} may have a more profound effect on human health²⁹. Welsh per capita emissions of PM₁₀ are 68% higher than the UK average, mostly as a result of emissions from iron and steel manufacture. Road transport accounted for 15% of PM₁₀ emission in Wales in 2010, down from 33% in 1990.

The concentrated presence of buildings, concrete and hard surfaces in large conurbations causes the ‘heat island effect’ and in extreme cases can cause inner city temperatures to be 10°C higher than surrounding areas. These higher temperatures can increase levels of ground-level ozone that exacerbate symptoms of chronic lung conditions. If temperatures persist, this can bring on heart or respiratory failure or dehydration, particularly amongst the elderly, very young or chronically ill.

Trees, especially with healthy canopies, are beneficial in reducing levels of both;

- PM₁₀ and PM_{2.5} from industry and transport corridors
- O₃, where high, due to the overly built environment of urban centres

Research, e.g. Lancaster University’s study, clearly demonstrates the benefits of certain tree species in mitigating the worst effects of airborne pollutants.³⁰ It is increasingly common practice to incorporate tree planting schemes within air quality improvement programmes, or to prioritise tree planting initiatives based on air quality records. For example, as part of the “Million Trees for New York City”³¹ initiative, special focus was paid to reducing the Bronx’s particularly high asthma rates through its street-tree planting programme. Similar initiatives are underway in Wales, as the Port Talbot example below demonstrates.

²⁶ Nowak, D., Crane, D., Stevens, J., (2006) *Air pollution removal by urban trees and shrubs in the United States*. Urban Forestry and Urban Greening 4, 115-123, USDA Forest Service

²⁷ Labrador, L., AEA, (2012) *Particle Composition, a Science & Innovation Report for the Welsh Government and Wales Air Quality Forum* - on the Welsh Air Quality Forum website

²⁸ Environmental Audit Committee, (2010) *Air Quality, Fifth Report*- on the Parliament website

²⁹ Air Quality Expert Group, (2012) *Fine Particulate Matter [PM2.5] in the UK* - on the DEFRA website

³⁰ Hope S, Owen S, Donovan R, Mackenzie R, Hewitt N, (2005) *Trees and sustainable urban air quality - using trees to improve air quality in cities*. Lancaster University - on the Lancaster University Environmental Science website

³¹ Million Trees for New York City website



The 2014 Forest Research i-Tree Eco report, *Valuing Wrexham's Urban Forest*³², commissioned by Natural Resources Wales and Wrexham County Borough Council, identified that 60 tonnes of air pollution were removed annually across the county's 12 urban areas. This included NO₂, O₃, SO₂, CO, PM₁₀ and PM_{2.5}. Ozone showed the greatest reduction by urban trees. Using the US valuation system, £637,500 worth of pollutants are removed annually.

Additional studies reported on in 2015 for the Tawe catchment, including Swansea, and across Bridgend County Borough reinforces the role of trees in removing pollutants – 136 and 61 tonnes annually.

Cross mapping canopy cover with air quality datasets

Aligning tree cover with WIMD wards (LSOAs) identified places with high and low canopy as well as highlighting deprived wards with particularly low cover. The study's initial analysis has begun to home in on those areas deserving of increased tree cover.

Air quality is one element of the overall WIMD equation. The worst affected areas often occur in the more deprived communities, close to busy roads and lacking in green space.

As a next step it would be highly beneficial to identify 'hot spots' of pollution across Wales' urban areas and to cross reference this data with canopy cover. The 'Air Quality Management Areas' would be the obvious locations to analyse. Whether there is high or low cover, increasing tree cover, particularly with the right species, will be advantageous to improving air quality.

As an initial overview Figure 47 offers an insight of where Wales' main concentrations of PM₁₀ exist. Whilst aligning with the main towns, cities and surrounding areas, what also stands out are the major transport corridors. The M4, A449 /A40 and A465 in South Wales and the A55 North Wales coast road are clearly identifiable. Rural hinterland towns, arguably not associated with urban air pollution, such as Monmouth, Carmarthen and St. Clears in the South and St Asaph and Bodelwydden in the North, all display high levels of PM₁₀.

Further cross-referencing is needed between wards with low canopy cover, air pollution and health datasets. This would help to identify specific areas where increasing canopy cover should be seen as a priority in respect of air quality.



³² Rumble H, Rogers K, Doick K, Hutchings T, (2014) *Valuing Wrexham's Urban Forest*. Forest Research i-Tree Eco report

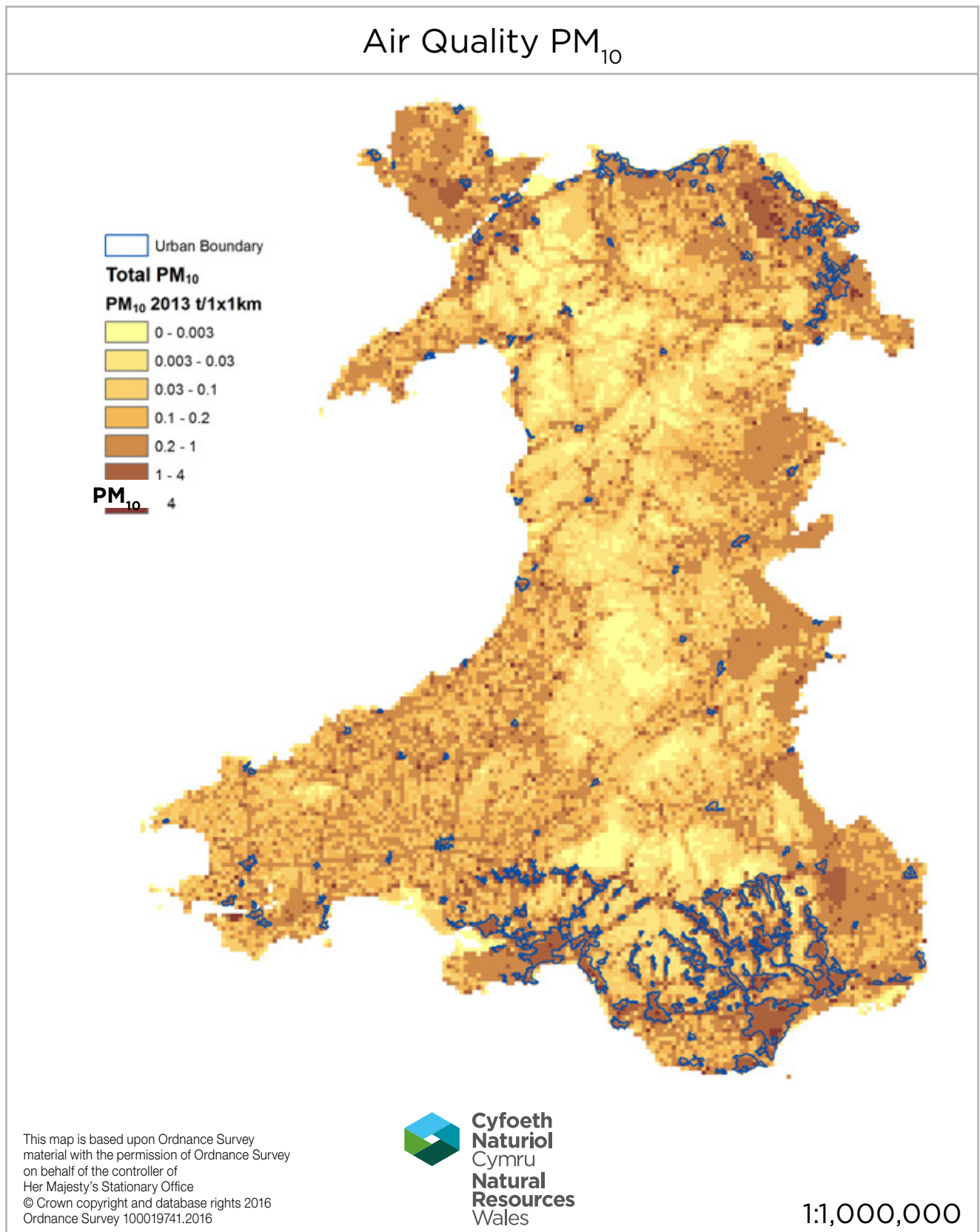


Figure 47: Levels of PM₁₀ (particulate matter) pollution in relation to urban areas and transport corridors



‘Coed Talbot Trees’ – an initiative to tackle Port Talbot’s air quality issues

The ‘Air Quality Management Area’ (AQMA) of Tai Bach and Margam was designated in 2000 as a focus for addressing failing air quality levels. PM₁₀ particulate matter has been the main concern, primarily emanating from Tata Steel, but also from the M4 motorway. High levels of PM₁₀ affect people’s health, mainly causing respiratory problems due to particulates damaging lung tissue. Asthma sufferers are particularly sensitive to high levels of PM₁₀ pollution.

The Local Service Board (LSB), made up of leaders from the public, private and voluntary sectors, have instigated a number of initiatives to improve poor air quality. In 2012 Coed Talbot Trees³³ was set up to run as a pilot community planting exercise. 1,200 trees have been planted to date on a mix of sites, e.g. schools, recreation areas, parks and street verge locations. The trees, e.g. alder, birch and maple, were chosen for their ability to scrub PM₁₀ from the air, as recommended by the Lancaster University research.

This initial contribution of tree planting is a modest start to an area with already low canopy cover, in sharp contrast with other nearby towns in Neath Port Talbot such as Cwmavon and Neath itself.



Figure 48: An aerial view of Port Talbot with the Tata steel works in the mid-distance and the communities of Tai Bach and Margam to the left. Sandfields is in the foreground, to the right of the M4. This large community falls mainly within the highest 2 WIND categories. Canopy cover here is 0.8-4.8%. © Crown Copyright: RCAHMW

³³ Coed Talbot Trees - on the Neath Port Talbot County Borough Council website



Neath Port Talbot Contrasting canopy cover at county, town and ward level
Margam & Tai Bach constitute the AQMA - Air Quality Management Area

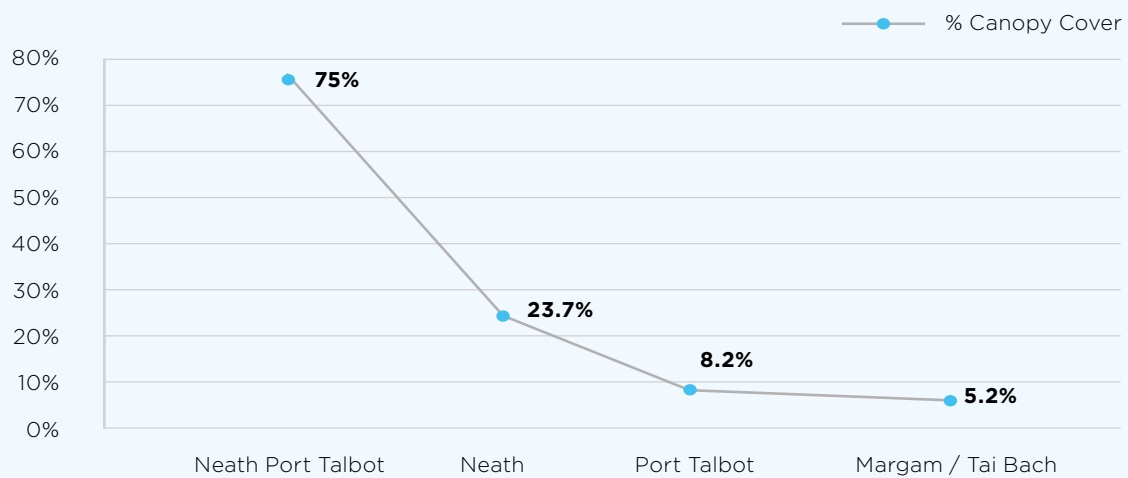


Figure 49: Contrasting canopy cover – the wards of Margam & Tai Bach in relation to the urban areas of Port Talbot & Neath and the overall county woodland cover.

4.4 Summary: actionable findings

Adopting a ward-level focus to identify priority communities for action

Ward-level data provides a useful insight into those areas most deficient in tree cover, especially if aligning with those urban areas that have been identified as priorities for town-scale strategic action in section 2.5.

1-570 WIMD wards have already been identified as having serious social, economic and environmental problems. The low levels of tree cover that exist in the majority of these needy communities also emphasise how poorly they are provided for, in terms of pleasant, leafy surroundings. These initial findings are particularly powerful in highlighting the case for action, once further detailed scoping for opportunities has been undertaken.

