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Urban Vegetation Cover Change in Melbourne

2014 — 2018

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This report is an update to the report initially released in July 2019. The original 2014 vegetation data had some areas of incorrect vegetation height classification, which resulted in the over reporting of trees. This report is based in revised 2014 data which has corrected the height classification issue.

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1. INTRODUCTION

This report presents a descriptive analysis of vegetation cover change between 2014 and 2018 in Melbourne, Australia. The project sits within a broader research context, under the “Making greening happen in consolidating cities” project of the Clean Air and Urban Landscapes (CAUL) research hub of the Australian Government’s National Environmental Science Program. The project is a collaboration between RMIT University, The University of Western Australia, CSIRO and the Victorian Government Department of Environment, Land, Water and Planning (DELWP) as part of the “Cooling and Greening Melbourne” work for Plan Melbourne 2017-2050.

The goal of this research project is to understand the spatial distribution of urban vegetation and the relationship to land-use. The data assembled can support further investigation of the impacts of urban development on vegetation cover and the potential mediating role of land-use planning interventions in this. This report focuses on the extent and change in the spatial distribution of vegetation across Melbourne between 2014 and 2018, reported against major land-use classes and against metropolitan sub-regions. To do this the research integrates high resolution urban vegetation coverage (including canopy cover and total vegetation) at a modified Mesh Block level for two years – 2014 and 2018; with land-use information derived from ABS Mesh Block attributes.

2. APPROACH

2.1 OVERVIEW

The goal of this research project is to understand the extent and distribution of vegetation cover change in Melbourne and the relationship between vegetation change and land-use categories. To do this the project has produced several new primary and secondary datasets. We combine high resolution urban vegetation coverage data (including canopy cover and total vegetation) for two different time-points – 2014 and 2018; with land-use data derived from ABS Mesh Block attributes and Victorian government data on cadastral parcels and road casements. The result is a vector dataset with significant coverage of the Melbourne Metropolitan area that enables spatial analysis of the relationship between vegetation cover, vegetation change and land-use characteristics.

2.1 DATA SUMMARY

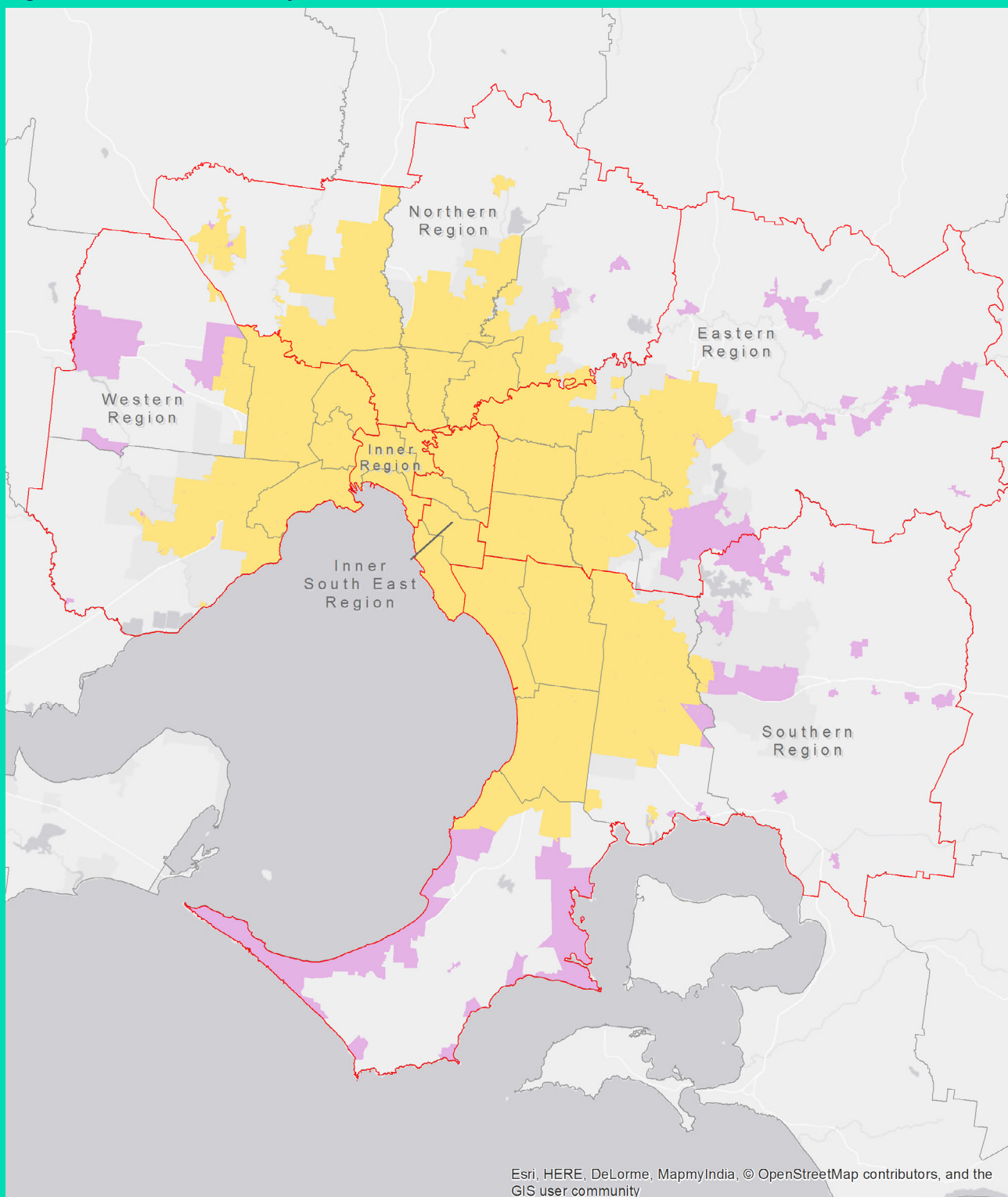
The vegetation structure data was produced using The Commonwealth Scientific and Industrial Research Organisation's (CSIRO) Urban Monitor® approach (Caccetta et al, 2016). Monitoring land surface and cover in urban and peri-urban environments using digital aerial photography. This provides a three-dimensional representation of the spatial distribution of vegetation at 20-centimetre resolution. Vegetation cover was grouped into five height classes: grass (0-0.5m, shrub (0.5 - 3m, small tree (3 - 10m, medium tree (10 - 15m, and large tree (15m+. The Urban Monitor® data used as the basis of this study was provided in ERS raster format with a 0.2m cell size.

For the purposes of this study, Urban Monitor® data were available for a geographical area covering the majority of the urban area of Metropolitan Melbourne. Coverage was limited to the extent of State Government acquired aerial imagery, which is the primary data required for the Urban Monitor® approach. Data covering approximately 674,000 ha were available for 2018, however a smaller area of coverage was available for 2014. This report focuses on vegetation change from 2014 to 2018 and subsequently the study area considers only areas for which data were available for both 2014 and 2018, limited to urban areas, defined by ABS Urban Centres and Localities (UCLs) (348,000 ha (see Figure 1). This amounts to approximately 87 billion cells of data. Observations in this report should therefore not be compared with summaries of the full 2018 or full 2014 data extent, as they cover different study areas. In particular, it should be noted that the additional urbanised area covered in 2018 (see Figure 1), includes large areas in the outer east and the Mornington Peninsula, which are associated with significantly higher than average tree cover. For this reason, the average 2018 metropolitan tree cover in the study area (13.4% is lower than the metropolitan tree cover for the full extent of the 2018 urbanised area data (15.3%).

In terms of this report, the emphasis is on vegetation within urban areas as defined as urban centres and localities (UCLs in the ABS Census 2016. Within the study area, the modified ABS Mesh Block is the smallest unit of measurement to derive measures of vegetation by land use. The land-use data was produced by combining ABS Mesh Block features (and associated land-use attributes with cadastral parcels and road casements. GIS processing of these datasets has produced a new space-filling partition of land-use characteristics in Melbourne – referred to as a modified Mesh Block. The principal advantage of this partition is that it allows the street network to be separated out from parcelled land.

For the purposes of measuring vegetation change between 2014 and 2018, Geographical Information Systems software was used to perform zonal statistics on this data, aggregating vegetation measures across 141,095 modified Mesh Block features.

Figure 1 - Data Extent and Study Area



National Environmental Science Programme



0 4.5 9 18 Kilometers

Legend

- Urban Areas Not Included in 2014 to 2018 Change Statistics*
- Urban Areas Included in 2014 to 2018 Change Statistics*
- Regions
- Local Government

Note: Urban Areas - based on ABS urban centres and localities

2.3 DEFINITION OF TERMS

Vegetation classification

The Urban Monitor® methodology for measuring vegetation data uses proprietary techniques derived by CSIRO Australia to identify the presence or absence of reticulated vegetation within any given cell. Allied to the ability to identify the presence of vegetation, the Urban Monitor® uses stereo photogrammetry to compare the height of identified vegetation through a digital surface model relative to a ground elevation model to provide an estimate of vegetation height (Caccetta et al, 2016).

Whilst the Urban Monitor® provides an accurate indication of the presence and height of vegetation, it is not able to identify specific typologies of vegetation, subsequently, for the purposes of this analysis we have adopted a vegetation height-based classification to describe different vegetation typologies. This approach uses the terms grass, shrubs and trees to describe vegetation with heights of less than 0.5m, 0.5 to 3m and over 3m respectively (Table 1).

Table 1 - Vegetation Typologies

Vegetation Typology	Definition
Grass	Vegetation height: $0 < 0.5\text{m}$
Shrubs	Vegetation height: $0.5\text{m} < 3.0\text{m}$
Trees	Vegetation height: $> 3.0\text{m}$
Total Vegetation	Any vegetation $> 0\text{m}$ high

When examining change over time using the Urban Monitor® derived vegetation cover data it is important to note the limitations in detecting grass cover for this method. Grass and ground cover detection is impacted by vegetation vigour, with dry and dormant cover being difficult to detect. This means there can be significant fluctuations in cover based on recent rainfall activity at the time of aerial imagery capture. This makes comparison over time difficult. For this reason, the two-date analysis in this report largely focuses on tree canopy cover ($> 3.0\text{m}$ and shrub cover ($0.5\text{m} < 3.0\text{m}$).

Mesh Blocks

Mesh Blocks are the smallest geographic unit compiled by the ABS as part of the Australian Statistical Geography Standard (ASGS). Mesh Block based geometries were first introduced in 2006 and provide a unit of measurement that is designed to accommodate approximately 30 to 60 dwelling units. Mesh Blocks can vary in size, but are generally relatively small in size, especially in urbanised areas. They form the building blocks of all other statistical geographies. From 2016 Mesh Blocks have been designed to align closely to local government boundaries. Mesh Blocks are attributed with a principal land use to indicate the major land use within any given delineated area (Table 2). For further information see ABS Cat: 1270.0.55.001

Modified Mesh Block

A modified Mesh Block is a unit of measurement designed by the CAUL Hub that incorporates linear infrastructure into the ABS Mesh Block structure based on Victorian cadastral and road/rail easement boundaries. The modified Mesh Block Structure works in a hierarchical manner with each feature retaining the original Mesh Block category and also being allocated a reclassified Mesh Block Code identifying whether the land in question is a lot or an infrastructure corridor (Figure 2 and Table 3). This allows an additional land class ('Infrastructure') to be designated in addition to the ABS categories, allowing all infrastructure corridors (largely streets, but also rail) to be identified.

Public and Private Realm

The modified Mesh Block reclassification is also allocated an attribute of either 'public realm' or 'private realm' (Table 3). The private realm is assumed to include all residential, commercial, industrial and primary production land, excluding the

linear infrastructure networks within these categories. The public realm includes all the linear infrastructure networks from the ABS Mesh Block categories, plus the categories of parkland, education; hospital and/or medical, transport and water. It is acknowledged that this split will only approximate public land ownership/management as many of these service categories include privately owned and managed land. In this public/private designation, land classed as 'Other' by ABS remains as 'Other' (except for infrastructure networks within the class, which are added to 'public').

Table 2 - Mesh Block Based Land Use

Mesh Block Category	Description
Residential	Generally, residential areas have been separated from other land uses. Residential Mesh Blocks can include houses, duplexes, apartments, serviced/long stay apartments, townhouses, gated communities, complexes, caravan parks, retirement villages, military bases where people live, and prisons.
Commercial	Mesh Blocks categorised as commercial will contain a number of businesses, and where possible, will have a zero population count. Some commercial Mesh Blocks may contain population, for example, where a residential flat is above a shop.
Industrial	Mesh Blocks categorised as industrial will contain a number of businesses, and where possible, will have a zero population count.
Parkland	Mesh Blocks with parkland, nature reserves and other minimal use protected or conserved areas have been categorised as Parkland. Parkland Mesh Blocks may also include any public open space and sporting arena or facility whether enclosed or open to the public, including racecourses, golf courses and stadiums.
Education	Education Mesh Blocks aim to capture education facilities and may contain population in non-private dwellings such as boarding schools or universities.
Hospital and/or Medical	Mesh Blocks with hospital or medical facilities have been classified as such. Hospital/Medical Mesh Blocks will also include aged care facilities, which are independent to larger retirement villages.
Transport	Mesh Blocks which only contain road or rail features have been categorised as transport.
Other	Mesh Blocks classified as other are representative of land uses which could not be easily placed in one of the other nine categories due to the nature of the land use, or due to evidence of high mixed use.
Water	Water Mesh Blocks aim to identify water bodies where possible.
Primary Production	Primary production has replaced the previous category of agricultural. Mesh Blocks categorised as primary production must have more than 50 per cent of their area attributed to a primary production land use, and has been categorised as this using a range of available datasets. Mesh Blocks which were previously categorised as agricultural and did not meet this criteria were categorised as other.

Source: ABS Cat: 1270.0.55.001

Figure 2 - Mesh Block to Modified Mesh Block

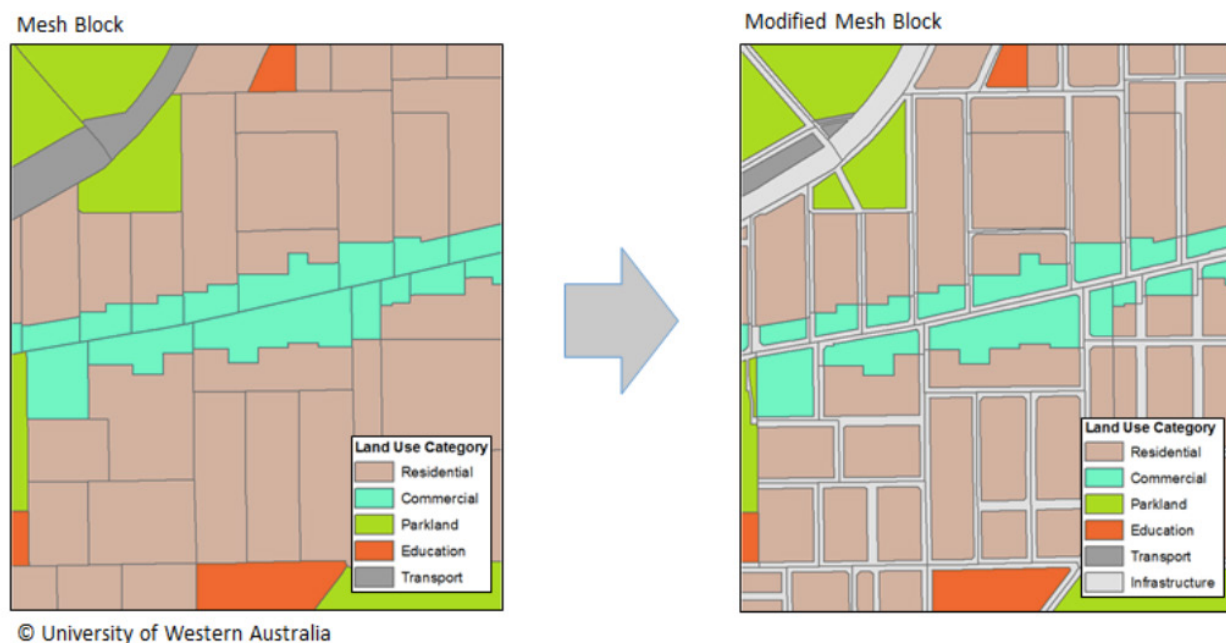


Table 3 - Modified Mesh Block Based Land Use

Mesh Block Category	Mesh Block Reclassification	Description	Land Type
Residential	Residential	Land made up of Residential lots	Private
	Infrastructure	Linear infrastructure in residential areas	Public
Commercial	Commercial	Land made up of Commercial lots	Private
	Infrastructure	Linear infrastructure in commercial areas	Public
Industrial	Industrial	Land made up of Industrial lots	Private
	Infrastructure	Linear infrastructure in industrial areas	Public
Parkland	Parkland	Parkland	Public
	Infrastructure	Linear infrastructure in parkland areas	Public
Education	Education	Education land	Public
	Infrastructure	Linear infrastructure in education areas	Public
Hospital/ Medical	Hospital/Medical	Hospital/medical land	Public
	Infrastructure	Linear infrastructure in hospital/medical areas	Public
Transport	Transport	Transport land (major transport infrastructure)	Public
	Infrastructure	Linear infrastructure in transport areas	Public
Other	Other	Other lots	Other
	Infrastructure	Linear infrastructure in other areas	Public
Water	Water	Water bodies (minimal)	Public
	Infrastructure	Linear infrastructure around water bodies	Public
Primary Production	Primary Production	Land made up of Primary production lots	Private
	Infrastructure	Linear infrastructure in primary production areas	Public

Locational definitions

Urban Centres and Localities: Urban Centres and Localities (UCLs) represent areas of concentrated urban development with populations of 200 people or more. These areas of urban development are primarily identified using objective dwelling and population density criteria using data from the 2016 Census.