Regeneration schemes focusing on designated Community First cluster areas should integrate urban forestry improvement measures looking at both quantitative and qualitative enhancement ensuring:

- Amenity trees are present where people live, shop, work and play;
- Existing woodlands are designed and managed to bring value to local communities.

One of the avenues to explore includes reviewing existing regeneration grant funding to make sure quantitative and qualitative enhancement to the local tree resource are qualifying expenditures.

Natural Resources Wales' focus on supporting and targeting action in Communities First cluster areas should, through working with partners, enable a better spatial understanding of where the priority planting needs are. Where realistic opportunities exist, pilot projects need to be resourced, implemented and publicised as exemplar case studies.

Analysis of air quality data: identifying hotspots where tree cover can make a difference

Detailed analysis of air quality data, as well as cross-mapping with datasets such as health, temperature, flood risk and accessible green space, is a next important step to identify localities of concern, especially where canopy cover is low. Overlaying this data with the WIMD findings will further refine those communities where action is of the utmost priority.



5. Estimating the potential for tree planting – a pilot exercise

This section presents a desktop methodology that was piloted across a sample 27 urban areas to identify where new tree planting might be possible.



This section presents a desktop methodology that was piloted across a sample 27 urban areas to identify where new tree planting might be possible. The approach and its findings are presented as follows:

- 5.1 Estimating the realm of the possible: the TCWTC method – potential canopy cover (PCC)
- 5.2 Potential green areas for targeting tree planting in 27 pilot towns
- 5.3 Cardiff Bay case study – Where are the ward-level ‘easy to plant’ areas to target for action?
- 5.4 Summary: actionable findings

Section 5 highlights

- The pilot desktop assessment of potential areas for tree planting focused on ‘green areas’ – it did not identify opportunities for new planting within ‘grey’ environs such as streets or car parks. Whilst the latter is arguably where the need for green infrastructure is greatest, such hard landscapes are usually also the most challenging settings for tree planting. In this respect the pilot findings offer the benefit of focusing on potential ‘easy wins’.
- Assuming existing tree cover remains stable, and as new planting conducted in target green spaces achieves 100% coverage of all these areas, canopy cover in the 27 pilot towns could potentially be increased by 35%-52%. This theoretically could result in a town’s overall tree coverage being as high as 50%-67%. In reality, several constraints will reduce this actual potential for increase.
- All towns identified as having very low canopy cover feature some ‘green areas’ worth targeting for potential new tree planting, e.g. Holyhead, Port Talbot and Rhyl. In all such instances, ground-truthing will be needed to ensure the feasibility and suitability of tree planting.
- The overview of Cardiff Bay’s 1-190 WIMD wards offers a revealing approach to assessing potential canopy cover. Understanding neighbouring communities’ differing character, and aligning potential planting opportunities to land-use type, paves the way for the next detailed level of site investigation.

5.1 Estimating the realm of the possible: the TCWTC method – potential canopy cover (PCC)

To enable tree strategies and canopy cover targets to be fully developed, national and local government not only need a clear picture of the existing resource but also an indication of what's potentially possible to achieve.

A number of cities in the United States have been particularly proactive, in conjunction with the United States Department of Agriculture's Forest Service, in underpinning urban tree management with canopy cover mapping, stocking level information and canopy cover targets. This is all part of a far more structured approach to urban forest management than exists in the UK. *Planning the Urban Forest*³⁴ and *Sustaining America's Urban Trees and Forests*³⁵ are two useful introductory publications by the American Planning Association and Forest Service respectively.

Over and above existing canopy cover data, many US cities now have information on land that is potentially 'plantable' and could form 'Potential Canopy Cover' (PCC). This often focuses on:

- Impervious areas, particularly streets, through assessments of 'stocking levels'; the number of street trees that can realistically be planted within a neighbourhood.
- Green space – based on land allocation and context.



Figure 50: Flint - large tracts of grass around the flats offering opportunities for tree cover. © Crown Copyright: RCAHMW

³⁴ American Planning Association, (2009) *Planning the Urban Forest* - on the Northeastern area state and private forestry website

³⁵ USDA Forest Service, (2010) *Sustaining America's Urban Trees and Forests* - on the US Forest Service website

The pilot assessment of tree planting potential, conducted as part of the TCWTC study, does not have the sophistication of American models. The datasets available to Natural Resources Wales confined this exercise to identifying 'green' land without existing canopy cover. It was not possible to identify potential 'grey/impervious' land, albeit these are often the locations in tough challenging urban environs where canopy cover is most needed.

Whilst not offering a holistic assessment of the realm of the possible, the method adopted below offers the advantage of highlighting potential 'easy wins': tree planting is typically less expensive in soft landscape environs than in hard landscapes. Trees are also likely to have a better chance of survival and better fulfil their genetic potential (i.e. grow as big as they can) if they have access to large soil volumes.

Twenty-seven pilot towns were selected across Wales' 22 local and three national park planning authorities based on selecting a major county town per authority (see Appendix 2.5).

Three basic categories have been identified within the urban boundary:

- Existing cover (based on 2009 canopy cover survey & NFI woodland data);
- Grey, impervious and blue areas - i.e. buildings, roads, rail and water - which might provide opportunities for tree planting, particularly along streets or within civic spaces and car parks, but which were not included within the scope of this study;
- Green areas that theoretically could be recruited for additional tree planting, and could help increase the overall local canopy cover - i.e. areas of bare soil, grass and beds of shrubs / young trees.

The aim of this pilot exercise is to:

- Highlight green areas to investigate for potential new (and low-cost) tree planting within, a) each urban area, b) their constituent wards, and c) each land-use category on a ward-by-ward basis.
- Offer observations as to where the key opportunities to investigate lie, in particular where the study's findings are already making the case towards increasing canopy cover in certain towns and wards.

5.2 Potential green areas for targeting tree planting in 27 pilot towns

Assuming that the existing tree cover level remains stable as new planting conducted in target green spaces achieves 100% coverage of all these areas, Table 32 below shows that canopy cover could potentially increase by 35-52% in all towns, resulting in an overall tree coverage as high as 50-67%. In reality, several constraints will reduce the actual potential for increase:

- Achieving a sustainable cover in the target green areas will take a significant amount of time. Maintaining tree cover levels in existing areas will require good planning and management, underpinned by a good understanding of required tree replacement rates (and capacity to implement the required replacements). The age pyramid and species distribution of the existing tree stock will have a strong influence on the timeframe within which this will be achievable.
- Achieving a 100% cover in the target green areas is unlikely to be suitable or desirable without compromising other highly valued benefits associated with green spaces e.g. playing fields, biodiversity sites with open habitats, allotments, etc. Ground-truthing and community engagement is required, to narrow down the identified wide range of potential green locations, to ear-mark realistic and suitable sites for planting, and to determine a consensual canopy cover target.

The figures presented in Table 32 confirm space is available to consider undertaking new planting. Together with the constraints and associated mitigation steps presented above, this suggests a methodology and starting point to begin defining approaches for increasing the local urban tree resource. What is encouraging is that those already identified as 'low cover' towns, especially Holyhead, Port Talbot and Rhyl, are all rich in green areas where increasing canopy cover might be possible.

Cardiff Bay illustrates the potential usefulness of this approach to broadly assessing the capacity for increasing cover at the ward scale. Once local authorities have this level of information, substantiated by a level of detailed ground verification, planners and policy makers have realistic evidence on which to set canopy cover goals.



Canopy Cover Size Classes:

0-5%	5.1-10%	10.1-15%	15.1-20%	20.1-25%	>25%
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Urban Area Size (ha) Category:

1: >5,000ha	2: 1,000-5,000ha	3: 500-1,000ha	4: 250-500ha	5: 0-250ha
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County Council	Urban Area	Urban Area (ha)	'Grey' Areas (ha)	Existing Cover* (ha)	Green' areas for potential planting (ha)	2009 Cover* %	Potential cover increase** %	Existing* + Potential** Canopy Cover %
Rhondda Cynon Taf	Aberdare	966	380	212	374	22	39	61
Monmouthshire	Abergavenny	400	158	73	170	18	42	61
Ceredigion	Aberystwyth	568	237	112	219	20	39	58
Carmarthenshire	Ammanford	346	136	57	153	16	44	61
Gwynedd	Bangor	472	200	94	178	20	38	58
Vale of Glamorgan	Barry	1,590	702	203	685	13	43	56
Powys	Brecon	407	157	53	197	13	48	61
Bridgend	Bridgend	2,188	951	392	846	18	39	57
Caerphilly	Caerphilly	1,236	500	224	519	18	41	60
Cardiff	Cardiff	8,081	3,747	1,264	3,071	16	38	54
Flintshire	Connah's Quay	1,582	605	225	752	14	48	62
Conwy	Conwy	203	74	48	81	24	40	64
Torfaen	Cwmbiran	1,542	506	386	650	25	42	67
Gwynedd	Dolgellau	150	56	40	54	27	36	63
Swansea	Gorseinon	519	204	72	244	14	47	61
Anglesey	Holyhead	351	174	29	148	8	42	50
Carmarthenshire	Llanelli	1,690	662	224	803	13	48	61
Merthyr Tydfil	Merthyr Tydfil	1,490	585	302	603	20	41	61
Newport	Newport	4,118	1,911	777	1,430	19	35	54
Powys	Newtown	475	205	72	198	15	42	57
Pembrokeshire	Pembroke Dock	443	182	65	196	15	44	59
Neath Port Talbot	Port Talbot	2,302	914	201	1,187	9	52	60
Denbighshire	Rhyl	659	328	40	291	6	44	50
Swansea	Swansea	5,912	2,479	1,212	2,223	20	38	58
Pembrokeshire	Tenby	169	72	28	68	17	41	57
Blaenau Gwent	Tredegar	657	240	137	280	21	43	64
Wrexham	Wrexham	1,471	660	196	615	13	42	55

Table 32: The potential, within the 27 pilot towns, to increase canopy cover by assessing green space without trees.

*Assuming existing tree cover remains stable overtime; ** Assuming 100% coverage is achieved in green areas targeted for planting

Canopy Cover Size Classes:



Urban areas with existing canopy cover ranking	Urban area ward total	Total 1-570 wards with PCC	WIMD 2011 categories (Focusing here on the top 3 categories only)											
			1 - 190				191 - 380				381 - 570			
			Wards with potential to increase canopy cover from <2 fold to >10 fold											
			<2	2-5	5-10	>10	<2	2-5	5-10	>10	<2	2-5	5-10	>10
Aberdare	19	10	3				2	2				2	1	
Abergavenny	10	3						1				2		
Aberystwyth	11													
Ammanford	8	1						1						
Bangor	11	2	1	1										
Barry	38	14	1	2	2			2	3			2	1	1
Brecon	7	1											1	
Bridgend	35	10	1	2			2	5						
Caerphilly	28	8	1		3		1	1				2		
Cardiff	200	70	2	12	13	5	5	8	8	1	6	6	4	
Connah's Quay	25	5			1	1		1	1			1		
Conwy	3													
Cwmbran	33	10	1	1			2	1			4	1		
Dolgellau	2													
Gorseinon	13	2					1					1		
Holyhead	9	6		1				3	2					
Llanelli	30	14		2	4				3	1		2	2	
Merthyr Tydfil	28	16	1	4	3		3				2	2	1	
Newport	81	37	4	8	2		6	5	2		3	6	1	
Newtown	7	2										2		
Pembroke Dock	6	3		1									2	
Port Talbot	27	14		2		5	1		3	1		1		1
Rhyl	17	9	1	2	2			1	1				1	1
Swansea	113	44	3	6	5	3	3	10	4		3	4	2	1
Tenby	4													
Tredegar	13	6		2	1		2						1	
Wrexham	36	11	1	1	2	1			2			2	2	
Total	814	298	20	47	38	15	28	41	29	3	18	36	19	4

Table 33: Number of wards (WIMD 1-570 categories only) within the 27 pilot urban areas where potential for increased canopy cover (PCC) has been identified on 'green' non-tree covered land. Wards are categorised as to their capacity to build on existing cover from up to doubling cover (<2 fold) to over 10 times existing levels (>10 fold).



5.3 Cardiff Bay case study - Where are the ward-level 'easy to plant' areas to target for action?

Cardiff: an overview of potential canopy cover

Figure 51 gives the impression that large parts of the capital already have canopy cover (coloured green) or, if not, at least have potential land (coloured yellow) theoretically available for planting. However, Cardiff South, especially around the 'Bay', shows limited existing canopy cover with limited areas for planting in green space. Cardiff Bay is particularly endowed with higher category WIMD wards, forming the Communities First Cluster Areas of Butetown, Riverside and Grangetown (BRG) and Splott, Tremorfa, Adamsdown and Roath / Plasnewydd (STAR).