ABS Cat. 1270.0.55.004

Data Coverage

The term data coverage is used to describe the proportion of any given vector feature in the Modified Mesh Block dataset for which valid Urban Monitor® data was available. For the purposes of this analysis and report only features with over 90% data coverage were included in descriptive statistics. Overall 138,790 modified Mesh Block features are included in this analysis. All these features had at least 90% data coverage, with 96.3% of these having over 99% data coverage.

Study area

The focus of this report is to provide summary statistics for vegetation change across the urbanised area of Melbourne Metropolitan Region for which vegetation cover data exists for both 2014 and 2018. The study uses ABS ASGS statistical geographies defined as areas located within ABS defined Urban Centres and Localities. The study provides a Metropolitan level summary; and six regional summaries for the metropolitan sub-regions of Melbourne.

Given the focus on urbanised areas, for several of the regions statistics generated relate to only a subset of their whole area. Allied with limitations of data coverage, this means that the reported statistics are limited to the portion of each region that is defined as urbanised and for which high levels of data coverage is available. A summary of the data coverage is provided in Table 4. The Inner and Inner South East have complete data cover; while the Western, Northern, Eastern and Southern regions have extensive coverage, but are all missing coverage of some fringe urban areas (Figure 1).

Table 4 - Percentage Data Coverage by Region

Region	Region Area (ha)	Percentage of Region Urbanised	Percentage of Urbanised Area covered in Study
Inner	7,760	100%	100%
Inner South East	16,172	100%	100%
Western	133,196	40%	83%
Northern	159,276	36%	99%
Eastern	204,565	33%	79%
Southern	276,594	35%	68%
Overall	797,564	37%	82%

3. RESULTS

3.1 METROPOLITAN MELBOURNE

Comparison of the 2014 and 2018 vegetation cover across the study area reveals an overall vegetation cover change from 95,004 ha to 95,104 ha; representing a stable vegetation cover of 39.3% . However, variation in detection of grass cover makes this overall figure an unreliable measure of change. Comparison of the 2014 and 2018 combined tree and shrub cover across the study area reveals an overall change of 47,615 ha to 46,332 ha; representing a change from 19.7% to 19.2 % cover and a loss of 0.5 percentage points (or 1,283 ha). For tree cover alone the change is from 32,980 ha to 32,295 ha; representing a change from 13.6% to 13.4% cover and a loss of 0.3 percentage points (or 685 ha) (due to data rounding values do not sum).

Table 5 compares the tree cover and tree cover change across the six regions; and Figure 3 provides a visual presentation of the distribution of tree canopy loss and gain. Together they show that:

- Across the Inner, Western and Northern regions we see areas of stagnant tree cover and of moderate increase; with few occurrences of loss.
- Across the Eastern region, Inner South East, and Southern region we see more extensive areas of average tree cover loss. This is most extensive across the Eastern region. The losses here are highest on residential lots, with losses also on parkland and streets trees, as well as on other land classes. These areas of Melbourne are typically where the baseline vegetation cover is high compared to the Melbourne average.

Table 5 - Tree Canopy Cover and Cover Change in Urbanised Areas by Region

Region	Tree Canopy Cover 2014 (ha)	Tree Canopy Cover 2018 (ha)	Tree Canopy Loss/gain 2014 - 2018 (ha)	Tree Canopy Cover 2014 (%)	Tree Canopy Cover 2018 (%)	Tree Canopy Percentage Point Change 2014 - 2018
Inner	915	981	65	11.8%	12.6%	0.8%
Inner South East	2,952	2,821	131	18.3%	17.4%	-0.8%
Western	2,206	2,573	367	5.0%	5.8%	0.8%
Northern	6,180	6,546	366	11.0%	11.7%	0.7%
Eastern	13,103	11,900	1,202	24.9%	22.6%	-2.3%
Southern	7,625	7,474	151	11.7%	11.5%	-0.2%
Metro wide (Total)	32,980	32,295	686	13.6%	13.4%	-0.3%

Table 6, Table 7 and Table 8, along with the charts in Figure 4, present vegetation loss and gain across the whole study area against land-use categories and vegetation type.

Based on 2018 figures, residential land provides the largest area of vegetation cover and of tree cover across the study area (38,689 ha of vegetation cover; of this 15,165 ha is tree cover). Between 2014 and 2018 residential land experienced the largest amount of tree canopy loss in absolute terms (737 ha) and the largest amount of combined shrub and tree loss (1,306 ha). In percentage tree cover, this is a change from 15.0% cover in 2014 to 14.3% cover in 2018, a loss of 0.7 percentage points. Considering combined tree and shrub cover, we see a change from 23.4% cover in 2014 to 22.2% cover in 2018, a loss of 1.2 percentage points.

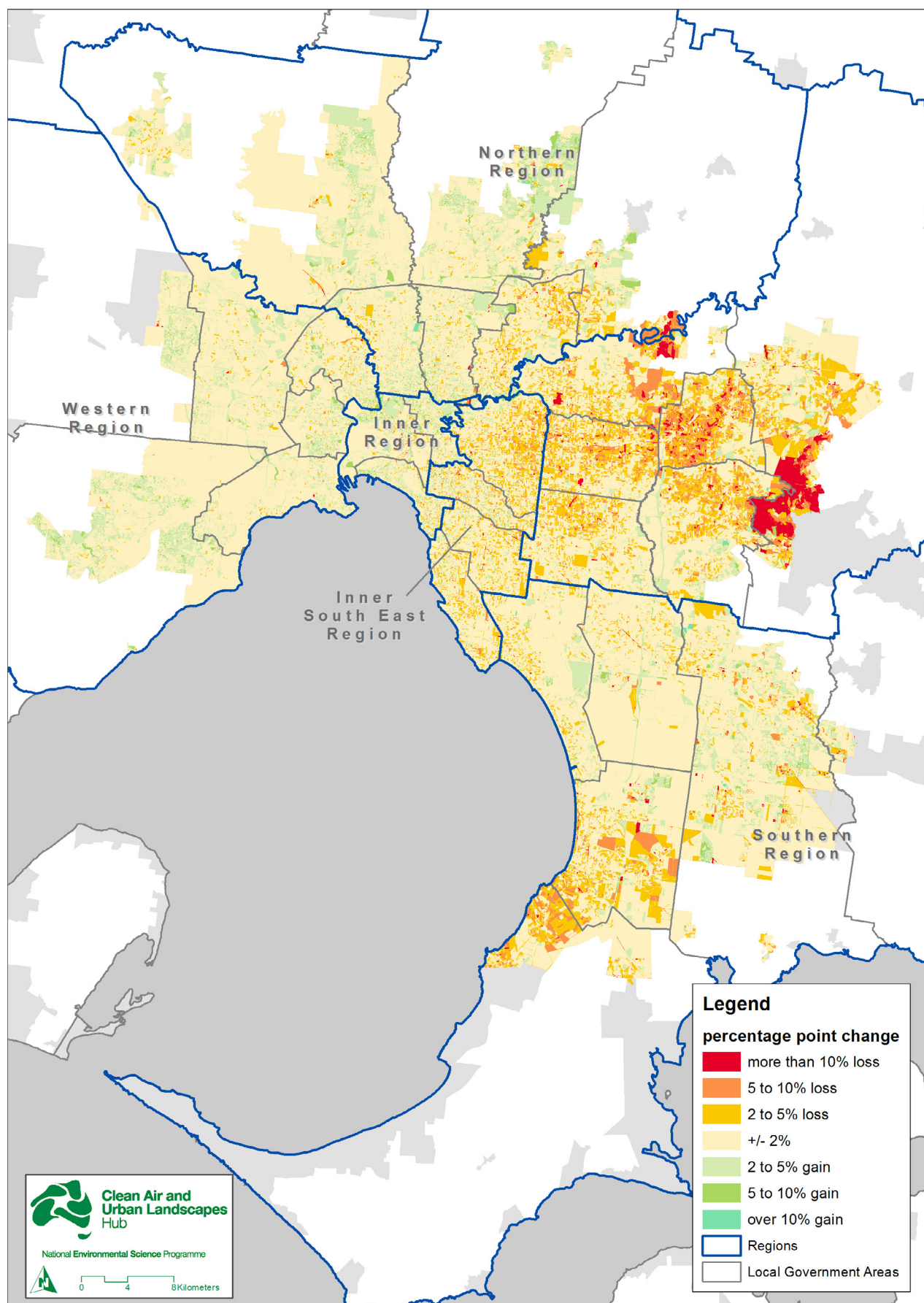
Based on 2018 figures, parkland provides the second largest area of vegetation cover and of tree cover across the study area (20,217 ha of vegetation cover; of this 6,608 ha is tree cover). Between 2014 and 2018 parkland experienced the second largest amount of tree canopy loss in absolute terms (158 ha) and the second largest amount of combined shrub and tree loss (222 ha). In percentage tree cover, this is a change from 21.1% cover in 2014 to 20.6% cover in 2018, a loss of 0.5 percentage points. Considering combined tree and shrub cover, we see a change from 27.6% cover in 2014 to 26.9% cover in 2018, a loss of 0.7 percentage points.

Based on 2018 figures, infrastructure land (largely the street network) provides the third largest area of vegetation cover and of tree cover across the study area (11,958 ha of vegetation cover; of this 5,364 ha is tree cover). Between 2014 and 2018 infrastructure land experienced a gain in tree canopy (229 ha) and in combined shrub and tree (240 ha). In percentage tree cover, this is a change from 13.3% cover in 2014 to 13.9% cover in 2018, a gain of 0.6 percentage points. Considering combined tree and shrub cover, we see a change from 17.3% cover in 2014 to 17.9% cover in 2018, a gain of 0.6 percentage points.

The fourth and fifth largest contributors to vegetation in the study are 'Other' and Primary Production land. These land classes are largely associated with the urban fringe and have a high proportion of grass cover. They both experienced limited loss of tree cover between 2014 and 2018. The other land use categories make minor (but not insignificant) contributions to metropolitan vegetation. On average, between 2014 and 2018 all remaining land-use categories experience limited change to tree cover.

When considering the overall Metropolitan study area, the change in tree cover and shrub cover is small, but negative. The extent of change varies considerably across the city; and varies depending on land-use type. Canopy loss is concentrated in areas where there is significant existing vegetation and significant urban re-development activity. Canopy gain is concentrated in areas where there is limited existing vegetation. Loss is most evident on residential land; while gain is most evident on the street network.

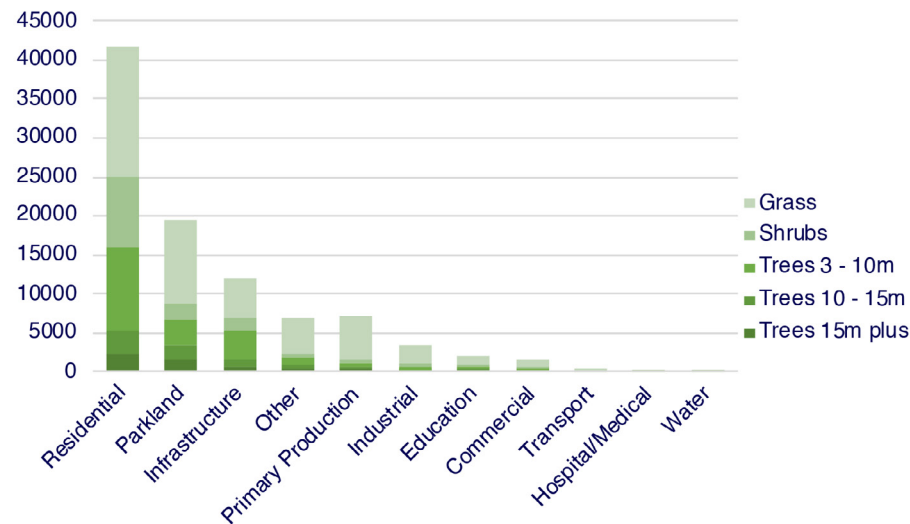
Figure 3 - Tree Cover Change in Melbourne



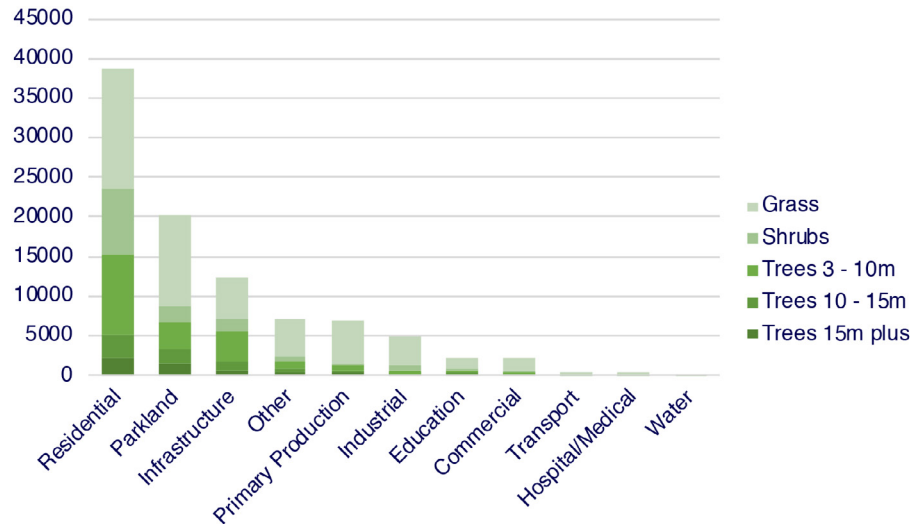
Study area limited to urban areas (ABS urban centres and localities) and by data availability

Figure 4 - Summary Charts of Metropolitan Melbourne Vegetation Cover Change 2014-2018

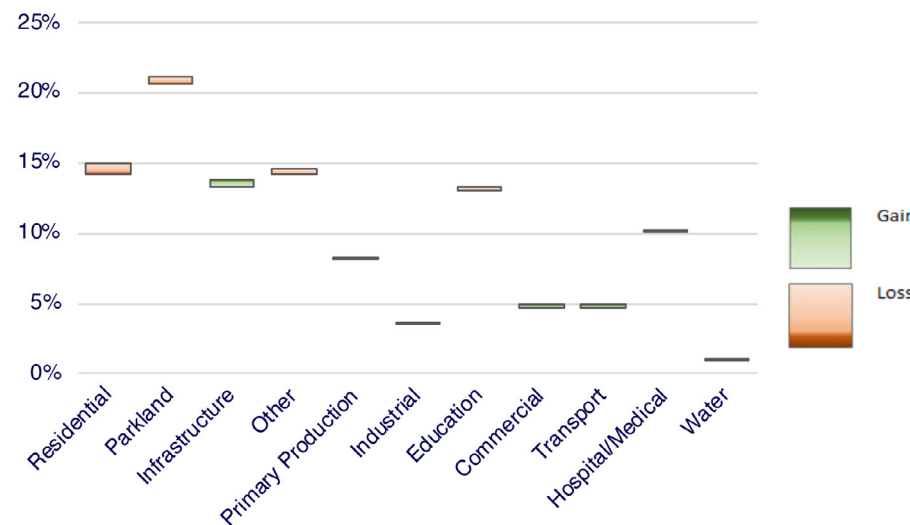
Vegetation by Land Use (ha) - 2014



Vegetation by Land Use (ha) - 2018



Cover and Change 2014 - 2018 Tree Cover



Cover and Change 2014 - 2018 Tree + Shrub cover

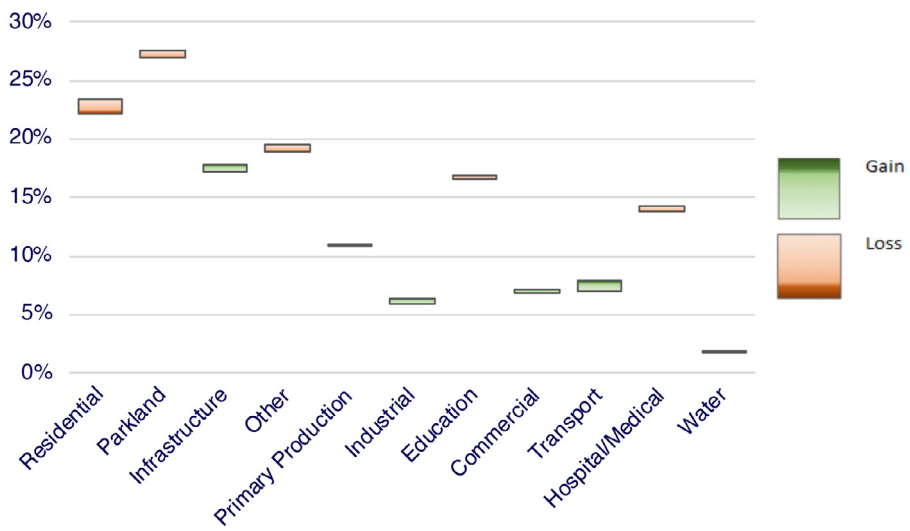
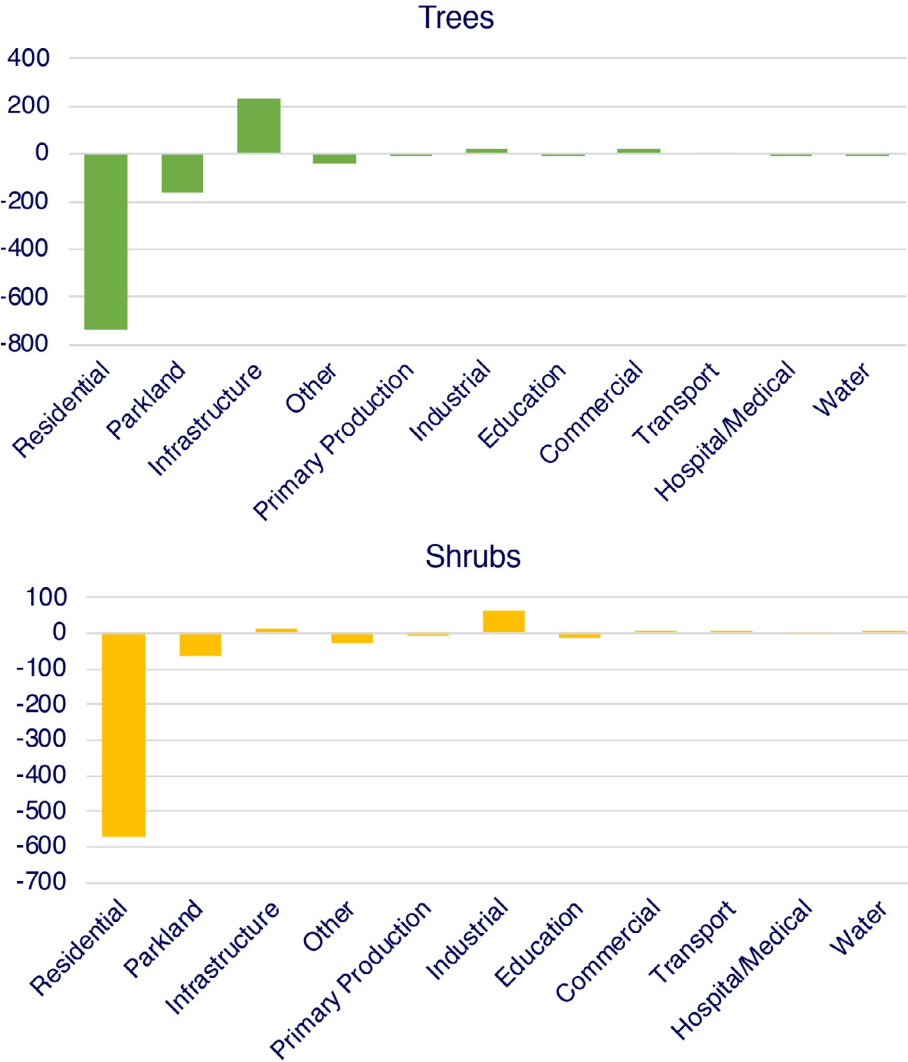
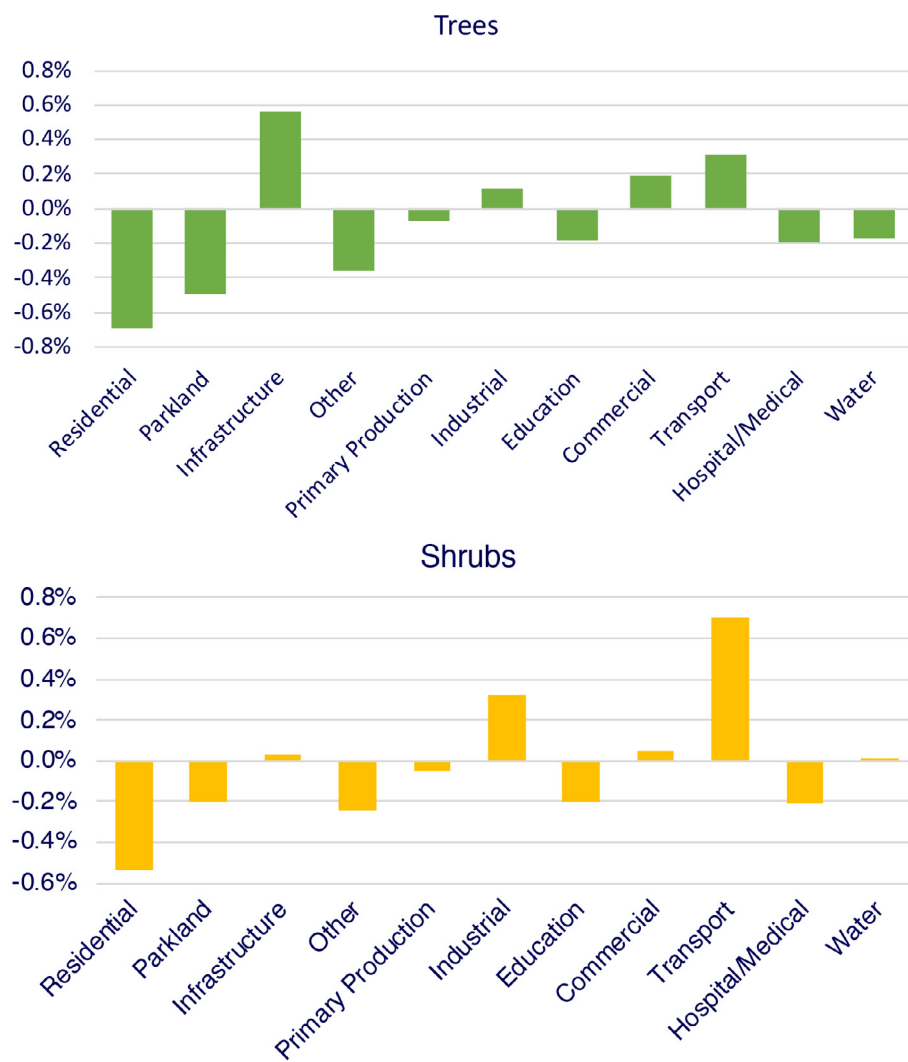


Figure 4 (continued) - Summary Charts of Metropolitan Melbourne Vegetation Cover Change 2014-2018

Change in Vegetation by Land Use (ha)



Percentage Point Change in Vegetation by Land Use



Notes:

Study area limited to urban area (ABS urban centres and localities) and by data availability.

Table 6 - Metropolitan Melbourne Total Vegetation Cover in Urbanised Areas

Land Use	Vegetation Cover 2014 (ha)	Vegetation Cover 2018 (ha)	Vegetation Loss/gain 2014 - 2018 (ha)	Vegetation Cover 2014 (%)	Vegetation Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	41,674	38,689	-2,985	39.2%	36.4%	-2.8%
Parkland	19,526	20,217	691	60.9%	63.1%	2.2%
Infrastructure	11,958	12,358	401	29.6%	30.6%	1.0%
Other	7,014	7,093	79	57.7%	58.3%	0.6%
Primary Production	7,085	6,999	-86	49.7%	49.1%	-0.6%
Industrial	3,538	4,866	1,328	18.3%	25.2%	6.9%
Education	2,156	2,198	42	39.4%	40.2%	0.8%
Commercial	1,651	2,133	482	16.6%	21.4%	4.8%
Transport	287	431	144	24.8%	37.2%	12.5%
Hospital/Medical	95	97	1	23.8%	24.2%	0.3%
Water	20	24	3	4.6%	5.4%	0.8%
Grand Total	95,004	95,104	100	39.3%	39.3%	0.0%

Table 7 - Metropolitan Melbourne Combined Shrub & Tree Canopy Cover in Urbanised Areas

Land Use	Tree and Shrub Cover 2014 (ha)	Tree and Shrub Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree and Shrub Cover 2014 (%)	Tree and Shrub Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	24,924	23,618	-1,306	23.4%	22.2%	-1.2%
Parkland	8,849	8,627	-222	27.6%	26.9%	-0.7%
Infrastructure	6,972	7,213	240	17.3%	17.9%	0.6%
Other	2,375	2,302	-73	19.5%	18.9%	-0.6%
Primary Production	1,580	1,563	-17	11.1%	11.0%	-0.1%
Industrial	1,156	1,240	84	6.0%	6.4%	0.4%
Education	928	906	-21	17.0%	16.6%	-0.4%
Commercial	685	708	23	6.9%	7.1%	0.2%
Transport	81	93	12	7.0%	8.0%	1.0%
Hospital/Medical	57	55	-2	14.3%	13.9%	-0.4%
Water	9	8	-1	2.0%	1.8%	-0.2%
Grand Total	47,615	46,332	-1,283	19.7%	19.2%	-0.5%

Table 8 - Metropolitan Melbourne Tree Canopy Cover in Urbanised Areas

Land Use	Tree Cover 2014 (ha)	Tree Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree Cover 2014 (%)	Tree Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	15,901	15,165	-737	15.0%	14.3%	-0.7%
Parkland	6,766	6,608	-158	21.1%	20.6%	-0.5%
Infrastructure	5,364	5,593	229	13.3%	13.9%	0.6%
Other	1,770	1,727	-43	14.6%	14.2%	-0.4%
Primary Production	1,185	1,175	-10	8.3%	8.2%	-0.1%
Industrial	696	718	22	3.6%	3.7%	0.1%
Education	727	717	-10	13.3%	13.1%	-0.2%
Commercial	472	490	19	4.7%	4.9%	0.2%
Transport	54	57	4	4.6%	4.9%	0.3%
Hospital/Medical	41	40	-1	10.3%	10.1%	-0.2%
Water	5	4	-1	1.1%	1.0%	-0.2%
Grand Total	32,980	32,295	-686	13.6%	13.4%	-0.3%

3.2 INNER REGION

Comparison of the 2014 and 2018 vegetation cover across the Inner region reveals the following cover change:

- Overall vegetation cover change of 1,842 ha to 2,077 ha; representing a change from 23.7% to 26.8% vegetation cover, an increase of 3.0 percentage points (or 235 ha).
Note: this change is likely affected by the impact of rainfall and irrigation patterns on grass cover at the time of aerial imagery capture.
- Combined tree and shrub cover change of 1,175 ha to 1,268 ha; representing a change from 15.1% to 16.3% cover, an increase of 1.2 percentage points (or 93 ha).
- Tree cover change of 915 ha to 981 ha; representing a change from 11.8 % to 12.6 % cover, an increase of 0.8 percentage points (or 65 ha).

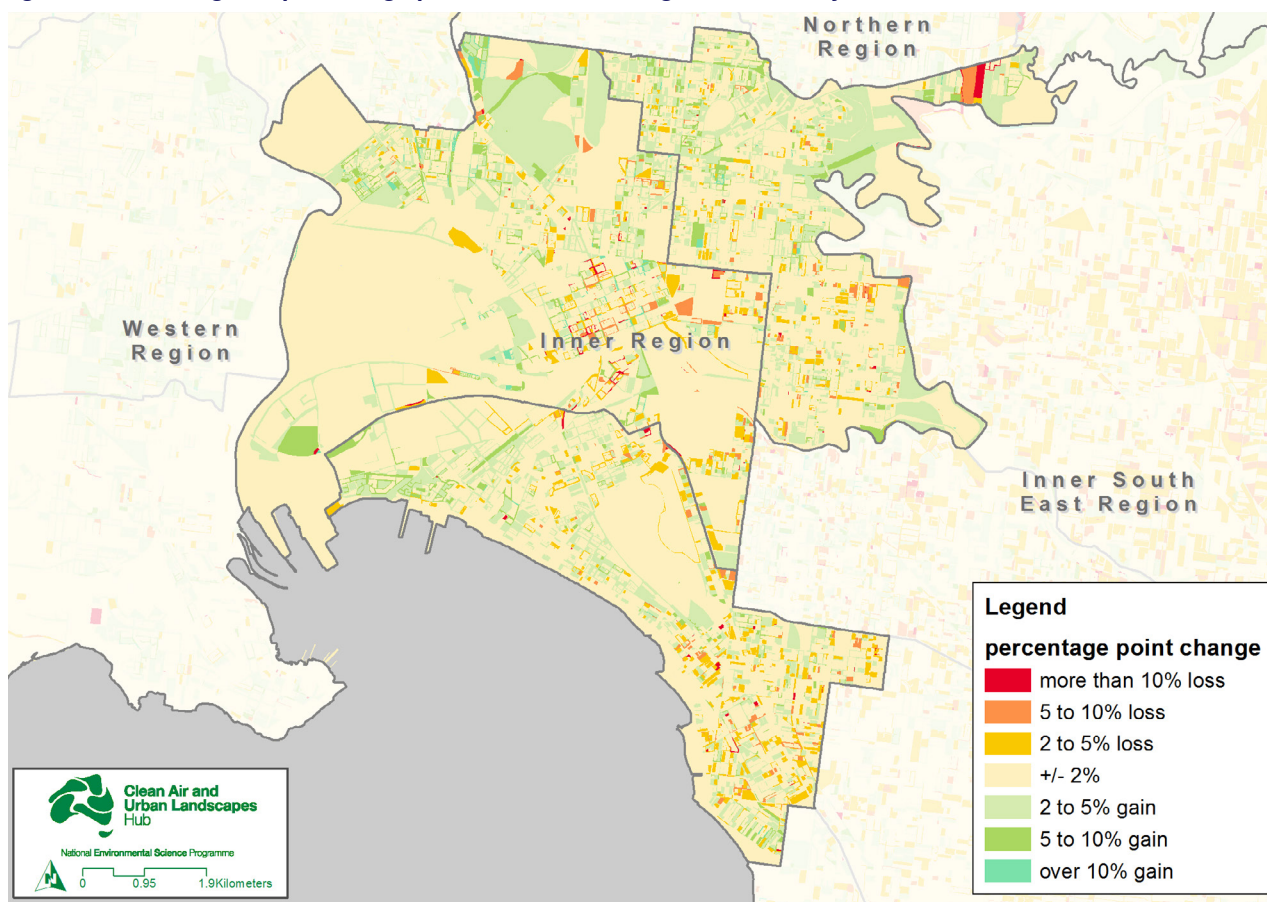
Figure 5 presents the spatial distribution of tree canopy loss and gain, and summary charts of the change in vegetation cover by land-use categories for the Inner region. Table 9, Table 10 and Table 11 present vegetation loss and gain across the Inner region against land-use categories and vegetation type.

When considering vegetation cover change between 2014 and 2018 in the Inner region we note:

- A mixed distribution of areas of loss and gain, with more areas of gain evident. There are some notable pockets of loss, including selected streets in the Central Business District; the redevelopment of the Alphington paper mill (eastern edge of the area); and in the southern suburbs of Port Phillip City Council (southern edge of the area).
- Parkland provides the largest area of tree cover in 2018 (334 ha). Tree cover on parkland changes from 20.9% to 22.2%, an increase of 1.4 percentage points (or 18 ha) (due to data rounding values do not sum). Combined tree and shrub cover on parkland changes from 25.8% to 28.0%, an increase of 2.2 percentage points (or 34 ha).
- Infrastructure land (primarily streets) provides the second largest area of tree cover in 2018 (308 ha). Tree cover on infrastructure land changes from 13.8% to 14.9%, an increase of 1.2 percentage points (due to data rounding values do not sum) (or 24 ha). Combined tree and shrub cover on infrastructure land changes from 16.0 % to 17.4 %, an increase of 1.4 percentage points (or 29 ha).
- Residential land provides the third largest area of tree cover in 2018 (232 ha). Tree cover on residential land changes from 11.5% to 12.2%, an increase of 0.7 percentage points (or 13 ha). Combined tree and shrub cover on residential land changes from 17.1% to 17.8%, an increase of 0.7 percentage points (or 14 ha).
- In absolute terms, the contribution of the remaining land use categories in the Inner region are small by comparison, however they all experience stable or slight increases in shrub and tree cover. While small in area, the percentage of education land with tree cover is higher in this region than any other region (17.8% tree cover in 2018; Melbourne average is 13.1% in 2018).

When considering the Inner region, we see a relatively even distribution of areas of loss and gain across the region. On average, all land-use categories saw small percentage point gains, which is counter to the metropolitan trend. Parkland is the largest contributor of trees, followed by streets, then residential, which contrasts with most of the metropolitan area, where residential provides the largest contribution, followed by parks then streets.