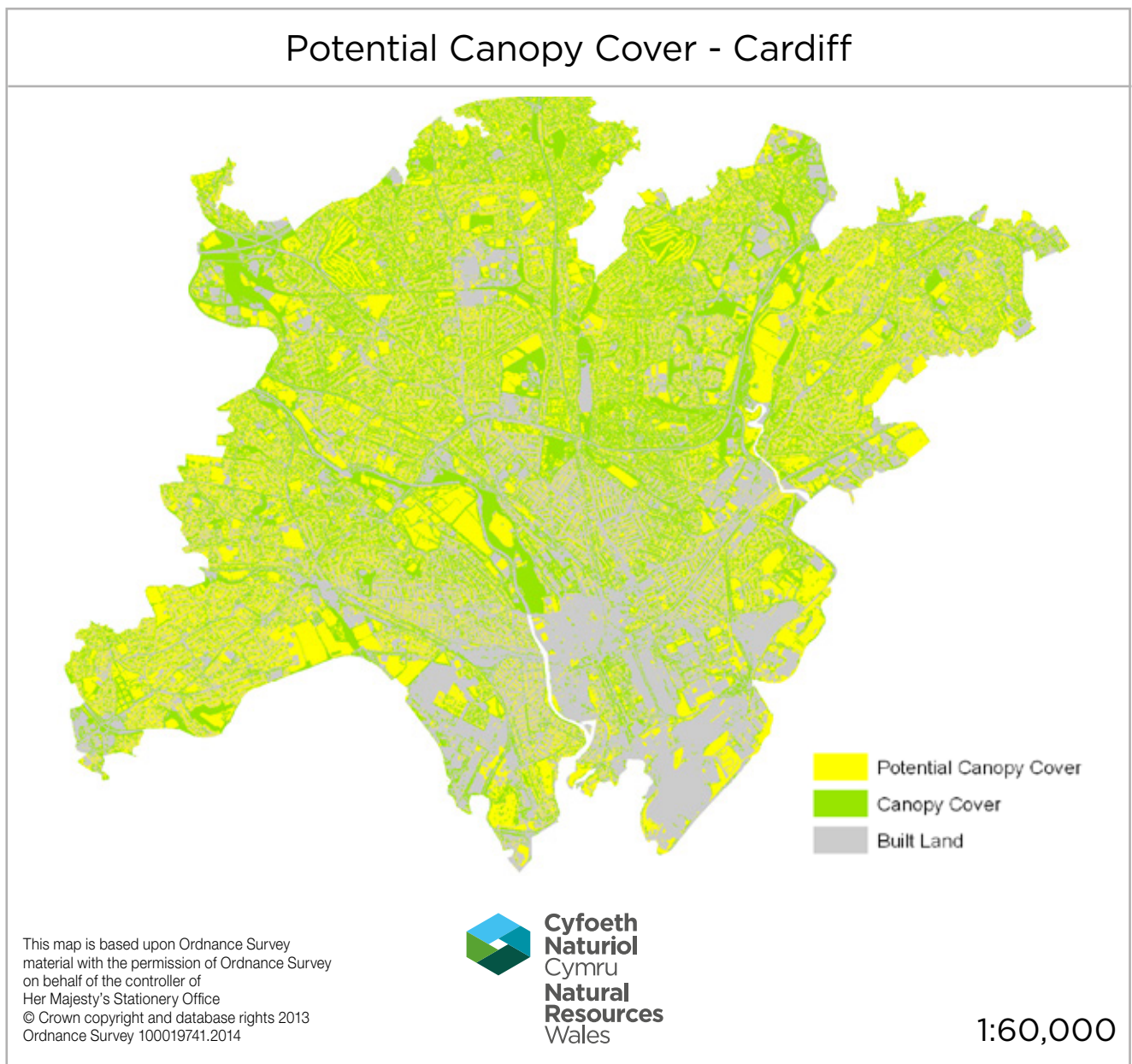


Figure 51: Cardiff canopy cover and green areas with potential to explore for new planting



Figure 52 gives an indication of the extent land-uses contribute to Cardiff's canopy cover. Unlike the national average, Cardiff's main land use is formal open space (OSF) followed by residential low-density (RLD), then informal open space (OSI).

Cardiff's 2009 Canopy Cover per Land-Use

Percentage of Total City Area (Excluding Unclassified Land-Use)

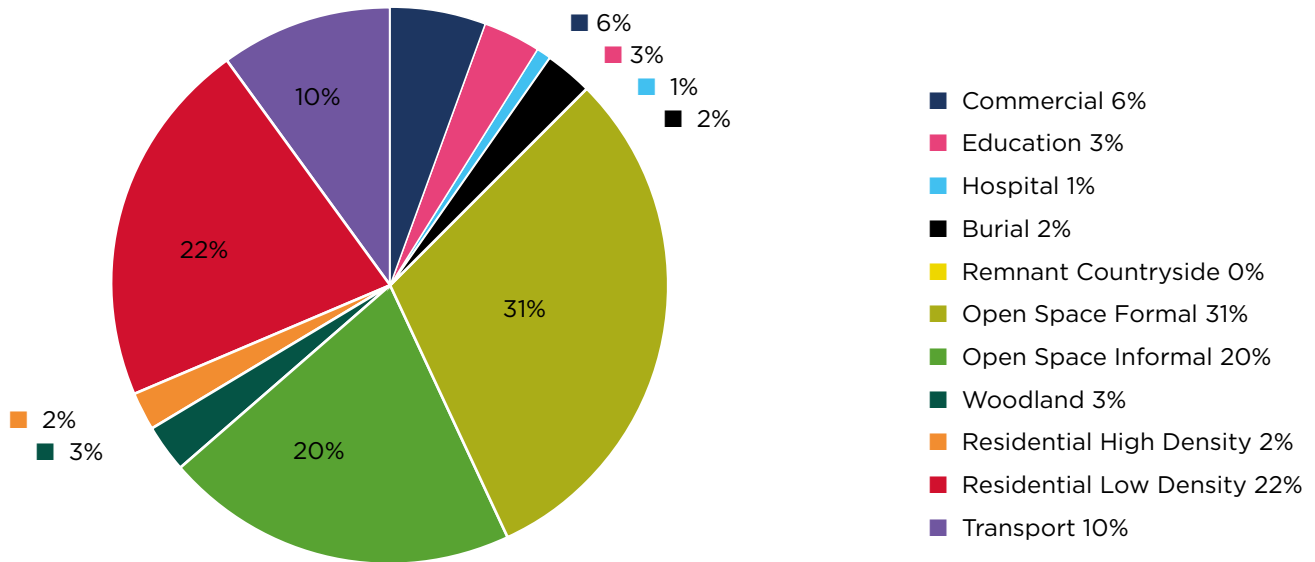


Figure 52: Cardiff's existing tree cover per land use

Cardiff's potential canopy Figure 53 shows residential low-density (RLD), i.e. private gardens, capable of accommodating almost 50% of the PCC area. Note that residential high density (RHD) could take 12% of extra cover. Arguably this land-use, often where the less advantaged populace reside, is where targeted planting should be focussed. Currently the national average for this land-use is only 1.0%. Education land potential in Cardiff, on 8%, offers scope although much of this will exist as playing fields. Transport doesn't register at all as it is predominantly 'grey' in character.

Cardiff's Potential Canopy Cover per Land-Use

Percentage of Total City Area

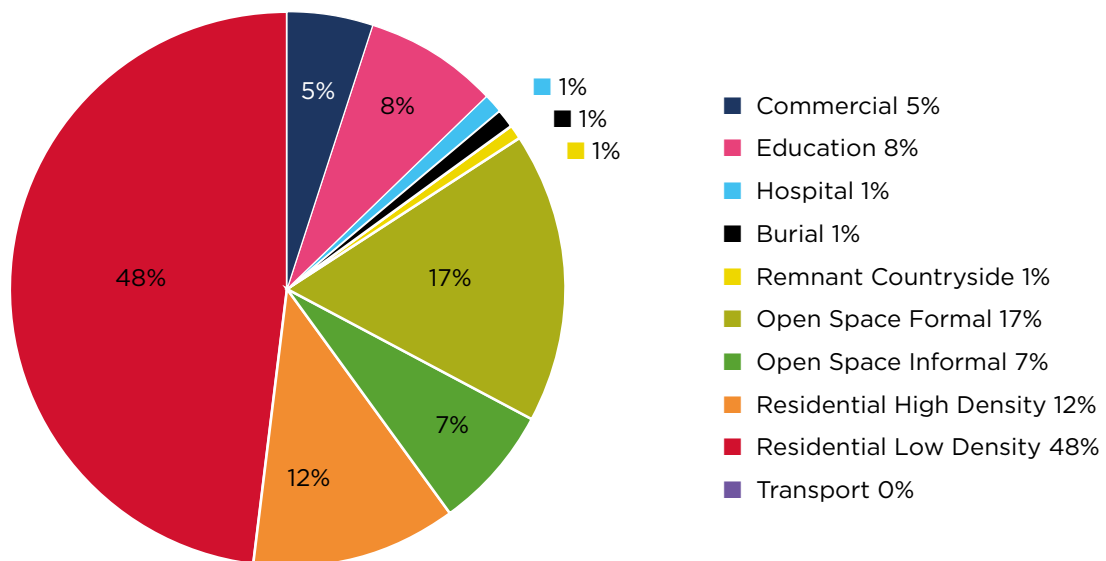


Figure 53: Cardiff's potential canopy cover per land-use





Figure 54: Oblique aerial of Cardiff Bay study area: Riverside and Grangetown to the left of the Taf, Butetown to the right (Butetown 3 to the right of the distinct Lloyd George avenue is in the lowest WIMD category). Adamsdown and Splott are out of picture to the right. © Crown Copyright: RCAHMW

Cardiff Bay: potential areas for tree planting

The 1-190 WIMD communities of Cardiff Bay (the wards of Adamsdown 1,3,& 5, Butetown 1 & 2, Grangetown 4, Riverside 2 & 3 and Splott 3,6,and 8) have been studied as a desk exercise to highlight:

- What potential 'green' land exists for increasing tree cover and,
- In which land-use category these opportunities exist.

Figure 51 shows there is a preponderance of 'grey' land in the Bay area which also could potentially be available for retro-fitting trees. This needs to be explored beyond this study.

Figure 55 highlights the limited tree cover in all of Cardiff Bay's deprived communities, with Riverside 2 as low as 3%, closely followed by Adamsdown 5, Butetown 2 and Splott 8, all on 5% (2009 figures). Should systematic planting be undertaken in existing green spaces, potential cover varies from as low as 14% in Butetown 2 to as much as 59% in Splott 3.

The green areas identified in most of the wards as warranting further exploration for tree planting are unlikely to be all available or suitable. Only further ground-truthing will determine what is practicably achievable.



Cardiff Bay's % Potential Canopy Cover
as per Welsh Index of Multiple Deprivation '1-190' Wards

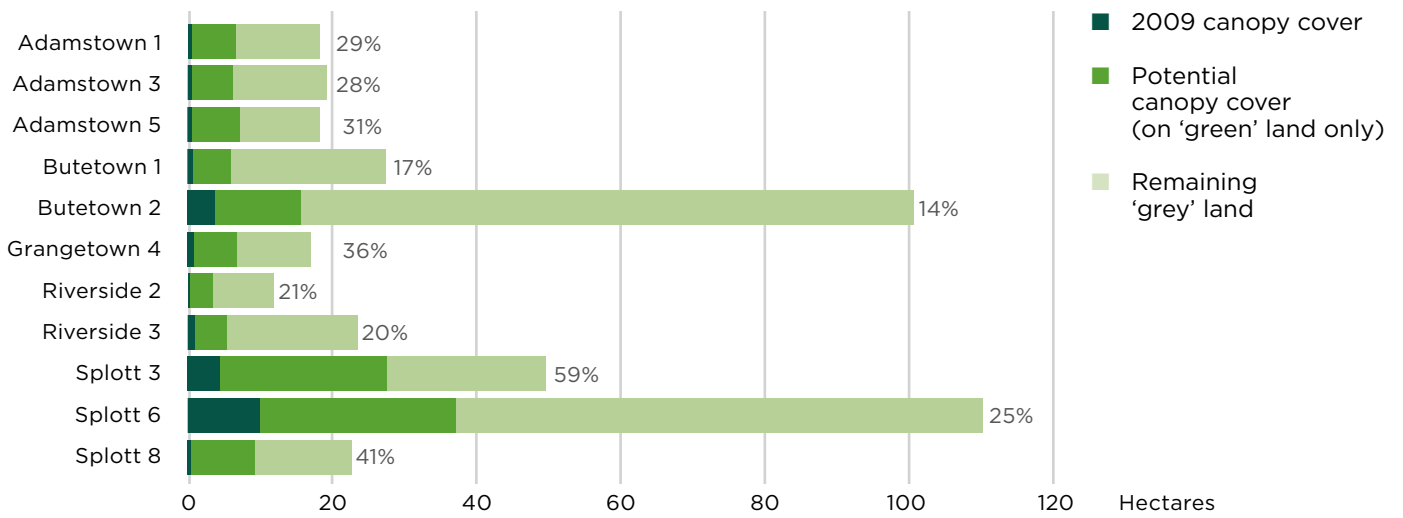


Figure 55: Cardiff Bay 1-190 WIMD wards showing existing and potential cover (PCC is highlighted as a % of the total ward).