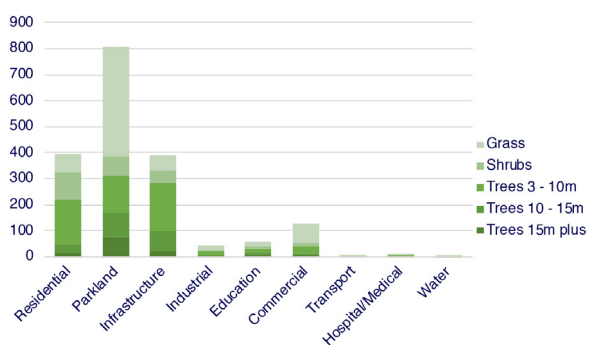
Figure 5 - Inner Region - percentage point tree cover change 2014-2018 by modified mesh block



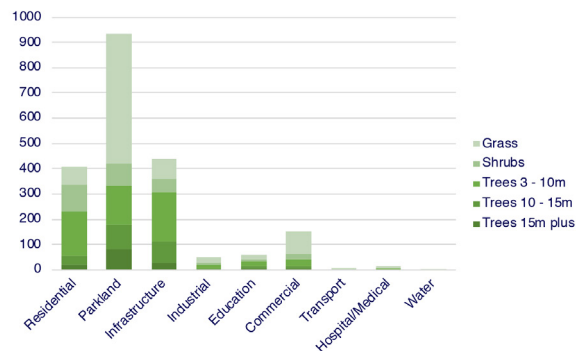
Study area limited to urban areas (ABS urban centres and localities) and by data availability

Inner Region

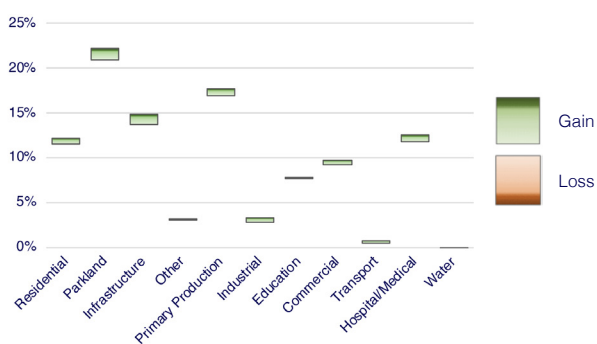
Vegetation by Land Use (ha) - 2014



Vegetation by Land Use (ha) - 2018



Cover and Change 2014 - 2018 Tree Cover



Cover and Change 2014 - 2018 Tree + Shrub Cover

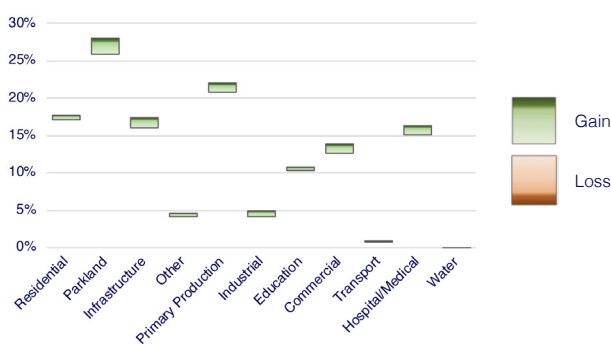


Table 9 - Inner Region Total Vegetation Cover in Urbanised Areas

Land Use	Vegetation Cover 2014 (ha)	Vegetation Cover 2018 (ha)	Vegetation Loss/gain 2014 - 2018 (ha)	Vegetation Cover 2014 (%)	Vegetation Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	395	411	16	20.7%	21.5%	0.8%
Parkland	806	935	129	53.6%	62.2%	8.6%
Infrastructure	393	441	49	19.0%	21.4%	2.4%
Industrial	44	53	9	7.0%	8.4%	1.4%
Education	60	60	0	32.7%	32.9%	0.2%
Commercial	126	154	28	9.5%	11.6%	2.1%
Transport	6	7	1	15.6%	18.1%	2.5%
Hospital/Medical	12	15	3	20.3%	25.3%	5.0%
Water	1	1	0	1.8%	1.7%	0.0%
Grand Total	1,842	2,077	235	23.7%	26.8%	3.0%

Table 10 - Inner Region Combined Shrub and Tree Canopy Cover in Urbanised Areas

Land Use	Tree and Shrub Cover 2014 (ha)	Tree and Shrub Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree and Shrub Cover 2014 (%)	Tree and Shrub Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	326	339	14	17.1%	17.8%	0.7%
Parkland	388	421	34	25.8%	28.0%	2.2%
Infrastructure	330	359	29	16.0%	17.4%	1.4%
Industrial	27	29	3	4.2%	4.6%	0.4%
Education	38	40	2	20.8%	22.0%	1.3%
Commercial	55	66	11	4.1%	4.9%	0.8%
Transport	4	4	0	10.3%	10.7%	0.4%
Hospital/Medical	7	8	1	12.6%	13.8%	1.3%
Water	0	0	0	0.8%	1.0%	0.2%
Grand Total	1,175	1,268	93	15.1%	16.3%	1.2%

Table 11 - Inner Region Tree Canopy Cover in Urbanised Areas

Land Use	Tree Cover 2014 (ha)	Tree Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree Cover 2014 (%)	Tree Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	220	232	13	11.5%	12.2%	0.7%
Parkland	314	334	21	20.9%	22.2%	1.4%
Infrastructure	285	308	24	13.8%	14.9%	1.2%
Industrial	19	20	1	3.1%	3.2%	0.1%
Education	31	32	1	17.0%	17.8%	0.8%
Commercial	38	44	5	2.9%	3.3%	0.4%
Transport	3	3	0	7.7%	7.9%	0.1%
Hospital/Medical	6	6	0	9.3%	9.7%	0.5%
Water	0	0	0	0.6%	0.7%	0.2%
Grand Total	915	981	65	11.8%	12.6%	0.8%

Note: tables based on area of data available for both 2014 and 2018, limited to urban area (ABS urban centres and localities). Due to data rounding some values do not sum.

3.3. INNER SOUTH EAST

Comparison of the 2014 and 2018 vegetation cover across the Inner South East region reveals the following cover change:

- Overall vegetation cover change of 6,310 ha to 5,370 ha; representing a change from 39.0% to 33.2% vegetation cover, a loss of 5.8 percentage points (or 939 ha).
Note: this change is likely affected by the impact of rainfall and irrigation patterns on grass cover at the time of aerial imagery capture.
- Combined tree and shrub cover change of 4,270 ha to 3,891 ha; representing a change from 26.4% to 24.1% cover, a loss of 2.3 percentage points (or 379 ha).
- Tree cover change of 2,952 ha to 2,821 ha; representing a change from 18.3% to 17.4% cover, a loss of 0.8 percentage points (due to data rounding values do not sum) (or 131 ha).

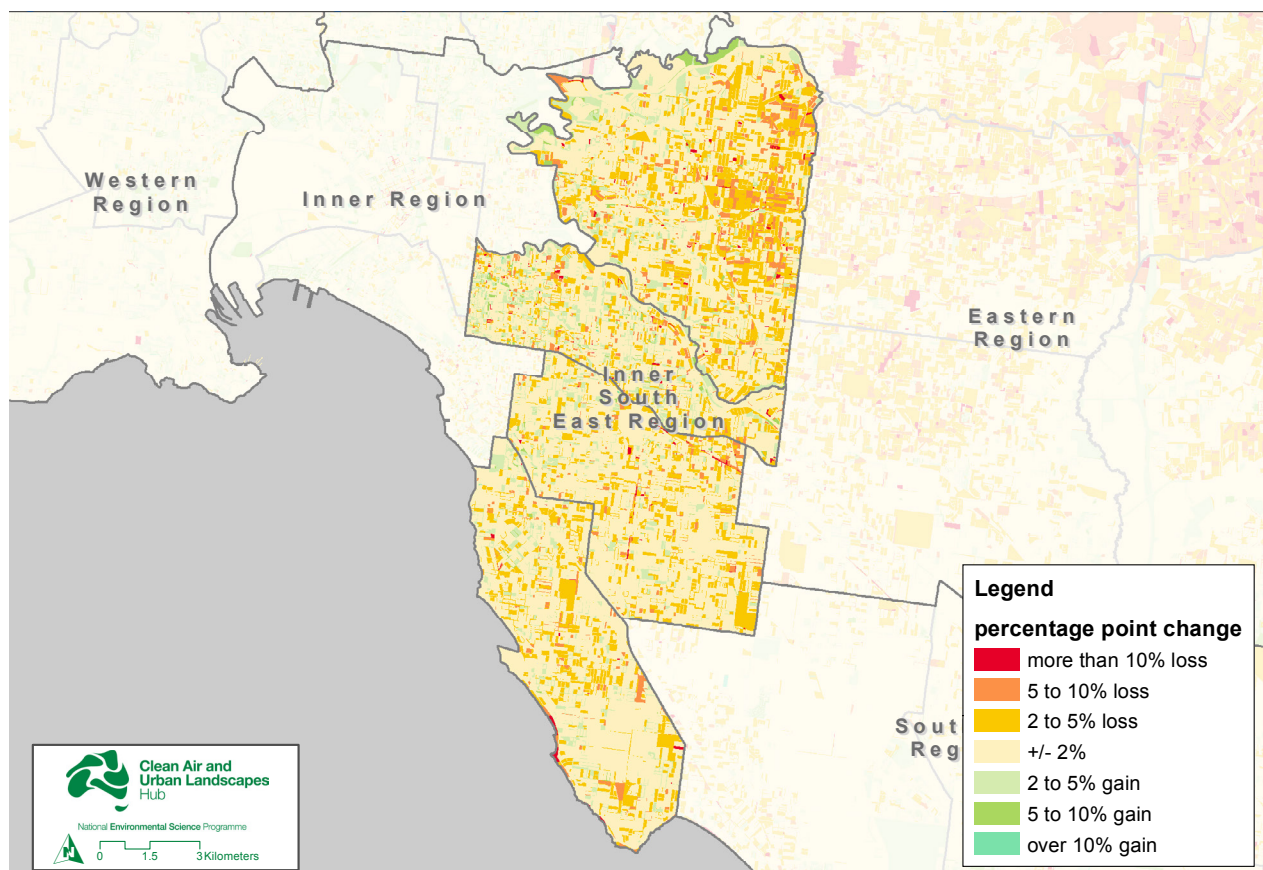
Figure 6 presents the spatial distribution of tree canopy loss and gain, and summary charts of the change in vegetation cover by land-use categories for the Inner South East region. Table 12, Table 13 and Table 14 present vegetation loss and gain across the Inner South East region against land-use categories and vegetation type.

When considering vegetation cover change between 2014 and 2018 in the Inner South East region we note:

- A mixed distribution of areas of loss and gain, with more areas of loss evident; and a concentration of higher areas of loss in the municipality of Boroondara (the northern edge of the area).
- Residential land provides the largest area of tree cover in 2018 (1,574 ha). Tree cover on residential land changes from 16.9% to 15.8%, a loss of 1.1 percentage points (or 108 ha). Combined tree and shrub cover on residential land changes from 27.1% to 24.0 %, a loss of 3.1 percentage points (or 306 ha).
- Infrastructure land (primarily streets) provides the second largest area of tree cover in 2018 (722 ha). Tree cover on infrastructure land changes from 21.8% to 21.4%, a loss of 0.4 percentage points (or 13 ha). Combined tree and shrub cover on infrastructure land changes from 26.3% to 25.1%, a loss of 1.2 percentage points (or 41 ha).
- Parkland provides the third largest area of tree cover in 2018 (428 ha). Tree cover on parkland changes from 23.4% to 23.2%, a loss of 0.2 percentage points (or 4 ha). Combined tree and shrub cover changes from 30.4% to 29.4%, a loss of 1.1 percentage points (or 20 ha).
- In absolute terms, the contribution of the remaining land use categories in the Inner South East region are small by comparison, however they all experience declines in shrub and tree cover (a combined loss of 13 ha).

When considering the Inner South East region, we see a relatively consistent and even distribution of tree cover loss. The loss is greatest on residential land in both absolute terms (108 ha lost) and as a proportion of the land use (1.1 percentage point loss). There are also small losses on average for parkland (4 ha lost) and infrastructure land (13 ha lost), and all land use categories register a loss in cover. Residential land is the largest contributor of trees, as it is for most of the metropolitan area. However, the second largest contributor is streets, followed by parkland, which reverses the metropolitan trend for second and third. The Inner South East region is characterised by overall average losses. It is important to note the high levels of tree cover in the region (17.4% in 2018) (second only to the Eastern region at 22.6% in 2018).

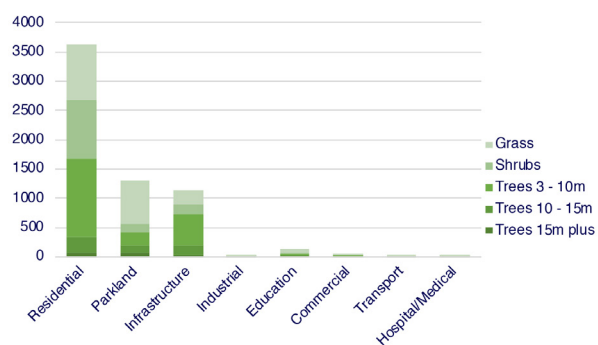
Figure 6 - Inner South East Region - percentage point tree cover change 2014-2018 by modified mesh block



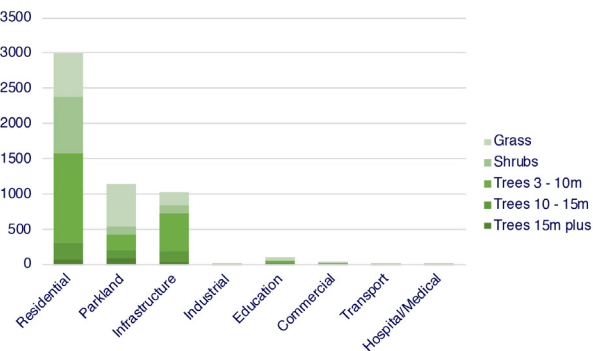
Study area limited to urban areas (ABS urban centres and localities) and by data availability

Inner South East Region

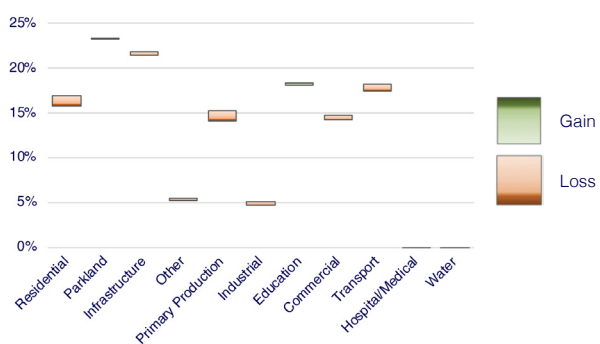
Vegetation by Land Use (ha) - 2014



Vegetation by Land Use (ha) - 2018



Cover and Change 2014 - 2018 Tree Cover



Cover and Change 2014 - 2018 Tree + Shrub Cover

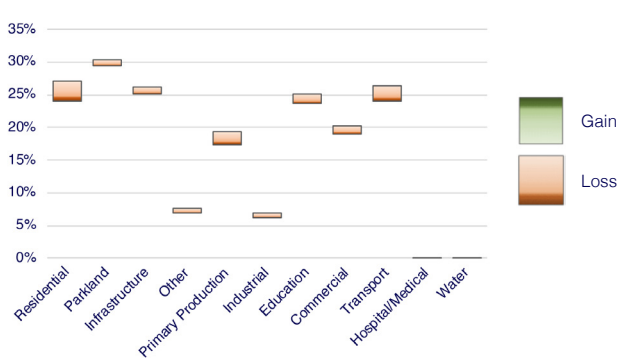


Table 12 - Inner South East Region Total Vegetation Cover in Urbanised Areas

Land Use	Vegetation Cover 2014 (ha)	Vegetation Cover 2018 (ha)	Vegetation Loss/gain 2014 - 2018 (ha)	Vegetation Cover 2014 (%)	Vegetation Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	3,636	3,002	-634	36.6%	30.2%	-6.4%
Parkland	1,298	1,152	-146	70.4%	62.5%	-7.9%
Infrastructure	1,149	1,024	-125	34.1%	30.4%	-3.7%
Industrial	13	10	-2	11.5%	9.6%	-2.0%
Education	143	119	-24	36.9%	30.6%	-6.3%
Commercial	38	32	-6	9.0%	7.6%	-1.4%
Transport	13	12	-1	35.6%	31.8%	-3.8%
Hospital/Medical	20	19	-1	31.0%	29.0%	-2.1%
Grand Total	6,310	5,370	-939	39.0%	33.2%	-5.8%

Table 13 - Inner South East Region Combined Shrub & Tree Canopy Cover in Urbanised Areas

Land Use	Tree and Shrub Cover 2014 (ha)	Tree and Shrub Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree and Shrub Cover 2014 (%)	Tree and Shrub Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	2,687	2,381	-306	27.1%	24.0%	-3.1%
Parkland	561	542	-20	30.4%	29.4%	-1.1%
Infrastructure	887	846	-41	26.3%	25.1%	-1.2%
Industrial	8	8	-1	7.7%	6.9%	-0.8%
Education	75	68	-7	19.3%	17.4%	-1.9%
Commercial	29	26	-3	6.9%	6.2%	-0.7%
Transport	9	9	-1	25.1%	23.7%	-1.4%
Hospital/Medical	13	12	-1	20.2%	18.9%	-1.3%
Grand Total	4,270	3,891	-379	26.4%	24.1%	-2.3%

Table 14 - Inner South East Region Tree Canopy Cover in Urbanised Areas

Land Use	Tree Cover 2014 (ha)	Tree Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree Cover 2014 (%)	Tree Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	1,682	1,574	-108	16.9%	15.8%	-1.1%
Parkland	432	428	-4	23.4%	23.2%	-0.2%
Infrastructure	735	722	-13	21.8%	21.4%	-0.4%
Industrial	6	6	0	5.5%	5.2%	-0.3%
Education	59	55	-4	15.3%	14.1%	-1.2%
Commercial	22	20	-1	5.1%	4.8%	-0.4%
Transport	7	7	0	18.1%	18.3%	0.2%
Hospital/Medical	9	9	0	14.8%	14.2%	-0.6%
Grand Total	2,952	2,821	-131	18.3%	17.4%	-0.8%

Note: tables based on area of data available for both 2014 and 2018, limited to urban area (ABS urban centres and localities). Due to data rounding some values do not sum.

3.4 WESTERN REGION

Comparison of the 2014 and 2018 vegetation cover across the Western region reveals the following cover change:

- Overall vegetation cover change of 9,181 ha to 12,836 ha; representing a change from 20.8% to 29.1% vegetation cover, an increase of 8.3 percentage points (or 3,655 ha).
Note: this change is likely affected by the impact of rainfall and irrigation patterns on grass cover at the time of aerial imagery capture.
- Combined tree and shrub cover change of 3,990 ha to 4,701 ha; representing a change from 9.0 % to 10.7 % cover, an increase of 1.6 percentage points (or 712 ha).
- Tree cover change of 2,206 ha to 2,573 ha; representing a change from 5.0 % to 5.8 % cover, an increase of 0.8 percentage points (or 367 ha).