Understanding ward character

Closer analysis of the character of these areas helps to explain why tree planting opportunities vary between wards. The land-use analysis helps to identify where the greatest opportunities exist.








Scene Setter	Ward Character
	<p>BUTETOWN 1 60s / 70s high-density housing - high-rise flats, walk-up flats and maisonettes. Adjacent green space corridor with minimal tree cover.</p>
	<p>ADAMSDOWN, GRANGETOWN, RIVERSIDE , SPLOTT 8 Mainly high-density, industrial-era terrace streets with some 50s semi-detached housing. Very little tree cover. Green space limited to some pocket parks and riverside.</p>
	<p>BUTETOWN 2 Mix of industrial, commercial and business, plus new apartments with some terraced housing. (N.B. In 2011 dropped out of WIMD 'Top 10' most deprived wards to 68th and in 2014 is now 1,495). Very little tree cover though has accessible linear green space corridor.</p>
	<p>SPLOTT 3 Semi-detached housing with gardens front and back, some terraced housing. Expansive school grounds feature as does undeveloped informal green space. Low tree cover but potential land exists for planting.</p>
	<p>SPLOTT 6 Limited terraced housing to north. Majority is dominated by the old industry of Tremorfa and the new commercial / business estates. As a consequence 'green' available land features strongly. Current tree cover low despite notable investing in trees along Ocean Way.</p>

Table 34: Cardiff Bay 1-190 WIMD wards: Appraisal of ward character.

Identifying land-use opportunities

In those wards displaying the highest potential for planting, the following land-use categories offer the most favourable opportunities at this initial appraisal stage:

- Splott 3: 59% of the ward has been identified as showing potential for tree planting. 13 hectares of this is education land and over six hectares is informal open space. Whilst playing fields will feature prominently in school grounds and the open space may be earmarked for development, these offer the most realistic areas to target planting. Nine hectares are also available in private gardens, if a community initiative were able to facilitate and encourage individual tree planting.
- Splott 6: 17 hectares are potentially available for tree planting in the extensive commercial and business parks around Tremorfa.
- Butetown 2: 12 hectares across a mix of open space, school and commercial opportunities exist in an area presently with only 5% cover.



WIMD (1-190) Wards (Colour-coded as per ward character - see Table 34)	Potential Canopy Cover per Land-Use Category (Hectares)										TOTAL WARD POTENTIAL CANOPY COVER (HA)
	COMMERCIAL AREAS (COM)	EDUCATION (EDU)	HOSPITAL (HOS)	BURIAL (BUR)	REMNANT COUNTRYSIDE (FLD)	OPEN SPACE FORMAL (OSF)	OPEN SPACE INFORMAL (OSI)	RESIDENTIAL HIGH DENSITY (RHD)	RESIDENTIAL LOW DENSITY (RLD)	TRANSPORT CORRIDORS (TRN)	
Adamsdown 1		0.1				0.4		3.8	0.9		5.2
Adamsdown 3		0.7				0.8		2.6	1.1		5.2
Adamsdown 5		0.2						2.4	3.1		5.7
Butetown 1		0.1				1.6		1.5	1.5		4.7
Butetown 2	2.7	0.9				3.2	1.7	2.2	1.8		12.5
Grangetown 4		0.2				0.7		2.5	2.8		6.2
Riverside 2						2.5		0.5			3.0
Riverside 3			0.3			0.5		2.4	1.2	0.2	4.6
Splott 3	0.3	13.0				0.4	6.4	3.1	6.2		29.4
Splott 6	17.4					1.8	5.8	2.0	0.7		27.7
Splott 8						0.1	0.1	2.7	6.8		9.7

Table 35: Potential canopy cover per land-use (ha), assuming a 100% coverage is achieved in those areas targeted for planting.



5.4 Summary: actionable findings

All towns and wards offer scope for increasing planting and canopy cover

The pilot analysis of potential areas for tree planting has focused on what might be considered as 'easy wins': tree planting in green spaces has fewer constraints, and often lower upfront costs, than accommodating trees within hard landscapes.

Results have shown that large tracts of 'green' land – both public and private – seem to offer potential for tree planting. However, a detailed, on-the-ground appraisal is needed to enable decision makers to fully understand where planting is most achievable and desirable, so as to plan effectively for a more substantial and robust urban forest.

Consideration of this town assessment approach to potential canopy cover would benefit from:

- Feedback from stakeholders, especially local authorities, as to the usefulness of this approach. Closer analysis of and comment on each county's pilot town findings would be useful.
- An indication as to the merits of expanding the approach to other towns.
- Exploring methods to best identify and map potential 'grey' planting areas.

The importance of identifying land-use and available 'green' and 'grey' areas in understanding where it's feasible to plant and set realistic canopy cover targets

The pilot conducted has also shown that in some of the densely populated and more challenging areas, focusing exclusively on green areas for spotting opportunity to increase tree cover was not enough. The approach to mapping potential areas for planting across both green and grey areas, to the level of detail that US cities adopt, deserves to be investigated further and utilised as the way ahead for realistically developing tree strategies and setting urban canopy cover targets.

The next steps here would be to:

- Engage with pilot local authorities keen to take this approach to the next level of investigation;
- Select a pilot town or county, and work to build up comprehensive site-based data, enabling an approach to setting meaningful canopy cover targets.



6. Conclusion: disseminating, refining and updating the data

The *Tree Cover in Wales' Towns and Cities* study makes a significant contribution to the identification of where and how much tree cover Wales' towns possess. Making the most of these findings requires concerted efforts towards:

- 6.1 Disseminating the data
- 6.2 Improving and updating the dataset
- 6.3 Using the findings: sustaining and growing canopy cover



6.1 Disseminating the data

Dissemination of main TCWTC report and summary

The target audience is local and national government policy and programme formulators, chief executives and heads of department, politicians, professional practitioners and organisations working in both the urban green space realm and in less advantaged communities.

The report and summary are available online at the Natural Resources Wales's website.

Data sharing

The report and summary are supplemented by:

- Visiting the County Local Evidence Packages from the Infobase Cymru website, to identify those towns assessed for their canopy cover.
- Accessing the Welsh Government and Natural Resources Wales Lle geo-portal website for the study datasets in GIS and tabular formats.

Availability of 22 County Supplements

County reports, providing canopy cover highlights, suggested actions with potential target wards, plus a town-by-town data breakdown and analysis, are available from: urbantrees@naturalresourceswales.gov.uk



6.2 Improving and updating the dataset

Gathering feedback

Following the 2016 updated TCWTC study main report and summary, continued feedback on the methodology used, the findings and next steps will be sought from the target audiences. (Feedback and comments to urbantrees@naturalresourceswales.gov.uk).

This will aid Natural Resources Wales to further, a) refine the evidence gathering approach, b) build on where there are gaps in knowledge, and c) to, further work more closely together to promote urban canopy cover.

Aerial photography

The next available suite of aerial photography for Wales will be for 2017. It would therefore be timely, if feasible, following the 2006, 2009 and 2013 aerial assessments, to carry out a Phase 4 survey in 2017. With a suite of aerials of the same resolution spanning eight years, the picture of change in canopy cover comparison will become that much more reliable.

Pre-2006 aerial photography is potentially available to test change over time for specific towns and areas of interest.

The urban boundary

A review of the land-use rules, boundary checking and, in the light of any feedback, the urban areas as currently defined by Natural Resources Wales would be beneficial. Consideration should be given to aligning to Local Authority 'settlement boundaries'.

Tree and canopy data

To provide more consistent canopy cover figures, the urban NFI components need to be analysed more closely and, where canopy diameter does not exceed 3.0 metres, these need to be omitted from the findings.

No ground-truthing has been done to date, e.g. does taking the median for each of the three tree size categories give a fair reflection of actual canopy cover?

There would be merit in separately identifying canopy cover for those 1.0–3.0 metre diameter trees - their contribution to those 'grey' areas in low cover wards, while not adding greatly to canopy cover, does have an important 'greening' impact.

It would be useful to distinguish those local authorities who have invested heavily in planting in recent years, which has yet to register as canopy cover, from those who have had minimal or no programme of young recruitment planting.

Consider other tree and canopy data capture techniques, e.g. infrared hyperspectral imagery to identify tree height and species.

There is a case for adding additional layers of specific tree interest, partly related to canopy cover, e.g. tree preservation orders (TPOs), historic, ancient and veteran trees.



Public and private land ownership

There would be value in identifying private and public tree cover in towns, i.e. where local authorities could influence change greatest. Public land could be categorised further e.g. parks, street trees or educational, in the quest for more informed management and seeking out opportunities for planting. Identifying canopy cover and planting opportunities on land holdings, such as Registered Social Landlords, would appear in line with much of the WIMD and 'Communities First' cluster area focus this study has adopted.



*Figure 56: Pontcanna, Cardiff - town house gardens with space for trees, tree-lined streets, a tree-canopied pocket park and adjacent access to Sophia Gardens and Bute Park. An exemplar residential area where both private and public ownership has shared in the vision of investing in trees, providing a positive contribution to urban living.
© Crown Copyright: RCAHMW*

Potential planting

The planting opportunities assessment pilot deserves more investigation and validating on site. Case studies would help to raise the profile of this approach to setting canopy cover goals. Consider extending the approach to all towns along with refining the methodology, especially identifying potential paved 'grey' areas for trees when suitable datasets are available.

Cross-referencing datasets

The cross mapping with WIMD has been revealing and it would be equally invaluable to do more research against datasets such as air quality, health, temperature, flood risk, property values, crime, wildlife connectivity and access to green-space. In terms of an ecosystem approach these would no doubt highlight particular urban areas that would benefit from additional canopy cover.



Figure 57: Contrasting urban fringes to towns: Tywyn (left) with scant surrounding tree cover compared to the well-wooded slopes around Glyn-neath (right). © Crown Copyright: RCAHMW & © NRW

This study only identified trees and woodland within the built boundary. Urban fringe woodland is also important for potential recreational access and as a backdrop to life. An assessment of the degree of woodland beyond town boundaries would highlight communities lacking in trees on both counts, making their case for 'action on the ground' greater, as per Figure 57.

Valuing the benefits of tree cover

The Open University and Forest Research intend to upload this study's dataset onto the Treezilla 'Monster Map' site as point data. Over time local authorities, community groups and individuals can input species, girth, height, crown and ground surface information on those specific trees, which then generates values as to the benefits that tree provides society.

Wales currently leads the way in the UK in producing county and city-wide studies of i-Tree Eco. These assess the structure and value of the urban forest in Wrexham (12 towns) and Bridgend (5 towns) County Boroughs plus the Tawe catchment that includes Swansea. Highlighting the ecosystem benefits of trees by this approach will hopefully inspire other councils to follow suit.

6.3 Using the findings: sustaining and growing canopy cover

The TCWTC study provides local planning authorities with a critical component of the evidence base they need to produce tree strategies that can be embedded in council policy through guidance, development and infrastructure plans. However, a strategy must be fully costed to realistically sustain and grow the urban forest. To this end councils first need to know their tree resource. A major outcome from the strategy should be the setting of a local canopy cover goal, grounded in a good understanding of their existing tree resource - which the TCWTC data goes a long way in facilitating.