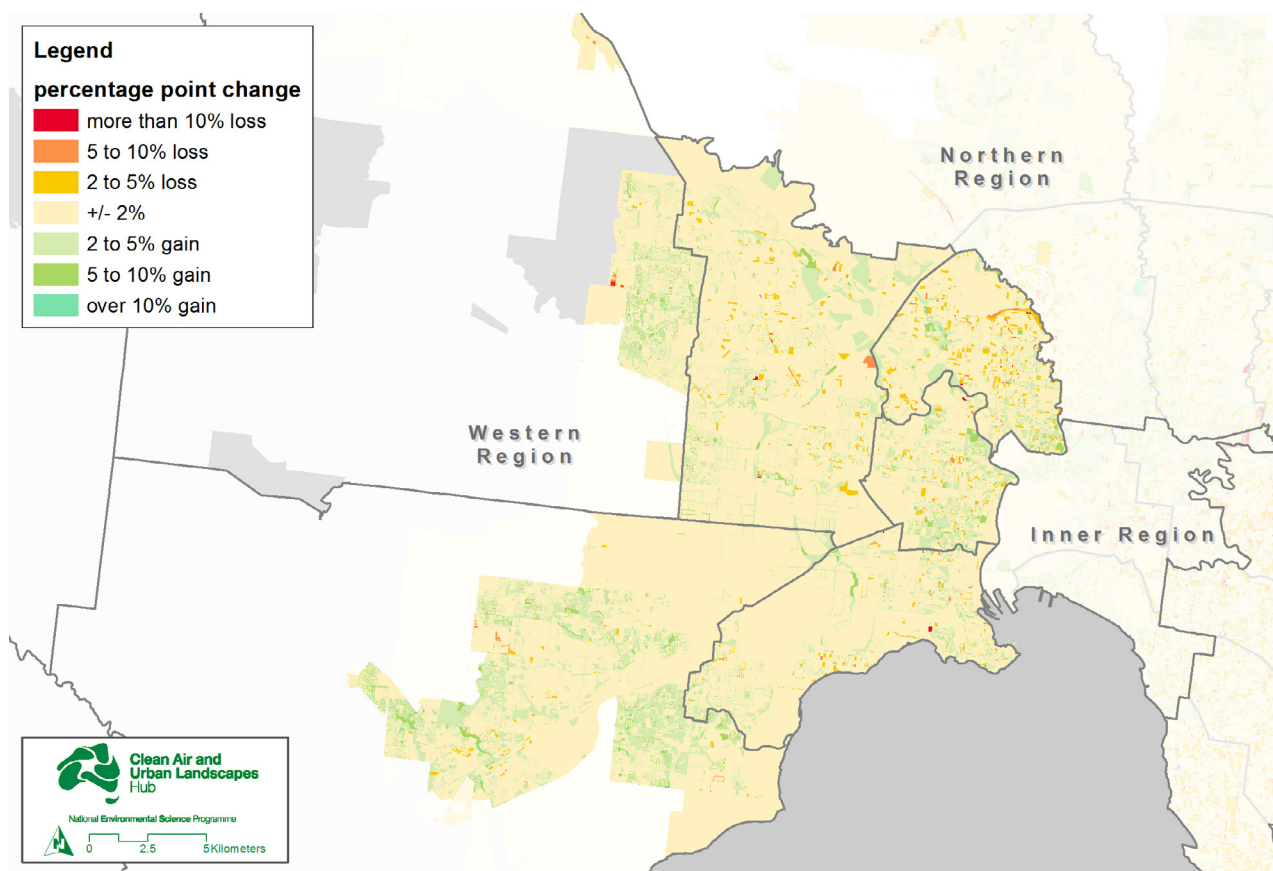
Figure 7 presents the spatial distribution of tree canopy loss and gain, and summary charts of the change in vegetation cover by land-use categories for the Western region. Table 15, Table 16 and Table 17 present vegetation loss and gain across the Western region against land-use categories and vegetation type.

When considering vegetation cover change between 2014 and 2018 in the Western region we note:

- Large areas characterised by no significant change in tree cover; and a mixed distribution of areas of loss and gain, with more areas of modest gain evident.
- Residential land provides the largest area of tree cover in 2018 (1,014 ha). Tree cover on residential land changes from 5.2% to 5.9%, an increase of 0.7 percentage points (or 113 ha). Combined tree and shrub cover on residential land changes from 11.8% to 13.4%, an increase of 1.6 percentage points (or 278 ha).
- Infrastructure land (primarily streets) provides the second largest area of tree cover in 2018 (686 ha). Tree cover on infrastructure land changes from 6.8% to 8.5%, an increase of 1.7 percentage points (or 139 ha). Combined tree and shrub cover on infrastructure land changes from 9.7% to 12.3%, an increase of 2.6 percentage points (or 211 ha).
- Parkland provides the third largest area of tree cover in 2018 (486 ha). Tree cover on parkland changes from 6.5% to 7.6%, an increase of 1.2 percentage points (or 75 ha). Combined tree and shrub cover on parkland changes from 10.0% to 11.8%, a gain of 1.9 percentage points (due to data rounding values do not sum) (or 119 ha).

When considering the Western region, we see a region with a very low baseline tree cover (up to 5.8% in 2018), experiencing gains across residential land, parkland and streets. The increase in parks and streets may reflect the significant focus across the western suburbs on greening the public realm.

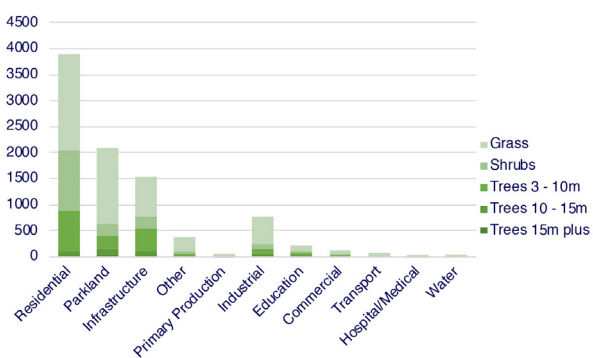
Figure 7 - Western Region - percentage point tree cover change 2014-2018 by modified mesh block



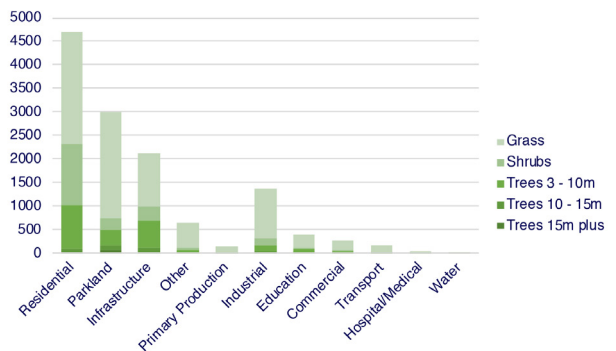
Study area limited to urban areas (ABS urban centres and localities) and by data availability

Western Region

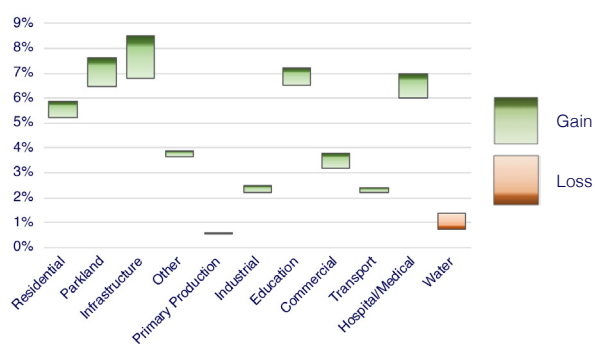
Vegetation by Land Use (ha) - 2014



Vegetation by Land Use (ha) - 2018



Cover and Change 2014 - 2018 Tree Cover



Cover and Change 2014 - 2018 Tree + Shrub Cover

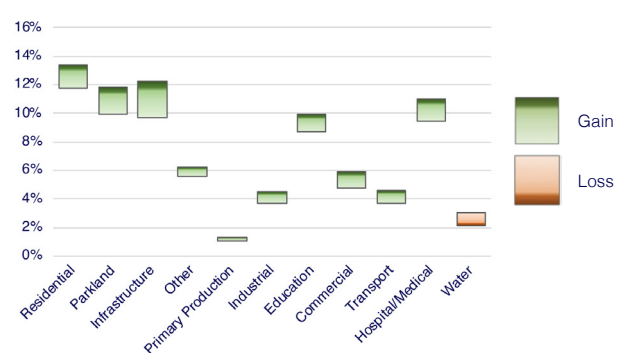


Table 15 - Western Region Total Vegetation Cover in Urbanised Areas

Land Use	Vegetation Cover 2014 (ha)	Vegetation Cover 2018 (ha)	Vegetation Loss/gain 2014 - 2018 (ha)	Vegetation Cover 2014 (%)	Vegetation Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	3,896	4,705	809	22.6%	27.2%	4.7%
Parkland	2,087	2,999	913	32.7%	47.1%	14.3%
Infrastructure	1,537	2,119	582	19.1%	26.3%	7.2%
Other	372	640	268	21.0%	36.1%	15.1%
Primary Production	64	137	73	8.0%	17.1%	9.1%
Industrial	768	1,369	601	11.2%	19.9%	8.7%
Education	222	399	177	20.0%	35.9%	15.9%
Commercial	132	272	140	11.9%	24.5%	12.6%
Transport	83	171	88	16.3%	33.7%	17.4%
Hospital/Medical	8	11	3	14.2%	20.5%	6.3%
Water	10	12	1	7.0%	7.8%	0.8%
Grand Total	9,181	12,836	3,655	20.8%	29.1%	8.3%

Table 16 - Western Region Combined Shrub and Tree Canopy Cover in Urbanised Areas

Land Use	Tree and Shrub Cover 2014 (ha)	Tree and Shrub Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree and Shrub Cover 2014 (%)	Tree and Shrub Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	2,036	2,314	278	11.8%	13.4%	1.6%
Parkland	636	755	119	10.0%	11.8%	1.9%
Infrastructure	780	991	211	9.7%	12.3%	2.6%
Other	99	111	12	5.6%	6.2%	0.7%
Primary Production	8	11	2	1.1%	1.3%	0.3%
Industrial	253	312	59	3.7%	4.5%	0.9%
Education	97	111	14	8.7%	9.9%	1.2%
Commercial	53	65	13	4.7%	5.9%	1.2%
Transport	19	23	4	3.7%	4.6%	0.9%
Hospital/Medical	5	6	1	9.4%	11.0%	1.6%
Water	4	3	-1	3.0%	2.1%	-0.9%
Grand Total	3,990	4,701	712	9.0%	10.7%	1.6%

Table 17 - Western Region Tree Canopy Cover in Urbanised Areas

Land Use	Tree Cover 2014 (ha)	Tree Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree Cover 2014 (%)	Tree Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	902	1,014	113	5.2%	5.9%	0.7%
Parkland	411	486	75	6.5%	7.6%	1.2%
Infrastructure	547	686	139	6.8%	8.5%	1.7%
Other	65	69	4	3.7%	3.9%	0.3%
Primary Production	4	5	0	0.5%	0.6%	0.1%
Industrial	152	173	20	2.2%	2.5%	0.3%
Education	73	80	8	6.5%	7.2%	0.7%
Commercial	35	42	7	3.2%	3.8%	0.6%
Transport	11	12	1	2.2%	2.4%	0.2%
Hospital/Medical	3	4	1	6.0%	7.0%	0.9%
Water	2	1	-1	1.4%	0.7%	-0.6%
Grand Total	2,206	2,573	367	5.0%	5.8%	0.8%

Note: tables based on area of data available for both 2014 and 2018, limited to urban area (ABS urban centres and localities). Due to data rounding some values do not sum

3.5 NORTHERN REGION

Comparison of the 2014 and 2018 vegetation cover across the Northern region reveals the following cover change:

- Overall vegetation cover change of 15,888 ha to 19,372 ha; representing a change from 28.3% to 34.5% vegetation cover, an increase of 6.2 percentage points (or 3,484 ha).
Note: this change is likely affected by the impact of rainfall and irrigation patterns on grass cover at the time of aerial imagery capture.
- Combined tree and shrub cover change of 9,068 ha to 9,553 ha; representing a change from 16.1% to 17.0% cover, a gain of 0.9 percentage points (or 485 ha).
- Tree cover change of 6,180 ha to 6,546 ha; representing a change from 11.0% to 11.7% cover, an increase of 0.7 percentage points (or 366 ha).

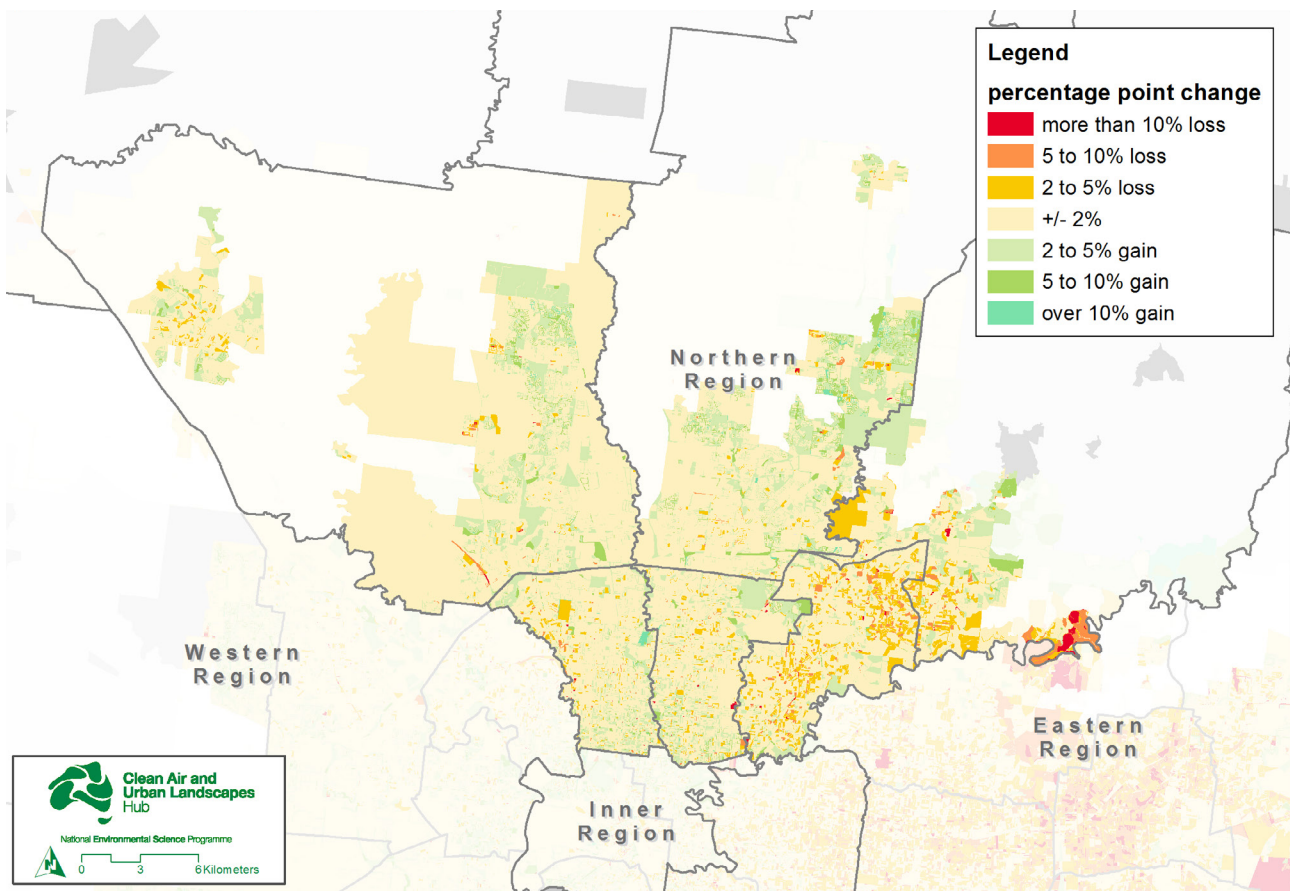
Figure 8 presents the spatial distribution of tree canopy loss and gain, and summary charts of the change in vegetation cover by land-use categories for the Northern region. Table 18, Table 19 and Table 20 present vegetation loss and gain across the Northern region against land-use categories and vegetation type.

When considering vegetation cover change between 2014 and 2018 in the Northern region we note:

- Large areas characterised by no significant change in tree cover; areas of gain concentrated in the western and central areas of the region; and areas of loss concentrated in the suburbs with higher baseline vegetation to the east of the region.
- Residential land provides the largest area of tree cover in 2018 (3,104 ha). Tree cover on residential land changes from 12.1% to 12.4%, an increase of 0.3 percentage points (or 76 ha). Combined tree and shrub cover on residential land changes from 19.6 % to 20.0 %, an increase of 0.5 percentage points (due to data rounding values do not sum) (or 114 ha).
- Parkland provides the second largest area of tree cover in 2018 (1,203 ha). Tree cover on parkland changes from 18.3% to 19.5%, an increase of 1.3 percentage points (or 79 ha). Combined tree and shrub cover on parkland changes from 23.7% to 24.8%, an increase of 1.1 percentage points (or 68 ha).
- Infrastructure land (primarily streets) provides the third largest area of tree cover in 2018 (1,065 ha). Tree cover on infrastructure land changes from 10.8% to 12.3%, an increase of 1.5 percentage points (or 131 ha). Combined tree and shrub cover on infrastructure land changes from 14.3% to 16.4%, an increase of 2.1 percentage points (or 179 ha).
- In addition to the above three land uses, the Northern region sees significant contribution to 2018 tree cover from 'Other' (407 ha), Primary Production (235 ha), Commercial (184 ha), Education (186 ha) and Industrial land (136 ha). All of these are seeing small gains in tree cover over the period between 2014 and 2018.

The Northern region is characterised by an increase in average tree cover, but with areas of average loss in areas where there is high baseline cover (eastern part of the region), which are countered by gains in areas where there is low base-line vegetation cover (western part of the region). With respect to land use, on average residential land sees modest average gains, while infrastructure land and parkland sees more significant average gains. This suggests efforts to increase park and street tree plantings across this region are having a benefit.

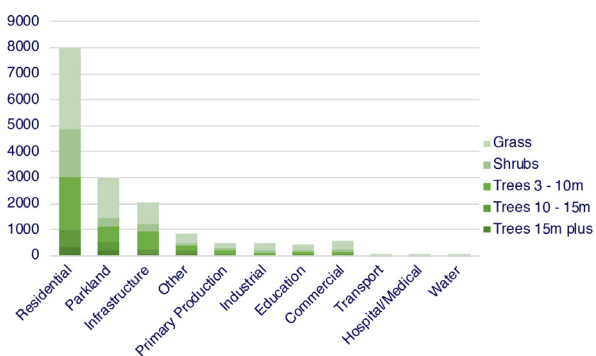
Figure 8 - Northern Region - percentage point tree cover change 2014-2018 by modified mesh block



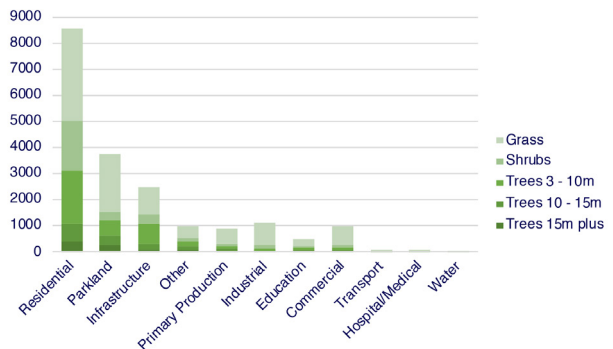
Study area limited to urban areas (ABS urban centres and localities) and by data availability

Northern Region

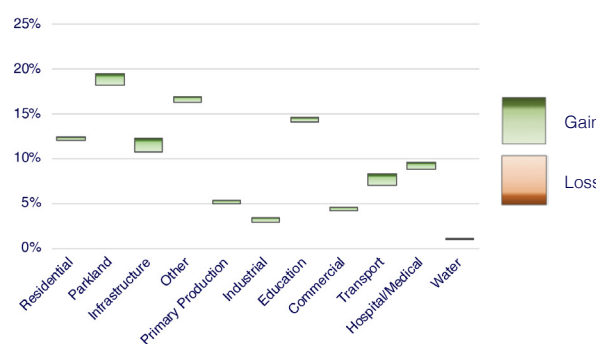
Vegetation by Land Use (ha) - 2014



Vegetation by Land Use (ha) - 2018



Cover and Change 2014 - 2018 Tree Cover



Cover and Change 2014 - 2018 Tree + Shrub Cover

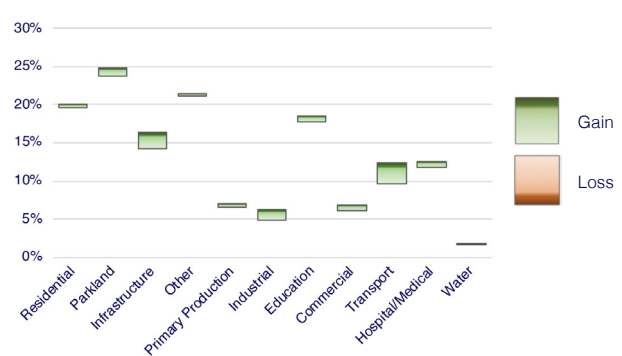


Table 18 - Northern Region Total Vegetation Cover in Urbanised Areas

Land Use	Vegetation Cover 2014 (ha)	Vegetation Cover 2018 (ha)	Vegetation Loss/gain 2014 - 2018 (ha)	Vegetation Cover 2014 (%)	Vegetation Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	7,964	8,552	587	31.9%	34.2%	2.4%
Parkland	2,964	3,749	784	48.1%	60.9%	12.7%
Infrastructure	2,052	2,498	445	23.7%	28.8%	5.1%
Other	853	997	144	35.6%	41.6%	6.0%
Primary Production	497	896	399	11.3%	20.4%	9.1%
Industrial	491	1,136	645	12.5%	29.0%	16.5%
Education	433	487	53	34.2%	38.4%	4.2%
Commercial	581	984	404	14.7%	25.0%	10.2%
Transport	29	47	19	16.0%	26.6%	10.5%
Hospital/Medical	16	18	2	20.7%	23.6%	2.9%
Water	7	9	2	3.9%	4.8%	1.0%
Grand Total	15,888	19,372	3,484	28.3%	34.5%	6.2%

Table 19 - Northern Region Combined Shrub and Tree Canopy Cover in Urbanised Areas

Land Use	Tree and Shrub Cover 2014 (ha)	Tree and Shrub Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree and Shrub Cover 2014 (%)	Tree and Shrub Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	4,889	5,003	114	19.6%	20.0%	0.5%
Parkland	1,460	1,528	68	23.7%	24.8%	1.1%
Infrastructure	1,239	1,418	179	14.3%	16.4%	2.1%
Other	508	513	5	21.2%	21.4%	0.2%
Primary Production	287	307	21	6.5%	7.0%	0.5%
Industrial	190	245	55	4.9%	6.2%	1.4%
Education	226	234	8	17.8%	18.5%	0.6%
Commercial	239	270	30	6.1%	6.8%	0.8%
Transport	17	22	5	9.7%	12.4%	2.8%
Hospital/Medical	9	9	1	11.7%	12.6%	0.9%
Water	3	3	0	1.6%	1.9%	0.3%
Grand Total	9,068	9,553	485	16.1%	17.0%	0.9%

Table 20 - Northern Region Tree Canopy Cover in Urbanised Areas

Land Use	Tree Cover 2014 (ha)	Tree Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree Cover 2014 (%)	Tree Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	3,029	3,104	76	12.1%	12.4%	0.3%
Parkland	1,124	1,203	79	18.3%	19.5%	1.3%
Infrastructure	934	1,065	131	10.8%	12.3%	1.5%
Other	389	407	18	16.2%	17.0%	0.8%
Primary Production	219	235	16	5.0%	5.3%	0.4%
Industrial	114	136	21	2.9%	3.5%	0.5%
Education	178	186	8	14.1%	14.7%	0.6%
Commercial	170	184	15	4.3%	4.7%	0.4%
Transport	13	15	2	7.1%	8.4%	1.3%
Hospital/Medical	7	7	1	8.9%	9.7%	0.8%
Water	2	2	0	1.1%	1.1%	0.0%
Grand Total	6,180	6,546	366	11.0%	11.7%	0.7%

Note: tables based on area of data available for both 2014 and 2018, limited to urban area (ABS urban centres and localities). Due to data rounding some values do not sum.

3.6 EASTERN REGION

Comparison of the 2014 and 2018 vegetation cover across the Eastern region reveals the following cover change:

- Overall vegetation cover change of 28,063 ha to 23,325 ha; representing a change from 53.4% to 44.4% vegetation cover, a loss of 9.0 percentage points (or 4,739 ha).
Note: this change is likely affected by the impact of rainfall and irrigation patterns on grass cover at the time of aerial imagery capture.
- Combined tree and shrub cover change of 17,316 ha to 15,283 ha; representing a change from 32.9% to 29.1% cover, a loss of 3.9 percentage points (due to data rounding values do not sum) (or 2,033 ha).
- Tree cover change of 13,103 ha to 11,900 ha; representing a change from 24.9% to 22.6% cover, a loss of 2.3 percentage points (or 1,202 ha).

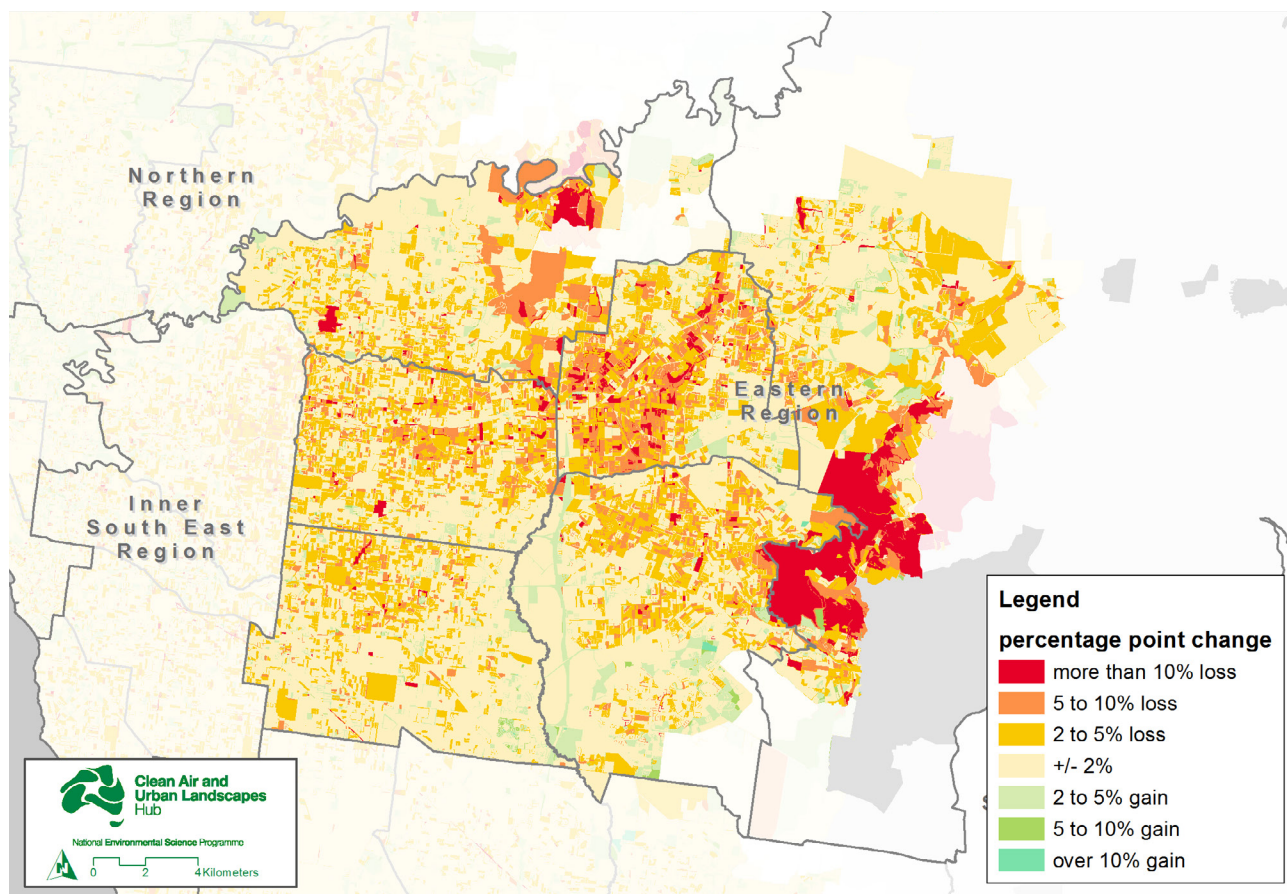
Figure 9 presents the spatial distribution of tree canopy loss and gain, and summary charts of the change in vegetation cover by land-use categories for the Eastern region. Table 21, Table 22 and Table 23 present vegetation loss and gain across the Eastern region against land-use categories and vegetation type.

When considering vegetation cover change between 2014 and 2018 in the Eastern region we note:

- Widespread areas of loss across the region, with limited areas of gain. Concentrations of significant loss across the region, with the largest areas in the municipality of Maroondah (although all six municipalities in the region have areas of high loss).
- Residential land provides the largest area of tree cover in 2018 (5,927 ha). Tree cover on residential land changes from 24.4% to 21.9%, a loss of 2.5 percentage points (or 684 ha). Combined tree and shrub cover on residential land changes from 34.6% to 30.0%, a loss of 4.6 percentage points (or 1,252 ha).
- Parkland provides the second largest area of tree cover in 2018 (2,549 ha). Tree cover on parkland changes from 36.3% to 32.2%, a loss of 4.0 percentage points (or 320 ha). Combined tree and shrub cover on parkland changes from 43.5% to 38.6%, a loss of 4.8 percentage points (or 382 ha).
- Infrastructure land (primarily streets) provides the third largest area of tree cover in 2018 (1,726 ha). Tree cover on infrastructure land changes from 21.2% to 20.2%, a loss of 1.0 percentage points (or 90 ha). Combined tree and shrub cover on infrastructure land changes from 26.3% to 24.1% cover in 2018, a loss of 2.2 percentage points (or 191 ha).
- In addition to the above three land uses, the Eastern region sees significant contribution to 2018 tree cover from Primary Production (646 ha), 'Other' (547 ha), Education (227 ha) and Industrial land (139 ha), and Commercial (125 ha). All of these are seeing small losses of tree cover over the period between 2014 and 2018.

When considering the Eastern region, we see widespread tree cover loss across the region (1,202 ha lost), with concentrations of high loss in several areas. The loss is greatest on residential land in absolute terms (684 ha lost); but higher on parkland as a proportion of land use (4.0 percentage point loss (or 320 ha)). The high loss in parkland warrants further investigation at the local scale to determine likely drivers of this loss. Of the six metropolitan regions, the Eastern region is experiencing the highest amount of tree cover loss. It is important to note the region also has the highest levels of baseline vegetation cover. As with the Inner South East, where a high baseline cover exists, we see the high levels of vegetation loss across the metropolitan region.

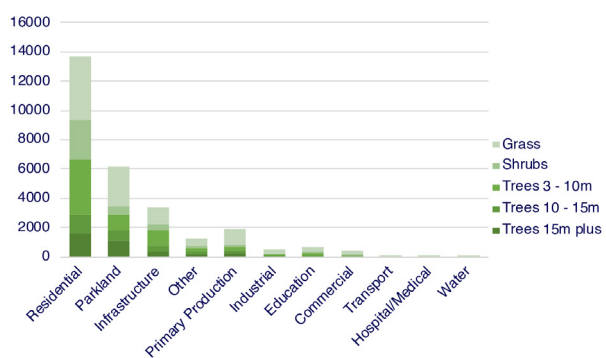
Figure 9 - Eastern Region - percentage point tree cover change 2014-2018 by modified mesh block



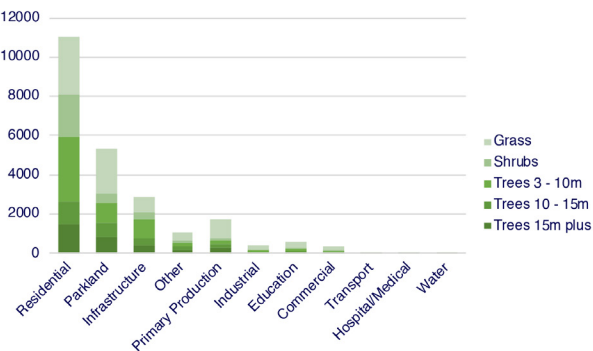
Study area limited to urban areas (ABS urban centres and localities) and by data availability

Eastern Region

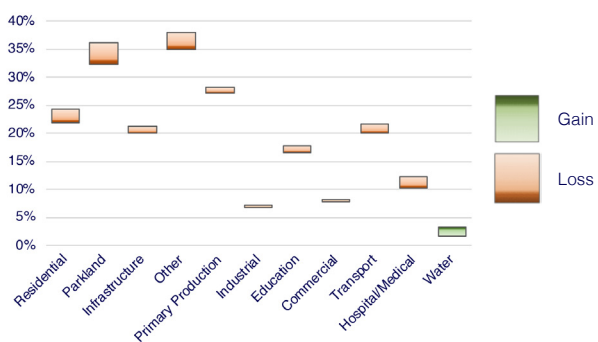
Vegetation by Land Use (ha) - 2014



Vegetation by Land Use (ha) - 2018



Cover and Change 2014 - 2018 Tree Cover



Cover and Change 2014 - 2018 Tree + Shrub Cover

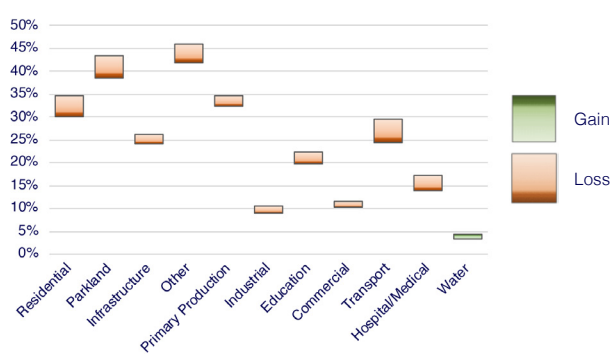


Table 21 - Eastern Region Total Vegetation Cover in Urbanised Areas

Land Use	Vegetation Cover 2014 (ha)	Vegetation Cover 2018 (ha)	Vegetation Loss/gain 2014 - 2018 (ha)	Vegetation Cover 2014 (%)	Vegetation Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	13,702	11,055	-2,647	50.6%	40.9%	-9.8%
Parkland	6,187	5,338	-849	78.2%	67.5%	-10.7%
Infrastructure	3,349	2,863	-486	39.1%	33.4%	-5.7%
Other	1,233	1,035	-198	78.8%	66.1%	-12.7%
Primary Production	1,935	1,703	-233	81.8%	72.0%	-9.8%
Industrial	501	397	-105	24.8%	19.6%	-5.2%
Education	709	574	-135	51.7%	41.9%	-9.9%
Commercial	402	328	-74	25.1%	20.4%	-4.6%
Transport	22	15	-6	62.7%	44.1%	-18.5%
Hospital/Medical	22	16	-6	28.3%	20.9%	-7.4%
Water	1	1	0	16.4%	13.9%	-2.5%
Grand Total	28,063	23,325	-4,739	53.4%	44.4%	-9.0%