The TCWTC study provides the Welsh Government (WG) with solid evidence of the state of the Welsh urban forest, both in terms of extent and distribution as well as of its evolution. This has highlighted some important issues regarding:

- Canopy cover loss: the TCWTC study show clear evidence that 159 towns and cities have lost canopy cover between 2009 and 2013.
- Canopy cover discrepancies between towns and wards.
- Unfulfilled potential to better use land for increasing cover.



- The findings provide grounds to undertake a review on current legislation and guidelines as to their effectiveness on delivering ecosystem goals, e.g. TPOs and ensuring robust conditions are adhered to on development sites.

The TCWTC study provides the Welsh Government and Natural Resources Wales with a strategic framework of priorities to allocate funding packages that promote both tree planting and the safeguarding of maturing stock, either through over-arching regeneration programmes, such as *Vibrant and Viable Places*³⁶, or tree-specific initiatives, similar to the 2004-8 Treegeneration in Flint and Wrexham.

The TCWTC study provides local community champions and third sector organisations, such as local tree ambassadors and tree wardens, with an open source dataset to inform their work in taking local action to increase and care for canopy cover, as well as to spread the word about the value of trees to the wider public:

- As Neath Port Talbot have demonstrated, Public Service Boards have a role to play in bringing together public, private and voluntary organisations to address issues where tree cover can offer solutions.
- Active local campaigners groups such as GAG (Greener Aberystwyth Group) work tirelessly to raise tree and green space issues amongst fellow residents and work alongside Ceredigion Council. Their existence has been very much a contributory factor in securing the 2012-14, £375,000 funded, Coed Aber project.
- Examining the neighbourhood tree approach, adopted successfully in many US cities and piloted over here in places such as Hackney, London³⁷ and Bristol³⁸, there is potentially the appetite to engage more fully with residents in tree-planting and on-going maintenance projects.



Figure 58: Abertillery - a South Wales Valleys community with a higher than average canopy cover of 27%. N.B: That does not include the woodland behind, which is beyond the urban boundary. © NRW

³⁶ *Vibrant and Viable Places* - on the Welsh Government website

³⁷ Hackney Community Trees - on the Sustainable Hackney website

³⁸ Tree Bristol - on the Bristol City Council website



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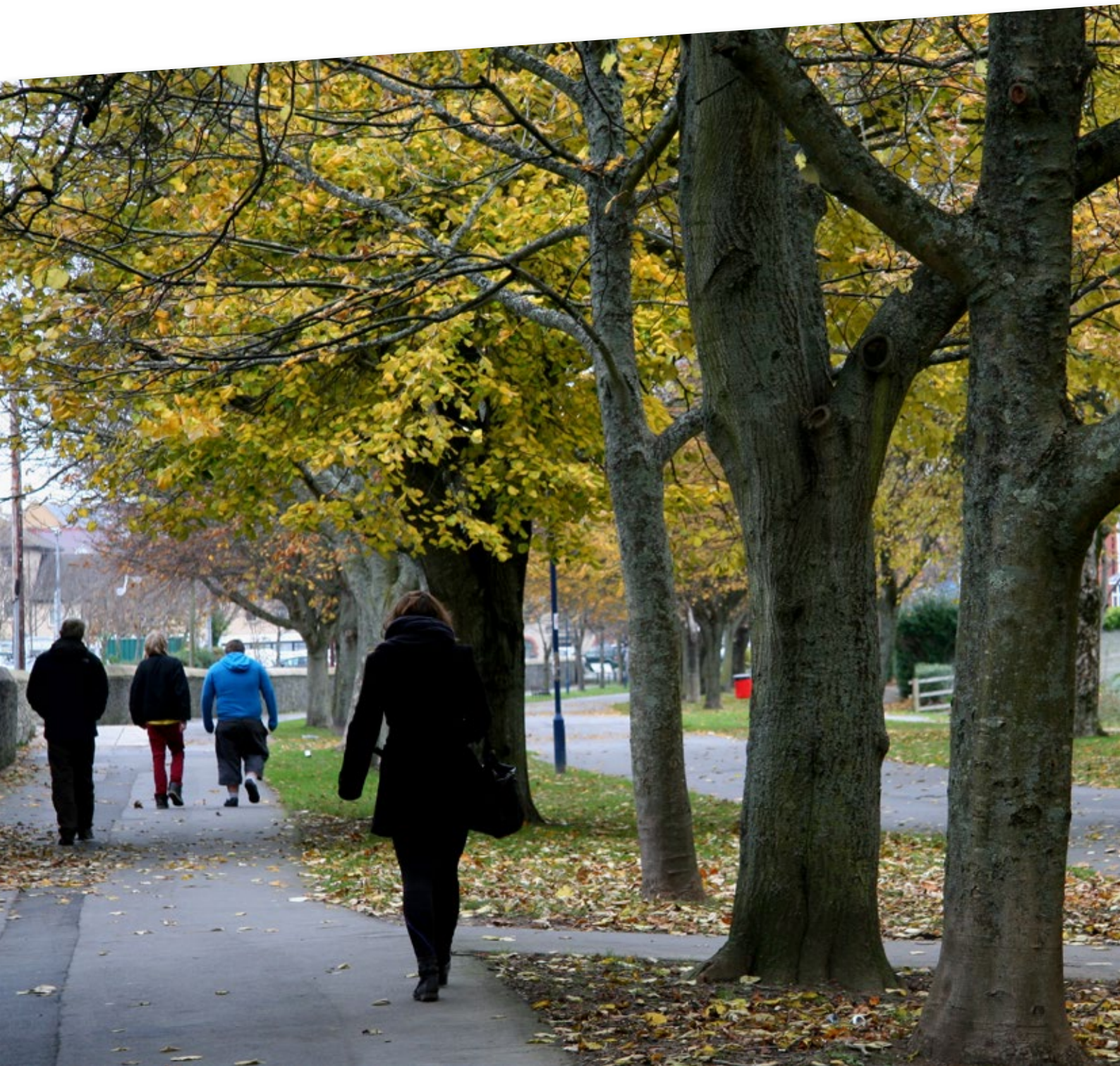
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Appendices



Appendix 1:

The economic, social and environmental value of trees for towns and cities

It is now widely accepted that trees and woodlands in and around towns and cities have a vital role to play in promoting sustainable communities. In the last few years a growing body of research has demonstrated that trees bring a wide range of benefits both to individual people and to society as a whole.

As the most important single component of green infrastructure, trees can contribute to improved health and well-being, increased recreational opportunities, and an enriched and balanced environment that ultimately boosts a town's image and prosperity.

A summary of key benefits associated with good tree canopy coverage in urban areas is presented below:

A1.1: Economic benefits

A1.2: Social benefits

A1.3: Environmental benefits



A1.1 Economic benefits

TREES:

- Increase property values by 5-18% and this growth increases proportionately with the tree growth
- Within mature landscapes, tend to make development sites worth more
- Create a positive perception of 'place' for potential property buyers be it home owners or commercial investors
- Contribute to retail areas performing better - people are more productive, with job satisfaction increased
- Improve the environmental performance of buildings by reducing heating and cooling costs, thereby cutting bills
- Provide a cost-effective and sustainable alternative to 'grey' infrastructure provision in tackling storm-water run-off
- Reduce, through shading, degradation of tarmac surfacing and frequency of replacement
- Reduce green space maintenance costs
- Add to tourism and recreational revenue
- Improve the health and well-being of local populations, so reducing healthcare costs
- Can enhance the prospect of securing planning permission if existing trees are protected and the new tree-planting design is imaginative
- Offer valuable by-products e.g. timber, firewood/woodchip, renewable fuel via coppicing, fruits (e.g. community orchards) and compost/leaf litter mulch.

A1.2 Social benefits

TREES:

- Create a sense of place and local identity
- Provide focal points and landmarks
- Benefit communities by increasing pride and social cohesion in the local area
- Have a positive impact on crime reduction
- Due to their stature, strength, and endurance, promote spiritual well-being, e.g. putting people in touch with nature and reducing depression and anxiety
- Provide a source of recreation, entertainment and quiet enjoyment, offering opportunities to unwind and de-stress, and provide families with a pleasant environment within which to spend quality time together
- Have a positive impact on people's physical and mental health e.g. less asthma and skin cancer and patient recovery times
- Encourage exercise that can counteract heart disease and Type 2 diabetes
- Offer a rich outdoor learning classroom for all, especially when part of a natural wooded environment



A1.3 Environmental benefits

TREES:

- Remove carbon dioxide to create a carbon sink
- Transpire, reflect sunlight and provide shade, all combining to reduce the 'urban heat-island effect'
- Remove dust and particulates from the air
- Reduce traffic noise by absorbing and deflecting sound
- Reduce wind speeds in winter
- Provide food and shelter for wildlife thus helping to increase biodiversity
- Create new habitat links across towns and to the countryside, and strengthen existing wildlife corridors
- Create attractive greener landscapes
- Hide eyesores
- Reduce the effects of flash flooding by slowing the rate at which rainfall reaches the ground
- Help to improve soil quality when planted on despoiled and degraded ground
- Create organic matter on the soil surface from their leaf litter and, with their roots increasing soil permeability, this results in:
 - Reduced surface water run-off from storms
 - Reduced rainwater soil erosion and sedimentation of streams
 - Increased ground water re-entry that is otherwise significantly reduced by paving
 - Lesser amounts of chemicals transported to streams
 - Reduced wind erosion of soil
- Are a key element of any urban climate change adaptation strategy. As the effects of climate change become better understood, it is becoming increasingly clear that one of the best ways in which we can make our communities more hospitable over the next few decades is to increase the number, size and species of trees.

The range of values associated with the urban forest, as highlighted above, demonstrates the crucial role that sustainable management of the urban forest plays in everyday urban life and emphasizes the need to develop a disciplined and comprehensive framework for their management.



Figure 59: Oxford Street, Swansea - generous canopy cover providing an attractive place to shop. ©NRW



Figure 60: The long-lived, large canopied London Plane, a lasting legacy from the Victorian era. It's characteristic of inner city parks and streets and offers multiple benefits to urban society. ©NRW



Figure 61: Canon Street, Aberdare - trees offering a beneficial ingredient to the urban landscape. ©NRW



Further reading

Trees and Design Action Group (TDAG):

No Trees No Future (2010)

The Canopy (2011)

Trees in the Townscape (2012)

Trees in the Hard Landscape (2014)

Forestry Commission England:

The Case for Trees in Development and the Urban Environment (2010)

Forest Research and Treeconomics (i-Tree Eco studies):

Torbay's Urban Forest (2011)

Green Benefits in Victoria Business Improvement District, London (2012)

Valuing Wrexham's Urban Forest (2014)

Valuing Urban Trees in Glasgow (2015)

Valuing London's Urban Forest (2015)

Valuing Urban Trees in the Tawe Catchment (2015)

Valuing the Urban Trees of Bridgend County Borough (2015)

CIRIA:

The Benefits of Large Species Trees in Urban Landscapes (2012)

Manchester University:

Adaptation Strategies for Climate Change in the Urban Environment ASSCUE project (2010)

Lancaster University:

Using trees to improve air quality in cities (2005)

The Woodland Trust:

Greening the Concrete Jungle (2010)

Trees or Turf (2011)

Urban Air Quality (2012)

Trees in Our Towns - their role in managing water quality and quantity (2013)

Healthy Trees, Healthy Places (2013)

Trees for Cities:

Trees Matter (2005)



Appendix 2:

Obtaining canopy cover data - the approach and methodology

This study follows a relatively simple methodology. The approach has been influenced by the level of information available through spatial data and realistically tailored to the resources available. Purely a desk exercise, it was an attempt to capture, for the first time, evidence of the extent of Wales' urban canopy cover. The approach focussed on providing a photographic interpretation of tree cover from aerial photography.

Various steps were involved as follows:

- A2.1: The urban boundary
- A2.2: Capture of canopy cover data
- A2.3: Assigning canopy cover to land-use
- A2.4: Cross-referencing with environmental, social and economic datasets
- A2.5: Assessing the potential for tree planting



A2.1 The urban boundary

Urban definition

The decision of what constitutes an 'urban' area was made using the Rural and Urban Area Classification - developed in 2004 by the Welsh Government, the Countryside Agency, DEFRA, the Office of the Deputy Prime Minister and the Office for National Statistics (ONS). These definitions are based on population figures for each 'settlement' (city, town, village or hamlet) and the district in which the settlement is located.

This study includes the following towns and urban areas contained within the following 'Lower Super Output Areas' (LSOAs):

Urban >10,000 population - Less Sparse

Urban >10,000 population - Sparse

Town and Fringe - Less Sparse

Town and Fringe - Sparse

(A number of sparse towns e.g. Tregaron, Ceredigion and Nefyn, Gwynedd were however excluded on the basis of size and their rural character and location).