Table 22 - Eastern Region Combined Shrub and Tree Canopy Cover in Urbanised Areas

Land Use	Tree and Shrub Cover 2014 (ha)	Tree and Shrub Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree and Shrub Cover 2014 (%)	Tree and Shrub Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	9,357	8,105	-1,252	34.6%	30.0%	-4.6%
Parkland	3,439	3,056	-382	43.5%	38.6%	-4.8%
Infrastructure	2,253	2,063	-191	26.3%	24.1%	-2.2%
Other	720	654	-66	46.0%	41.8%	-4.2%
Primary Production	819	767	-53	34.6%	32.4%	-2.2%
Industrial	213	183	-30	10.5%	9.0%	-1.5%
Education	306	273	-33	22.3%	19.9%	-2.4%
Commercial	185	163	-21	11.5%	10.2%	-1.3%
Transport	10	8	-2	29.6%	24.5%	-5.1%
Hospital/Medical	13	11	-3	17.1%	13.9%	-3.2%
Water	0	0	0	3.5%	4.4%	1.0%
Grand Total	17,316	15,283	-2,033	32.9%	29.1%	-3.9%

Table 23 - Eastern Region Tree Canopy Cover in Urbanised Areas

Land Use	Tree Cover 2014 (ha)	Tree Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree Cover 2014 (%)	Tree Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	6,612	5,927	-684	24.4%	21.9%	-2.5%
Parkland	2,868	2,549	-320	36.3%	32.2%	-4.0%
Infrastructure	1,816	1,726	-90	21.2%	20.2%	-1.0%
Other	596	547	-50	38.1%	34.9%	-3.2%
Primary Production	669	646	-23	28.3%	27.3%	-1.0%
Industrial	147	139	-8	7.3%	6.9%	-0.4%
Education	246	227	-19	17.9%	16.6%	-1.4%
Commercial	131	125	-6	8.2%	7.8%	-0.4%
Transport	7	7	-1	21.8%	20.1%	-1.7%
Hospital/Medical	10	8	-2	12.3%	10.3%	-2.0%
Water	0	0	0	1.7%	3.3%	1.6%
Grand Total	13,103	11,900	-1,202	24.9%	22.6%	-2.3%

Note: tables based on area of data available for both 2014 and 2018, limited to urban area (ABS urban centres and localities). Due to data rounding some values do not sum.

3.7 SOUTHERN REGION

Comparison of the 2014 and 2018 vegetation cover across the Southern region reveals the following cover change:

- Overall vegetation cover change of 33,719 ha to 32,124 ha; representing a change from 51.8% to 49.4% vegetation cover, a loss of 2.5 percentage points (due to data rounding values do not sum) (or 1,596 ha).
Note: this change is likely affected by the impact of rainfall and irrigation patterns on grass cover at the time of aerial imagery capture.
- Combined tree and shrub cover change of 11,795 ha to 11,635 ha; representing a change from 18.1% to 17.9% cover, a loss of 0.2 percentage points (or 160 ha).
- Tree cover change of 7,625 ha to 7,474 ha; representing a change from 11.7% to 11.5% cover, a loss of 0.2 percentage points (or 151 ha).

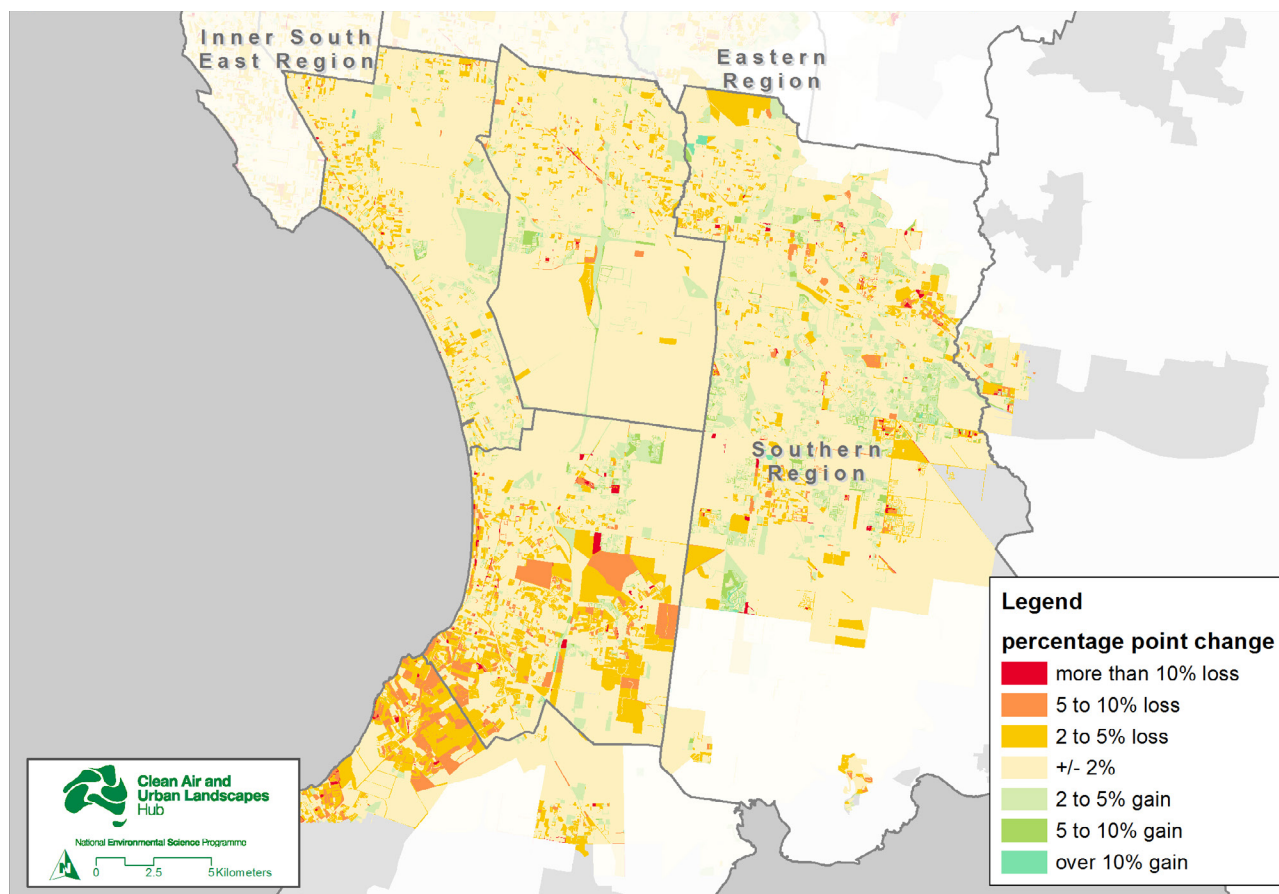
Figure 10 presents the spatial distribution of tree canopy loss and gain, and summary charts of the change in vegetation cover by land-use categories for the Southern region. Table 24, Table 25 and Table 26 present vegetation loss and gain across the Southern region against land-use categories and vegetation type.

When considering vegetation cover change between 2014 and 2018 in the Southern region we note:

- Large areas characterised by no significant change in tree cover; a mixed distribution of areas of loss and gain; with concentrations of loss to the south of the region and concentrations of gain to the east of the region.
- Residential land provides the largest area of tree cover in 2018 (3,312 ha). Tree cover on residential land changes from 13.7% to 13.2%, a loss of 0.6 percentage points (due to data rounding values do not sum) (or 145 ha). Combined tree and shrub cover on residential land change from 22.4% to 21.8%, a loss of 0.6 percentage points (or 154 ha).
- Parkland provides the second largest area of tree cover in 2018 (1,607 ha). Tree cover on parkland changes from 19.6% to 19.5%, a minor loss of 0.1 percentage points (or 9 ha). Combined tree and shrub cover on parkland change from 28.7% to 28.2%, a loss of 0.5 percentage points (or 40 ha).
- Infrastructure land (primarily streets) provides the third largest area of tree cover in 2018 (1,085 ha). Tree cover on infrastructure land changes from 10.9% to 11.2%, an increase of 0.4 percentage points (due to data rounding values do not sum) (or 37 ha). Combined tree and shrub cover on infrastructure land change from 15.4% to 15.9%, a gain of 0.5 percentage points (or 53 ha).
- In addition to the above three land uses, the Southern region sees significant contribution to 2018 tree cover from 'Other' (703 ha), Primary Production (289 ha), Industrial (245 ha) and Education (136 ha) land. All of these are seeing minor losses of tree cover over the period between 2014 and 2018 (a combined loss of 35 ha).

When considering the Southern region, on average we see minor tree cover loss across the region. The loss of tree cover is greatest on residential land (145 ha lost; or 0.6 percentage points). The region sees modest gains in tree cover on infrastructure land (streets) (37 ha gained; or 0.4 percentage points).

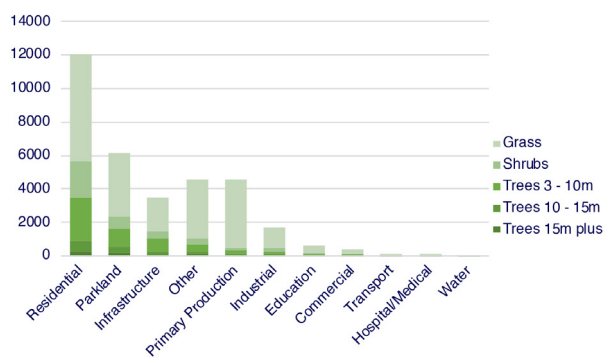
Figure 10 - Southern Region - percentage point tree cover change 2014-2018 by modified mesh block



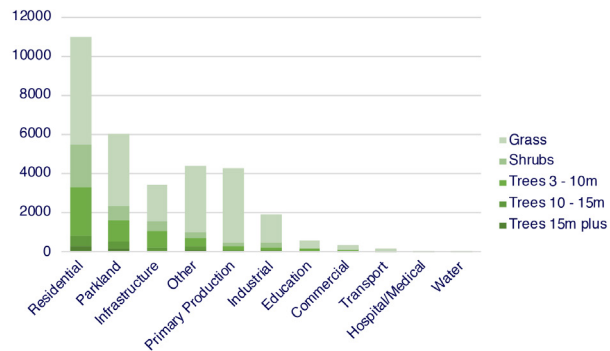
Study area limited to urban areas (ABS urban centres and localities) and by data availability

Southern Region

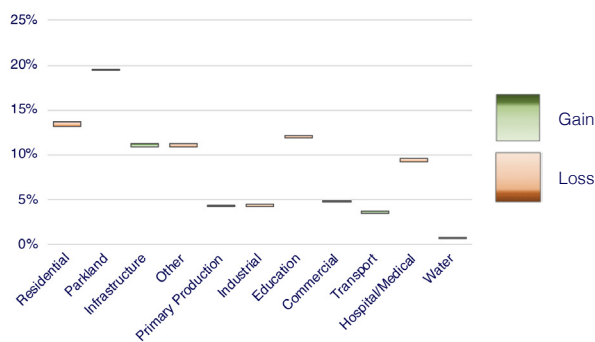
Vegetation by Land Use (ha) - 2014



Vegetation by Land Use (ha) - 2018



Cover and Change 2014 - 2018 Tree Cover



Cover and Change 2014 - 2018 Tree + Shrub Cover

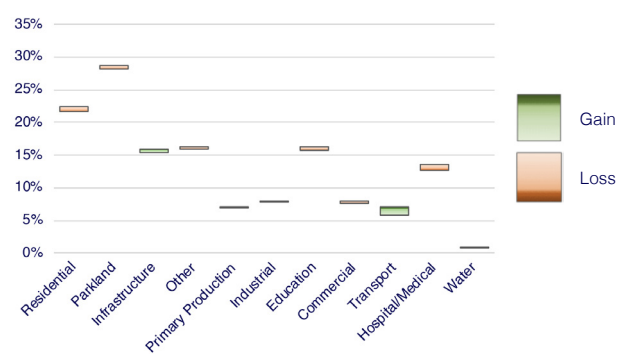


Table 24 - Southern Region Total Vegetation Cover in Urbanised Areas

Land Use	Vegetation Cover 2014 (ha)	Vegetation Cover 2018 (ha)	Vegetation Loss/gain 2014 - 2018 (ha)	Vegetation Cover 2014 (%)	Vegetation Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	12,080	10,964	-1,116	48.0%	43.6%	-4.4%
Parkland	6,185	6,043	-141	74.9%	73.2%	-1.7%
Infrastructure	3,477	3,413	-64	36.1%	35.4%	-0.7%
Other	4,555	4,420	-135	70.9%	68.8%	-2.1%
Primary Production	4,588	4,263	-325	68.6%	63.8%	-4.9%
Industrial	1,720	1,901	181	29.9%	33.0%	3.1%
Education	589	559	-29	51.5%	48.9%	-2.6%
Commercial	372	362	-10	24.0%	23.4%	-0.6%
Transport	135	179	44	37.1%	49.2%	12.1%
Hospital/Medical	18	18	0	26.1%	25.9%	-0.2%
Water	1	1	1	1.3%	2.3%	0.9%
Grand Total	33,719	32,124	-1,596	51.8%	49.4%	-2.5%

Table 25 - Southern Region Combined Shrub and Tree Canopy Cover in Urbanised Areas

Land Use	Tree and Shrub Cover 2014 (ha)	Tree and Shrub Cover 2018 (ha)	Loss/gain 2014 - 2018 (ha)	Tree and Shrub Cover 2014 (%)	Tree and Shrub Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	5,629	5,475	-154	22.4%	21.8%	-0.6%
Parkland	2,366	2,325	-40	28.7%	28.2%	-0.5%
Infrastructure	1,483	1,536	53	15.4%	15.9%	0.5%
Other	1,048	1,025	-23	16.3%	16.0%	-0.4%
Primary Production	465	478	13	7.0%	7.2%	0.2%
Industrial	465	463	-2	8.1%	8.0%	0.0%
Education	186	180	-5	16.2%	15.8%	-0.4%
Commercial	123	117	-6	7.9%	7.6%	-0.4%
Transport	21	26	5	5.9%	7.1%	1.3%
Hospital/Medical	9	9	-1	13.6%	12.7%	-0.8%
Water	1	1	0	1.0%	1.0%	0.0%
Grand Total	11,795	11,635	-160	18.1%	17.9%	-0.2%

Table 26 - Southern Region Tree Canopy Cover in Urbanised Areas

Land Use	Tree Cover 2014 (ha)	Tree Cover 2018 (ha)	Loss/gain 2014 - 2018(ha)	Tree Cover 2014 (%)	Tree Cover 2018 (%)	Percentage Point Change 2014 - 2018
Residential	3,457	3,312	-145	13.7%	13.2%	-0.6%
Parkland	1,616	1,607	-9	19.6%	19.5%	-0.1%
Infrastructure	1,047	1,085	37	10.9%	11.2%	0.4%
Other	720	703	-17	11.2%	10.9%	-0.3%
Primary Production	292	289	-2	4.4%	4.3%	0.0%
Industrial	256	245	-12	4.5%	4.3%	-0.2%
Education	140	136	-4	12.2%	11.9%	-0.3%
Commercial	76	76	0	4.9%	4.9%	0.0%
Transport	13	14	1	3.5%	3.7%	0.2%
Hospital/Medical	6	6	0	9.6%	9.2%	-0.4%
Water	0	0	0	0.9%	0.8%	0.0%
Grand Total	7,625	7,474	-151	11.7%	11.5%	-0.2%

Note: tables based on area of data available for both 2014 and 2018, limited to urban area (ABS urban centres and localities). Due to data rounding some values do not sum.

3.8 REGIONAL & LOCAL GOVERNMENT COMPARISON CHARTS

The following charts are provided to allow comparison of tree cover change by land-use for metropolitan regions and local government areas:

- Figure 11 compares total tree cover change across the six metropolitan regions for the major land-use categories.