Settlements within the following LSOAs were also excluded from the study:

Village, Hamlet and Isolated Dwellings - Less Sparse

Village, Hamlet and Isolated Dwellings - Sparse

N.B: Where small towns e.g. with a population of 1,000-1,500 fell within Urban Sparse & Less Sparse LSOAs these were included e.g. old mining communities such as Blaengwynfi and Fochriw. This resulted in a few 25-30 hectare towns being included, whilst some larger, but purely rural towns, were excluded.

This definition of 'urban' was adopted by FCW's Corporate Programme 7 'Urban Woodlands and Trees' in 2010. A future Wales Urban Forestry Network may take a different view in due course.

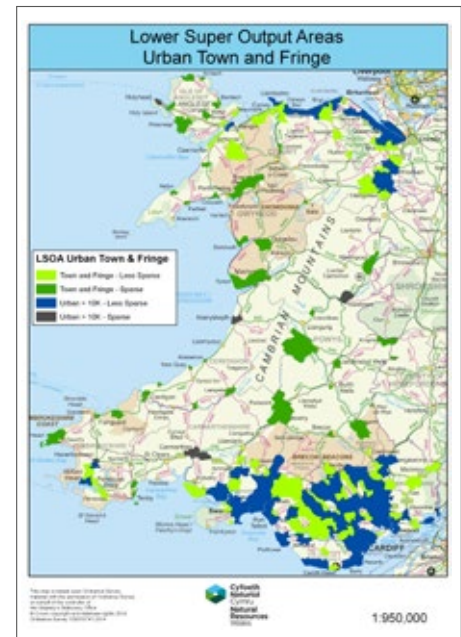


Figure 62: Urban town and fringe LSOAs

Determining the urban boundary

The urban areas were initially based upon Ordnance Survey 1:50,000 scale urban boundaries. These were refined to the built environment of the settlement, working to a set of agreed boundary land-use rules. FCW and Exegesis, the Phase 1 contractor, tested and refined the methodology and rules using Rhayader as the pilot town.

Exegesis undertook determining the boundary extent for 120 of the largest urban areas with the remaining 100 smaller town boundaries defined by Natural Resources Wales (FCW) prior to commencing Phase 2.

These rules were adopted and adhered to throughout the two contract phases for all urban areas. As part of Phase 3 boundaries to 12 towns in South Wales were extended with datasets updated using aerial imagery from 2006 and 2009.

The urban area (built environment) included:

- All buildings and associated curtilages
- Business & industrial parks
- Cemeteries
- Parks, playing fields & sports grounds
- Roads where adjacent to buildings

Clusters and single houses separated from the rest of the urban area were excluded.

The urban area included the following land-uses where over a third of their boundary ran alongside the built environment:

- Caravan & camping sites
- Disused quarries & mines
- Golf courses
- Sewage works

The urban area included the following land-uses where over two thirds of their boundary ran alongside the built environment:

- Common land or rough ground
- Agricultural land

Included around the whole area defined above was:

- A 20 metre urban buffer.

Defining the urban boundary was not straightforward. Further validation of the 220 urban boundaries, for anomalies highlighted below, would be a worthwhile exercise to undertake when resources allow.

Outlined below are issues that have emerged during the course of the study:

Urban fringe parkland

Interpretation of what constitutes parkland and its extent can lead to the over-inclusion of 'countryside'. In one instance, the extensive urban fringe Erddig Country Park in Wrexham was picked up from MasterMap as 'parkland' and included in its totality.

Urban fringe leisure and utilitarian land-uses

How far the identified land-uses are fully representative of the urban realm is something that was debated at some length initially (and arguably not entirely resolved). The one-third-plus rule seemed to strike the right balance between, a) their non-built, but developed character and b), the sometimes considerable land-take which could over-represent the urban hectareage and tree cover. A couple of land-use types, not initially identified along the urban fringe, which came to light during Phase 2 were:

- Ancient monuments such as castles and forts e.g. Kidwelly and Burry Port were included under the parkland, common land or rough ground rules. Caldicot castle, for example, lying beyond formal parkland, was deemed outside the urban extent.
- Airfields and airports were treated within the >1/3 ruling. Broughton's terminals and hangers, as a continuation of the town, meant the runways were included. The opposite was true for Rhoose, whose buildings were detached from the town.

Urban fringe common land & rough ground

The extent to which this category has been allocated, or not, to urban areas hasn't been analysed as it was not flagged up as an issue. For example a linear tract of well-used rough ground along the boundary of Brymbo could have justified inclusion but wasn't. Equally, unjustifiably large tracts of urban fringe land could have been included but this doesn't appear to have occurred.



Urban fringe woodland

The inclusion and exclusion of woodland alongside urban areas caused much discussion. The South Wales Valleys are often described as being the largest urban forest in Europe. The Welsh Government's 'forest' estate is such that it forms both a very visible backdrop to life as well as often providing ready recreation access into woods on people's doorsteps. For the purposes of this study, however, woodland alongside the built landscape, if not part of a park or a boundary land-use, would not be included. This is illustrated in Figure 7 where the Rhondda urban area clearly excludes the forested valley slopes. While this has been consistently upheld in most instances, the odd town may reveal discrepancies. Trimsaran, with its irregular and well-wooded boundary, has included two woodlands that could have been interpreted as lying outside the boundary.

The urban buffer

A 20 metre buffer was included for its immediate influence on the neighbouring built environment.

Local Planning Authority settlement boundary

This was highlighted as an alternative approach to defining the urban area. This would arguably align itself better to local authority plans and programmes. Greenfield sites earmarked for development but beyond this study's scope would be of particular interest to urban forest planners. Undertaking a base-line inventory of tree cover on these sites, monitored over time, could be quite revealing as to the extent development is eroding canopy cover.

The nature of the 220 individual and aggregated urban communities

Wales is often characterised as a nation of small communities. This is relatively straightforward in rural areas but in urban conurbations it becomes more complex, nowhere more so than the Valleys. Their linear layout is characterised by one community running seamlessly into the next. In following the urban boundary rules this has resulted in substantial areas emerging, in particular, the Valleys. For example, in the lower Ebbw valley, the urban area title endeavours to cover a representative selection of communities, namely Risca, Crosskeys and Abercarn. But others exist, such as Pontymister, Wattsville and Cwmcarn. Bargoed spans three valleys to include the sizeable towns of Blackwood and Newbridge. The Rhondda represents all those communities within the Rhondda Fawr beyond Pontypridd and up as far as Blaenrhondda. However, where there is a break in the urban extent e.g. the upper Afan, Cymmer, Glyncorwg and Blaengwynfi, settlements appear as small communities in their own right. In a similar vein, Fochriw and Abertysswg, both only 27ha, would logically sit within Rhymney if it was not for the non-urban land in between and, similarly, Pontrhydyfen (20ha) as part of Cwmafan.

Urban boundary anomalies

In defining urban areas, based on continuous 'built environment' entities, there were occasions when the urban area straddled county boundaries. Where this occurs it is highlighted in the separate supplementary county-by-county reports (available in 2016). Data for a particular urban area appears in the report under the county where most of the urban area lies.

Any overlapping areas from neighbouring counties are cross referenced on the introductory 'County Urban Area Size Category' map, e.g. a) Small urban areas from Bridgend, Pencoed, Llanharry and Cardiff (Wenvoe) fall with the Vale of Glamorgan and b) The communities of the upper Amman and Twrch straddle three counties, Carmarthen, Powys and Neath Port Talbot.

National boundary towns

Data for the urban areas of Saltney, Knighton, Presteigne and Hay-on-Wye were captured up to the English border but not beyond.



A2.2 Capture of canopy cover data

A2.2.1 Tree specification

Crown diameter

The Phase 1 pilot exercise, using 2006 aerial photography, determined that only trees with a canopy greater than 3.0 to 4.0 metres diameter could reliably be picked up.



Figure 63: - 3m street tree (centre) at 1:1,750 and 1:875 scales.

Clearly many urban trees were not being accounted for, for example:

- **Young trees:** This is a critically important resource as these will ultimately replace or supplement the existing canopy identified. Surveying the extent of these would identify whether a sustainable age-class structure to the urban tree population is being achieved, or that canopy cover goals are likely to be met. Towns, for example, on low cover, may have invested heavily on tree planting in the last 5-15 years but are yet to reap the benefits in terms of canopy. Conversely well-canopied towns may not have felt the need to supplement an aging population in decline.
- **Fastigate and heavily pollarded or pruned trees:** Many of these would be located in tight, challenging urban locations, where their contribution and impact would often be significant, if less so in canopy terms.

However, neither category of trees would add greatly to the overall town and ward canopy cover.

RMSI, the Phase 2 contractors, confirmed that the improved 25cm resolution for the 2009 photography could pick up trees with 2.0 metre diameter crowns. To adhere to the strict comparing of 2006 / 2009 ,and latterly 2013, aerials this was not adopted for the TCWTC study.

N.B: The National Inventory Woodland data does not align with the >3.0m crown diameter rule used to capture amenity trees in Phases 1,2 and 3. NFI does have an element of woodland that comes within either a) the 'registered young planting' classification or b) the 20% woodland cover definition. These two components of NFI woodland have not been extracted from the findings. Where this does occur certain towns will have higher canopy figure than is the case.



The following three simple crown diameter sizes in metres were selected:

- Small: 3m-6m
- Medium: 6m-12m
- Large: >12m

The contractors used an average mid-size template for capturing trees of 4.5m, 9m and 15m. This seemed reasonable and expedient considering the scale of manual capture involved. Specific detailed area studies, using ground-truthing, would offer a more refined level of canopy diameter.

Points and polygons

The Phase 1 pilot exercise, using 2006 aerial photography, determined that only trees with a canopy greater than 3.0 to 4.0 metres diameter could reliably be picked up.

Clearly many urban trees were not being accounted for, for example:

- **Points:** Single trees with a clear, visible crown. The size excluded most shrubs but where greater than 3.0 metres in diameter these were included as contributing beneficially to urban canopy cover.
- **Polygon:** Lines or groups of trees with over-lapping crowns. The selected size category chosen was that represented by the majority within the captured polygon. As wooded areas it was not always easy to interpret what average crown category the polygon fell into. What often appeared wooded did not necessarily mean that trees had reached the 3.0 metre crown diameter.

Whilst not affecting the overall canopy cover it was observed that, on occasions, trees were captured as points on 2006 aerials and then grouped as polygons on the 2009 aerials (or vice versa).

However, as part of the 2013 data capture, AECOM encountered some examples of over-zealous canopy capture within the 2009 polygons, e.g. particularly Swansea. Where this was clearly not all >3.0m crown canopy, AECOM revised the capture to identify only points and smaller polygons.

N.B.: All polygons greater than 0.5ha had already been captured as NFI woodland. See National Inventory Woodland section below.

Hedgerows were not captured if they were maintained; i.e. the outline of the hedge was straight on both sides. If tree crowns were clearly visible, the individuals or line of trees were captured.

Broadleaf, conifer and mixed

The following breakdown of tree type was interpreted from the aerials:

- Broadleaf: >75%.
- Conifer: >75%.
- Mixed: Canopy 25-75% broadleaf - conifer.

As section 3.4 highlights this assessment was of limited value, especially as the study had not analysed the NFI woodland content. The aerial photography resolution, seasonality and shadow all contributed to making identification difficult.

Whilst clearly beyond the scope of this study, gaining an understanding of species composition within the urban forest will be crucial to sustaining and building a robust and resilient tree population in the face of impending climate change.

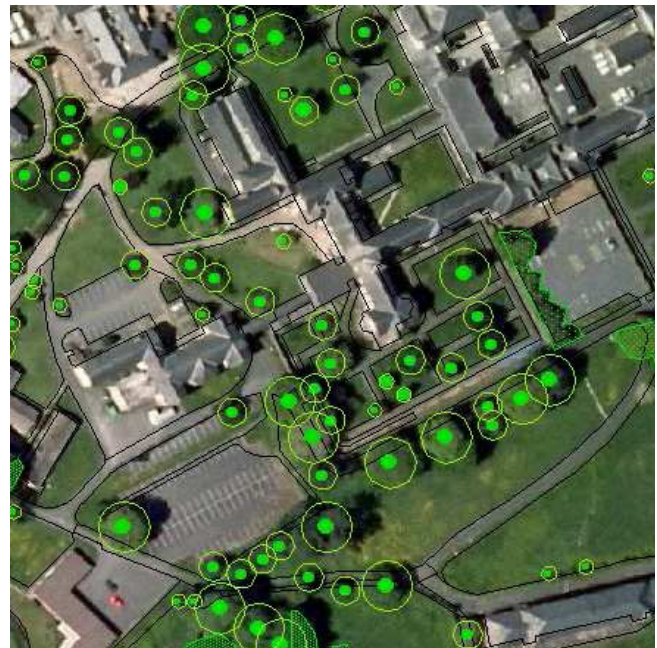


Figure 64: Thematic map of small, medium and large canopy sizes.