The following charts are provided to allow comparison of vegetation cover and cover change by land- use and local government area:

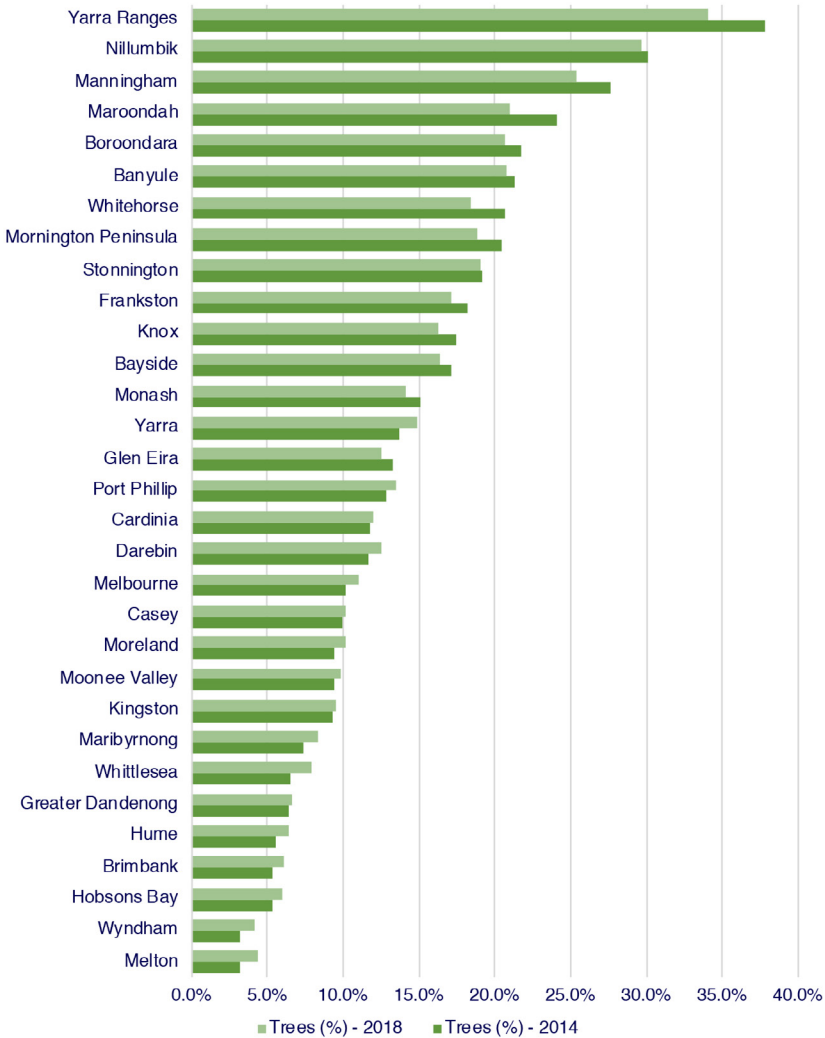
- Figure 12 compares tree cover and tree cover change by local government area.
- Figure 13 compares shrub cover change by local government area for the major land-use categories.

Figure11 - Metropolitan Regions - tree cover change 2014-2018 by major land-use category Urbanised areas (ABS urban centres and localities)



**Figure 12 - Local Government Comparison of Tree Cover Change 2014 - 2018 Urbanised Areas
(ABS urban centres and localities)**

Vegetation Cover (%) Trees



Percentage Point Change Trees

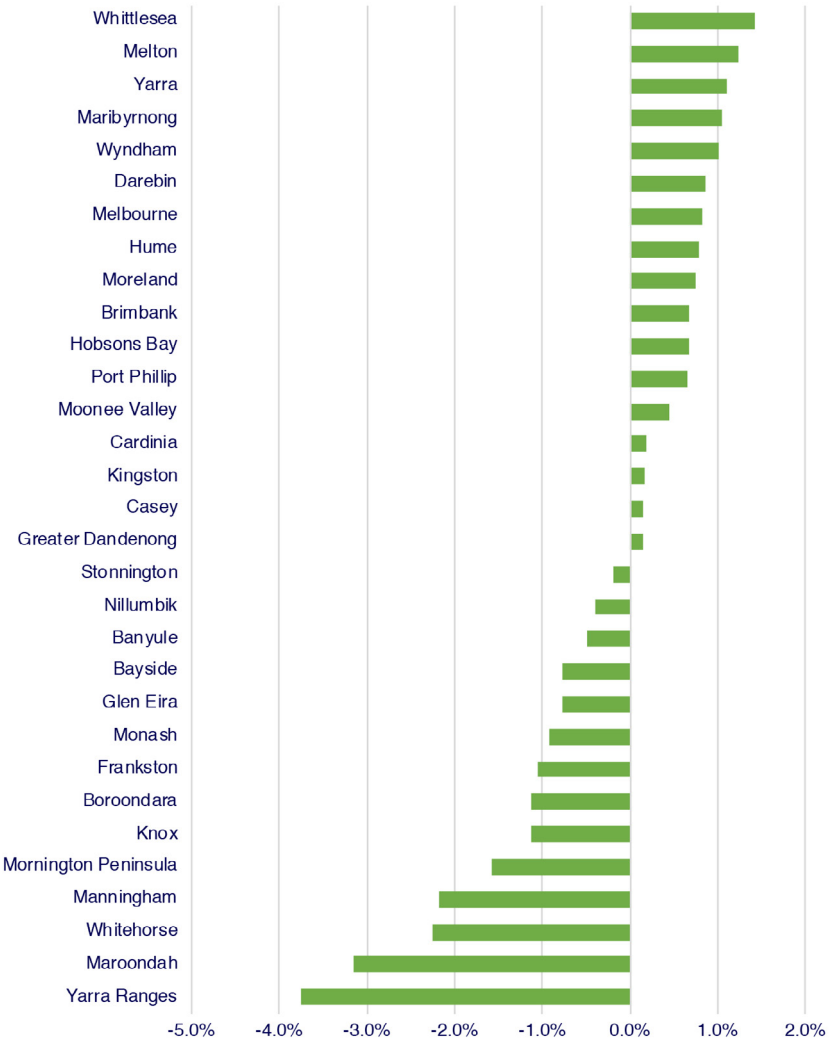
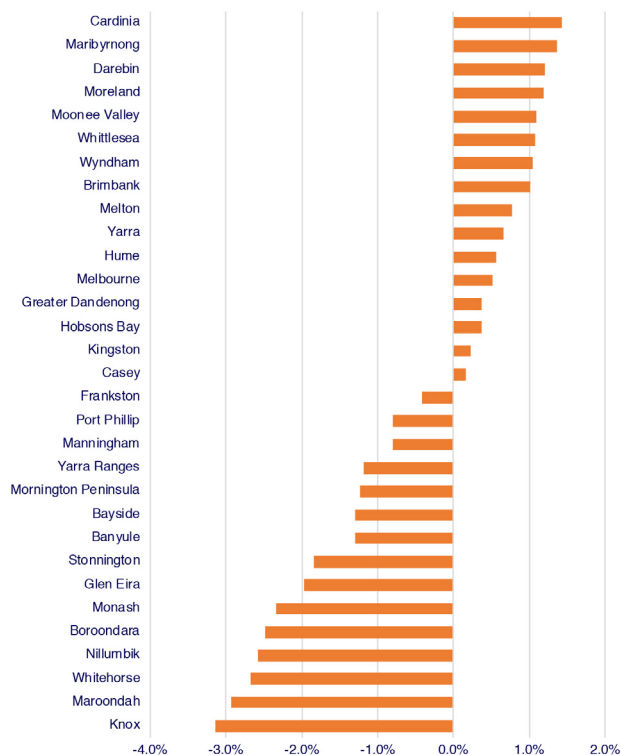
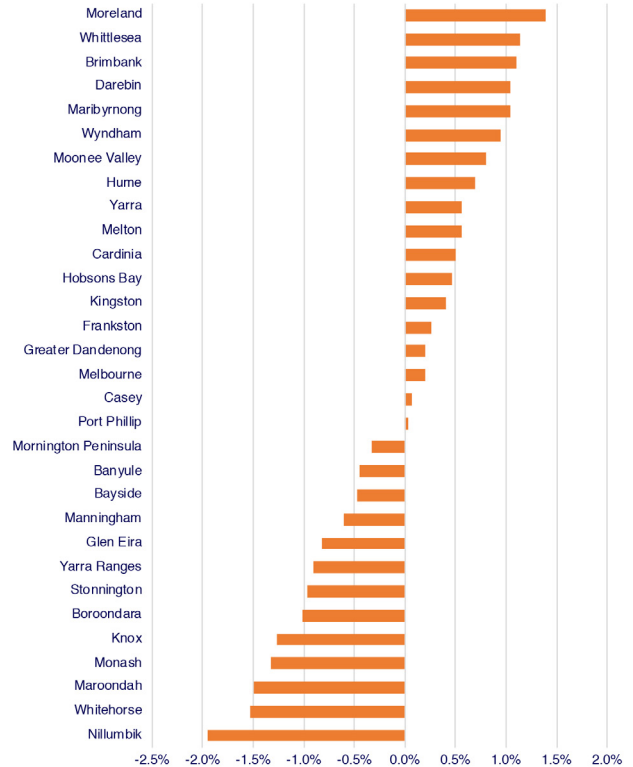


Figure 13 - Local Government Comparison of Tree Cover Change by Major Land Use Urbanised Areas (ABS urban centres and localities)

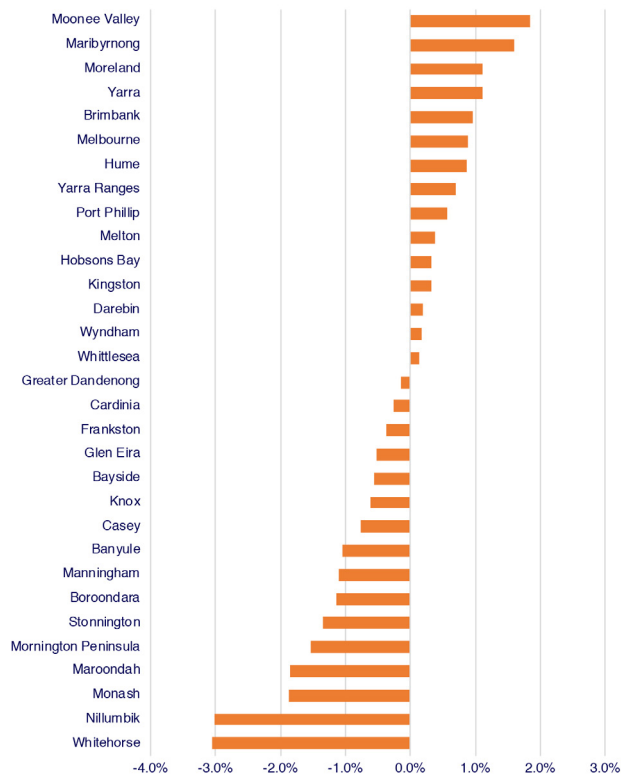
Percentage Point Change Residential



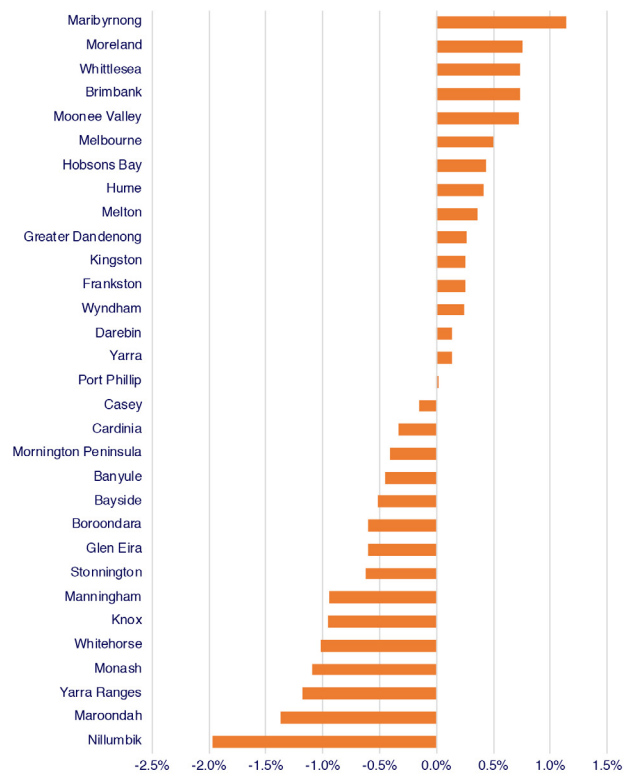
Percentage Point Change Streets



Percentage Point Change Parkland



Percentage Point Change Other Land Uses



Notes: Notes: Study area limited to urban area (ABS urban centres and localities) and by data availability.

Major land-use classes here are: Streets (Transport from ABS plus street and rail network (Infrastructure)), Residential (Residential from ABS), Parkland (Parkland from ABS), Other (Primary Production, Industrial, Commercial, Education, Hospital/Medical, Water, Other)

4. CONCLUSIONS

In this report we have documented the change in vegetation cover across the Melbourne metropolitan region between 2014-2018. To do this we combined high resolution vegetation cover land-use data at the modified Mesh Block scale. The separation of the street network from the ABS Mesh Block allows detailed and accurate measurement of the major land-use types that contribute vegetation cover in cities: residential land; parkland; and streets. This provides a significant step forward in providing an evidence base to support decision-making, strategy and policy formation, and action for improved management of urban vegetation.

For the study area, comprising the large majority of the urbanised area of Metropolitan Melbourne, overall vegetation cover on average between 2014 and 2018 is essentially static (95,004 ha to 95,104 ha; a cover of 39.3%). However, variation in the detection of grass cover makes this overall figure an unreliable measure of change. Detection of vegetation over 0.5 meters is much more accurate using the Urban Monitor® methodology. In this report we have focused on tree cover (vegetation over 3.0 meters) given the significant interest in tree cover as a key indicator of urban forest extent and location; and the relationship between tree cover and reduced urban heat island effect (Duncan et al, 2019). We also report on all vegetation over 0.5 meters (combined tree and shrub) as a useful indicator of the broader context for vegetation cover.

When considering the study area, the change in tree cover is small, but negative, from 32,980 ha to 32,295 ha. This represents a change from 13.6% to 13.3% cover and a loss of 0.3 percentage points. However, this is in a context where a baseline 'no-intervention' scenario (no vegetation removal or new planting) would typically see small to modest gains in cover as a result of vegetation growth. Comparison of the 2014 and 2018 combined tree and shrub cover across the study area reveals an overall change of 47,615 ha to 46,332 ha; representing a change from 19.7 % to 19.2 % cover and a loss of 0.5 percentage points. Therefore, the study period is characterised by an average loss that is small but significant. Continued losses of this magnitude over time would see continued erosion of the urban forest.

The big three land use classes contributing to vegetation cover in the urbanised area of Melbourne are residential land, parkland and infrastructure lands (primarily street networks). Residential land provides the largest contribution and is experiencing a loss on average (losing 0.7 percentage points of tree cover; and 1.2 percentage points of combined tree and shrub cover). This suggests a combination of urban re-development, landowner land-management practices, and climatic effects are combining to reduce urban vegetation cover on residential land. Vegetation loss is also occurring on parkland, the second largest contributor to vegetation cover (a loss of 0.5 percentage points of tree cover; and 0.7 percentage points of combined tree and shrub cover). The third largest contributor is infrastructure land, which is experiencing a modest average increase in cover over the study period (an increase of 0.6 percentage points of tree cover; and 0.6 percentage points of combined tree and shrub cover). This suggests that on average, efforts to manage street vegetation is bucking the trend of loss in the other major land uses categories.

There is significant variation of tree cover and tree cover loss across space. The range in baseline vegetation reflects differences in climate, soil type and quality, ecology and geography; but also, differences suburb age and era, built form, socio-economic factors, and development pressures. Across the Inner, Western and Northern regions we see areas of stagnant tree cover and of moderate increase; with fewer occurrences of loss. These areas, especially in the west and north, are characterised by low levels of existing tree and shrub cover.

The Western region has the lowest baseline tree cover, and is experiencing modest gains on residential land, and more significant gains on parkland and streets. The increase in parks and streets may reflect the significant focus across the

western suburbs on greening the public realm. It is important to note that the planting of new trees has limited impact on vegetation cover in the short term but will have an increasingly significant impact as the trees mature. Subsequent (and regular) monitoring will help detect and quantify the benefit of tree planting interventions over time. The Inner region is significantly smaller in area, but like the Western region is seeing modest gains in vegetation cover counter to the metropolitan trend. As with the Western region, the Inner region sees modest gains on residential land and more significant gains on parkland and infrastructure land, suggesting concerted efforts to increase canopy cover in the public realm is having some impact. The Northern region is characterised by a modest increase in average tree cover, but with areas of average loss in areas where there is high baseline cover (eastern part of the region), which are offset by gains in areas where there is low baseline vegetation cover (western part of the region). On average there are minor gains on residential land in the Northern region, but more significant gains on parkland and infrastructure land.

Across the Eastern region, Inner South East, and Southern region we see more extensive areas of average tree cover loss. The losses here are across a mixture of parkland, residential land and streets, as well as on other land classes. These areas of Melbourne are typically where the vegetation cover is high compared to the Melbourne average. Therefore, where a high baseline cover exists, we typically see the highest levels of vegetation loss across the metropolitan region. Of the six metropolitan regions, the Eastern region is experiencing the highest amount of tree cover loss, with significant loss on residential land and parkland. The Inner South East region is also experiencing significant loss on average, second in magnitude and proportion of loss behind the Eastern region, with losses concentrated on residential land. The Southern region sees more limited vegetation cover loss across the region concentrated on residential land, and counter to the Eastern and Inner South East regions it sees a modest increase in vegetation on infrastructure land (streets).

The rate of loss in the eastern and south eastern suburbs is a concern. The loss across these regions on residential land highlights the impact of redevelopment and potentially changing resident priorities in terms of space utilisation on their land, as well as broader climatic impacts. The loss on parkland in the east warrants further investigation and raises questions about the competing uses of public land, vegetation management practices, and the impact of climate and other vegetation factors that may affect vegetation health and viability.

The findings in this report are based on vegetation data that is extensive and has high spatial resolution. The two periods of data acquisition (summer 2014 and summer 2018) allow for insightful investigation of change over time. However, the time period of 4 years provides limited opportunity to detect the planting and growth of new trees, limiting the ability to evaluate planting interventions, or to evaluate policy and program mechanisms that require or encourage planting. A program of ongoing data acquisition would provide more powerful time series data to improve understanding of trends, aid monitoring and evaluation, and to guide investment priorities.

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Acknowledgment of Country

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