Tree density

This data was captured (again excluding analysis of NFI woodland) but not deemed to be of value for inclusion within the report and was not assessed for 2009.

To précis the results:

- 2009 Point Data: a national average of 10 trees / hectare.
- 2009 Polygon Data: a national average of 35 trees / hectare.
- There has been a 17 tree / hectare increase between 2006 & 2009.

If all trees were to be included (i.e. NFI trees and <3 metre diameter trees as well), then monitoring tree density would be more meaningful.

A2.2.2 Aerial photography (AP) – 2006, 2009 and 2013

As a desk exercise study the quality of the AP has been fundamental to accurately capturing canopy cover. With limited resources to undertake alternative and more expensive methods of assessing canopy cover e.g. remote sensing and/or ground surveying, it was the obvious approach to carry out a national survey of this scale. Whilst automated AP systems are available, FCW decided to opt for manually capturing data.

- Phase 1 used 2006 AP to capture the 40 largest urban areas.
- Phase 2 used 2006 & 2009 AP to give a complete data capture, a) completing the outstanding 80 urban areas for 2006, and b) re-capturing all 220 urban areas for 2009. A small percentage of the 2009 AP was flown in 2010.
- Phase 3 used 2013-2014 AP to re-run capture of the 220 urban areas which included added extensions to 12 towns in South Wales. For these areas this required additional 2006 and 2009 AP capture.

Resolution

The resolution for the respective APs is as follows:

- 2006 - 40cm
- 2009 & 2013 - 25cm

As commented upon previously, the 2006 AP's resolution could only pick up >3m crown diameter trees and there were issues of clarity in deciphering tree data. There was considerable improvement with the 2009 and 2013's 25cm resolution, with the potential to capture >2m trees, along with far greater clarity.

An important issue with the 2006-2009 comparative study was that the capturers were not comparing like with like. There was interest to see whether canopy cover was actually decreasing in Wales' towns, as anecdotal and some survey work suggested. Whilst this was the case to a degree in 2009, the like for like resolution of 2009 and 2013 has enabled a far more robust comparison of canopy and identifying of widespread loss across towns.

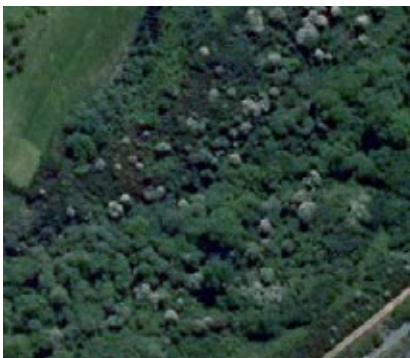


Figure 65: Quality resolution helps to distinguish >3.0m crowns from neighbouring young trees and scrub (2006 AP).



Figure 66: Visibility of trees not in leaf (points are captured trees) – 2006 AP 40cm resolution.



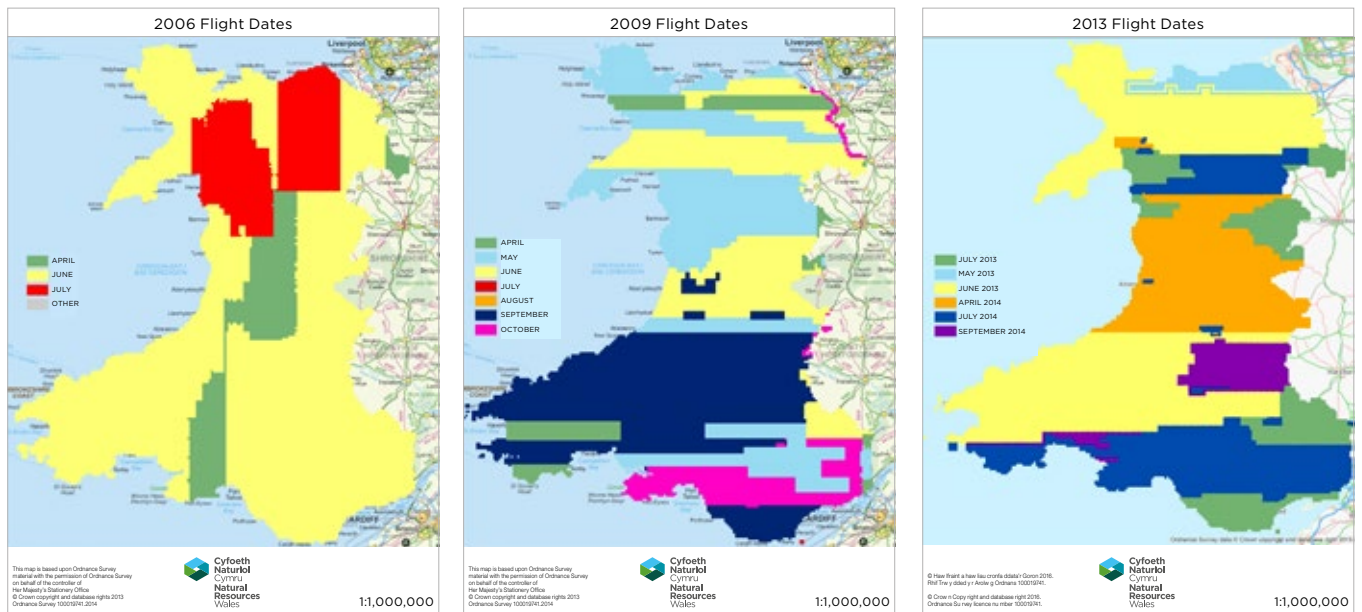


Figure 67: Aerial photography flight path maps for 2006, 2009 and 2013/14.

Seasonality

Clarity with picking out trees before they were in full leaf was an issue, especially with the 2006 AP.

Certain 2009 flight paths were flown in April and May. This may offer an explanation as to why so many of North Wales' towns showed a canopy cover decrease over 3 years and not elsewhere.

Whether this has actually influenced the decline in cover is difficult to determine. Certainly an appraisal of a couple of those towns, flown before leafing out, confirmed the difficulty the capturer had to contend with. Nevertheless, there were towns in the North-East flown in June and October showing a decrease too. Conversely, towns such as Holyhead and Rhyl, flown in May, showed an increase. Ideally photography should be from June onwards and finish no later than October.

Further investigation into clarifying those urban areas affected by AP early in the season might throw more light on this concern. These 'broad-brush' maps (Figure 67) made available for the analysis only offer an indication of what geographical area was covered in each month.

Fortunately the 2013/14 flight paths indicate the majority of urban areas were captured during the 'leaf-on' summer months. The April flights across mid-Wales possibly influenced capture in some of the hinterland and coastal towns of north Powys, Ceredigion and southern Gwynedd.

Shadow & cloud

The weather conditions obviously influence the quality of AP. Optimal weather goes hand in hand with the clarity of good sunny days. Depending on the time of day e.g. morning or evening, shadows will be cast. This understandably compromises the ability to pick out trees within the shade of other trees and buildings.

Fortunately cloud has been a rare occurrence. This did however influence the 2006 Llanelli canopy cover findings, where cloud hid potential tree cover north of the town centre.



Figure 68: Shadow and cloud compromising reliable canopy capture.

A2.2.3 National Forest Inventory (NFI)

The NFI dataset for 2011 was used for incorporating woodland into the 2006 and 2009-10 data capture, with the updated 2014 version used for the 2013-14 exercise. For the National Forest Inventory, woodlands are defined as areas with a canopy of 20% or more (or the potential to achieve this), with a minimum area of 0.5 hectares and width of 20m.

This seemed the most obvious and expedient approach to take, avoiding duplication of capture. However, the NFI data doesn't entirely correspond with the study's canopy approach. The NFI includes a range of woodland categories. The one most at odds with this urban study is young planted woodland that is yet to be recruited to the >3.0m minimal size. Similarly NFI woodland with less than 100% (>20%) cover is providing a misleading extent of canopy cover.

The extent to which this has over-recorded canopy cover is unclear but not thought to be significant overall. However, a notable local example was identified in Brymbo, Wrexham. A sizeable reclamation scheme, of young 0.5-1.0m transplants, on the old steel-works site, had been registered under NFI and no doubt contributes misleadingly to Brymbo's 21% canopy.

To align more consistently with the canopy study rules, further work on refining what NFI woodland should be omitted would be useful in the future.

Nationally NFI's contribution to the overall percentage cover is 35% in 2014. Some towns are split 50/50 but there are only 17 urban areas exceeding the amenity (non-woodland) contribution. Not surprisingly all these display higher than average cover, with half featuring in the 'Top 20'. The NFI in Abertillery and Trimsaran is almost double the amenity tree figure.

It's worth noting that the 2011 NFI update identified an extra 20,000 hectares of woodland across the entirety of Wales between 1997 and 2010. This has largely been put down to improved capture techniques including higher resolution aerial photography. There is arguably a parallel here with the overall increase of 2,046 hectares in three years with the urban canopy cover.



A2.3 Assigning canopy cover to land-use

This was not the main focus of the study and initially its importance was questioned. Whilst concentrating on determining town and ward cover, there did seem merit in identifying within which land-use tree cover fell e.g. how low canopy cover is within 'High Density Residential Areas', namely where serious concentrations of the urban populace live (and these often the most disadvantaged).

Land-use data has also been invaluable at the analysis stage in exploring where potential new planting could and should be targeted. The benefit of understanding where canopy cover sits in terms of land-use and ownership, e.g. public or private land, highways or parks, is invaluable in considering where and how to grow the urban tree resource. The accepted American approach to urban tree resource management focuses on understanding and targeting land-use types.

Both OS MasterMap and PointX data, despite the limitations of what detailed information their datasets can provide, have been the enabling tool to achieve this breakdown of canopy cover per land-use.

N.B. Canopy overlapping more than one land-use boundary was allocated to the location where the majority covered. Where there was an equal distribution across two or three land-uses the tree would be counted for each representative location.

A2.3.1 Datasets

Ordnance Survey MasterMap

The 2007 OS MasterMap layers were used for each period. These datasets were required to assist the aerial photo interpretation process by providing additional information about land-use and boundaries. OS MasterMap was also used to differentiate land-use classifications, in particular highway verges, residential gardens and transport links.

Points of Interest (PointX)

The 'PointX' point of interest dataset was created by Ordnance Survey and Landmark Information Group. It contains points of interest classified into 9 Level 1, 52 Level 2, and 616 Level 3 categories. This dataset was also used to differentiate between different types of land-use and thus assisted the location classification from aerial photographic interpretation. This enabled each of the single tree points and areas of tree polygons to be allocated a land-use.

Where the PointX or OS Mastermap data differed from the aerial photographs, the location category was captured based upon the aerial photography.

Land-use classifications not represented in the PointX data set were not captured as polygons - the data capture team classified these areas at the point-of-tree capture.

N.B: Not all land within OS MasterMap and the PointX datasets fell within the original 10 land-use category definitions. 11% (9,300ha) of Wales' total urban area fell into an 'unclassified' category. This land accounted for 741ha of amenity tree cover and 1,286ha of NFI woodland. An additional 'woodland' land-use category was created to accommodate this unallocated canopy cover. 12 land-use categories have therefore been reported upon.






Allocating this unclassified land-use when data becomes available would undoubtedly give a fuller picture across the 220 towns.

A2.3.2 Land-use categories

The land-use categories were broadly established from the outset with their definitions refined in conjunction with the Phase 1 contractor.

England's 2008 *Trees in Towns II* study chose a less detailed land-use breakdown. Three of their six categories were high, medium and low residential. The remainder were split between open space, industrial and town centre / commercial. Transport had been removed as a category following low representation in their initial 1993 sample plot study. Wales' complete coverage assessment, however, did find that 'Transport' made up 16% of the total land-use area, 9% of that being tree cover.



Land-Use Code	Character Scene Setter	Land-Use & Description
COM		<p>COMMERCIAL AREAS: Commercial / retail / industrial areas, e.g. factories, warehouses and heavy industry, business and retail parks. Identified using 'seed' data from the PointX dataset. Also includes caravan parks and camping sites.</p>
EDU		<p>EDUCATION: Schools, colleges and universities. Identified using 'seed' data from the PointX dataset. Including playing fields where these touch the boundary.</p>
HOS		<p>HOSPITALS: Hospitals and care homes and associated open areas. Identified using 'seed' data from the PointX dataset.</p>
BUR		<p>BURIAL: Cemeteries / churchyards / crematoria. Identified using 'seed' data from the PointX dataset then checked visually.</p>
FLD		<p>REMNANT COUNTRYSIDE: Areas of remnant fields that share at least 2/3 of their boundary with urban land-uses, e.g. agricultural land / horse grazing / orchards. (Aerial photography assisted in identification).</p>
OSF		<p>FORMAL OPEN SPACE: Managed open space / general amenity land, e.g. parks, gardens, playing fields, public green space within housing estates, squares, areas around public buildings, golf courses and allotments.</p>








Land-Use Code	Character Scene Setter	Land-Use & Description
OSI	 <p>© Crown Copyright: RCAHMW.</p>	<p>INFORMAL OPEN SPACE: Less managed or unmanaged land - derelict, neglected and abandoned open space, scrub, riparian zones, canal verges, woodland, also commons and greens - rougher/lighter appearance on aerial photo. OSI identified visually as largely unmanaged areas.</p>
WOD		<p>WOODLAND: An additional category added to account for all the NFI woodland falling within the unclassified land-use (24,907ha) as opposed to within the original 10 land-uses.</p>
RHD		<p>HIGH-DENSITY RESIDENTIAL: Trees found in and around high-density residential areas, i.e. houses with medium to zero gardens - defined by selecting a subset of the MasterMap urban area where polygon size of the garden (multi surface) is smaller than 0.01ha.</p>
RLD		<p>LOW-DENSITY RESIDENTIAL: Trees found in and around low-density residential areas, i.e. houses with medium to large gardens - defined by selecting a subset of the MasterMap urban area where polygon size of the garden (multi surface) is greater than 0.01ha.</p>
TRN		<p>TRANSPORT CORRIDORS: Transport corridors i.e. road, rail, including their verges (embankments and cuttings).</p>

Table 36: Land-use categories and descriptions.



The 11 adopted land-use categories and descriptions

Also included were 'Education' and 'Hospitals', not so much for their extent within towns but more as an aid towards focussing on the education, health and well-being agendas. Similarly, 'Burial', despite a specific and modest land category, often has a conspicuous tree presence contributing to the urban fabric (21% of the total land-use).

Strengths & weakness critique of adopting each land-use category

- **BURIAL** Despite being a specific and limited land category, religious sites often have a notable tree presence that enhances the urban landscape. Nationally, nearly a quarter of graveyards and cemeteries are canopied with trees. Overall it only contributes 1% to the national average but in Cardiff, for example, it provides 2%. Analysis is only as good as the data available. St. David's, with its cathedral and priory grounds, did not register any 'Burial' cover.
- **COMMERCIAL** This included a wide range of business, retail and industrial parks. Arguably these varying commercial sites could be broken down further to assess differences, e.g. what is the extent of town centre retail and degree of cover? Despite the tight and challenging environment, tree cover makes a positive contribution to the town centre's ambience, providing comfort for shoppers and benefits to retailers in terms of increased spend. This environment is so different from an industrial site, yet has been included here within the same category.
- **EDUCATION** Whilst contributing only a modest 3% nationally, further investigation would hopefully reveal the extent of land that could accommodate canopy cover. In the 'Assessment of Potential Tree Planting' work, educational land in Cardiff has as much as 8% of the potential 'green' land available throughout the capital (playing fields etc would need to be subtracted).
- **REMNANT COUNTRYSIDE** A possible concern was that this category could include over-representation of 'agricultural land' along the urban boundary. With the two-thirds rule and the definition as being either common / rough ground, fields grazed by horses, or orchards, the 1% national figure appears to have kept a tight interpretation of this land. As 'agriculturally' managed land it is offering a distinct land-type to OSI or OSF.
- **HOSPITALS** The 1% canopy cover for Wales is not offering any notable contribution to the national breakdown. Its value would become more apparent at a finer grain of analysis, where specific hospital grounds offer potential.
- **FORMAL OPEN SPACE** As 'communal' land such as parks, with an obvious managed feel, OSF contributes a valuable 17%. Whilst broadly a clear and easily defined category, there is an argument that OSF green space around housing estates is more closely aligned to 'Residential High Density'. These social housing sites, often with significant swathes of grass, offer considerable potential to accommodate trees. Similarly 'civic' squares around public buildings would often be associated with town centre retail ('Commercial'), making the distinction of land-use difficult.
- **INFORMAL OPEN SPACE** OSI contributes 29% to urban canopy cover and not surprisingly is the main land-use contributor. Making the OSF and OSI distinction was relatively straightforward. However what did not always get included was NFI woodland. Whilst over two-thirds of OSI cover is NFI woodland, 1,321 hectares of NFI fell into the 'unclassified' land-use.
- **WOODLAND** This category was created at the analysis stage to account for the outstanding 1,321 hectares identified within the 'unclassified' land-use. Further analysis, beyond what MasterMap could offer, would be needed to confirm whether these woods are located within OSI or an alternative land-use.
- **HIGH-DENSITY & LOW-DENSITY RESIDENTIAL** The Phase 1 contractors, in their report, highlighted the approach to distinguishing between high and low-density over and above the <0.01ha/>0.01ha rule:
 "High and low density residential areas were assigned automatically based upon garden size in OS MasterMap. This method provided reproducible results with a reasonable level of accuracy.

However the results were highly dependent on the layout of gardens surrounding a house [as in Figure 69].

1. Terraced housing automatically split the front and rear gardens into two separate smaller polygons which had a high chance of being classified as high density due to their area.
2. Semi-detached housing had a higher chance of being classed as low density even when the total garden was the same as neighbouring terraced housing because the gardens fell into a single polygon.
3. End-of-terrace houses were often classified as low density because the gardens normally extended around three sides of the house (right) leading to a larger single polygon".





Figure 69: Examples of automatic residential classification (orange - high, green - low); extended semi-detached (left) and end-of-terrace (right).

Whilst expecting the RHD% to be low, these figures are particularly low. The capture approach is sound and logical. It just means that many suburban and end-of-terrace gardens, that might be deemed to fall into a high-density environment, are in actual fact falling into the RLD category.

Further analysis of the data here would reassure that the methodology and findings are sound. In particular it would be useful to confirm as to whether the threshold of $>$ and <0.01 ha is a reasonable distinction between the residential classes.

- **TRANSPORT CORRIDORS**

The inclusion of TRN and its 8% contribution to cover across Wales has justified its presence as a category. This was a category that was not repeated in the *Trees in Towns II* study following its relatively low presence in England's earlier 1993 study. Reasons for this possibly are, a) the sample plot approach did not fairly reflect what was actually on the ground, or b) data wasn't sufficiently identifying TRN in the early '90s.

Whilst trees along distinct road and rail corridors are picked up, there doesn't seem to be the same consistency when it comes to more detailed 'street tree' locations. Here, through the datasets, trees would often be allocated to neighbouring land-uses. The Phase 1 contractor stated that transport was given if a choice had to be made. As to whether this is an issue, further exploration would be needed.

A2.4 Cross-referencing with environmental, social and economic datasets

This study primarily concentrates at looking at the Welsh Index of Multiple Deprivation as a dataset that can be cross-referenced with the canopy cover findings.

Exploring the relationship of canopy cover and other datasets in the future would be well worth considering. This could look at specific topic areas such as air quality, temperature ('heat-island') data, flood-risk management, wildlife connectivity, property values, access to green space, and levels of crime.



A2.4.1 Welsh Index of Multiple Deprivation 2011 (WIMD)

The study's principle objective has been to establish what canopy cover exists across Wales and suggest where to target new planting. Cross-referencing the study's findings with the Welsh Index of Multiple Deprivation 2011 offers an obvious first 'port of call' to identify those communities and wards in most need of action.

All told, there are as many as 200 wards (LSOAs) in the top 1-190 WIMD Category and 613 in the top three 1-570 Categories, and all are arguably deserving of analysis.

Directly linked to the WIMD classification are the Communities First Clusters. These 52 clusters offer a more manageable approach to presenting the findings for this study. As a rule they include wards at the higher end of the WIMD spectrum (1-380).

Clearly there are other high WIMD category wards that need scrutiny as to their need for greater canopy cover. Further analysis is required therefore at national and local level to highlight additional wards with low cover.

A2.5 Assessing the potential for tree planting

One town per local planning authority (22 counties and three National Park Authorities) has been selected. These are either the main or one of the major county towns. It was decided that one town for each of the seven Welsh Government regeneration areas (as were in 2011) needed to be represented, hence the addition of Ammanford. Tenby, Brecon and Dolgellau represent the three national parks. Gorseinon was included as a low canopy cover town falling within the County of Swansea – giving a total of 27 urban areas.

As highlighted in 5.1, current datasets available preclude identifying potential 'grey/impervious' land for potential canopy estimation as, say, is identified in the US bar-chart for the town of Cumberland, Figure 70. This potential 'plantable' category includes surfaces such as pavements, pedestrianised areas, roundabouts, central reservations etc. All offer important opportunities for trees within an environment in particular need of increased greening and canopy cover.

As a first step, support for this approach of analysing what land could be targeted for increased canopy cover is needed from across local and national government. Additional resources could then be assigned to refine this technique further.

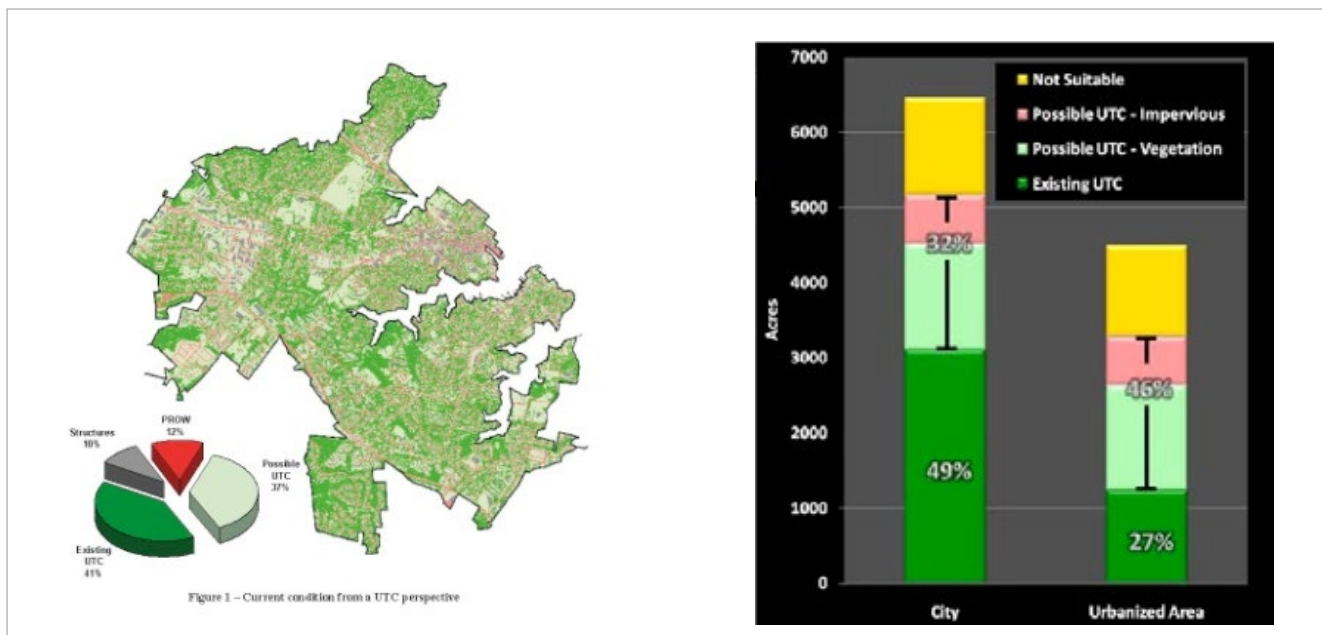


Figure 70: US example - Cumberland, Maryland; 1) spatially showing existing and potential cover and 2) quantifying potential impervious and 'green' vegetated areas for planting.





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