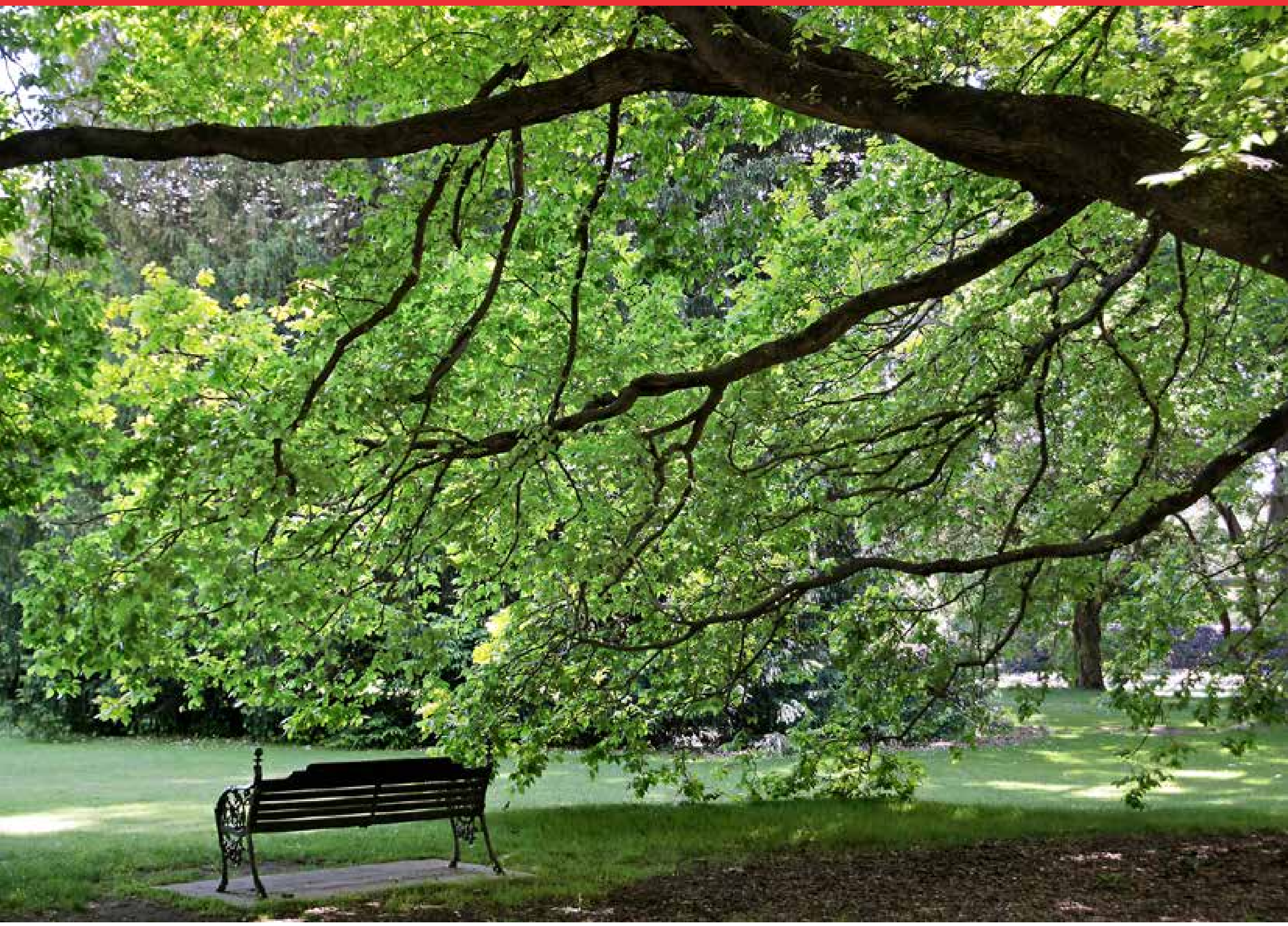
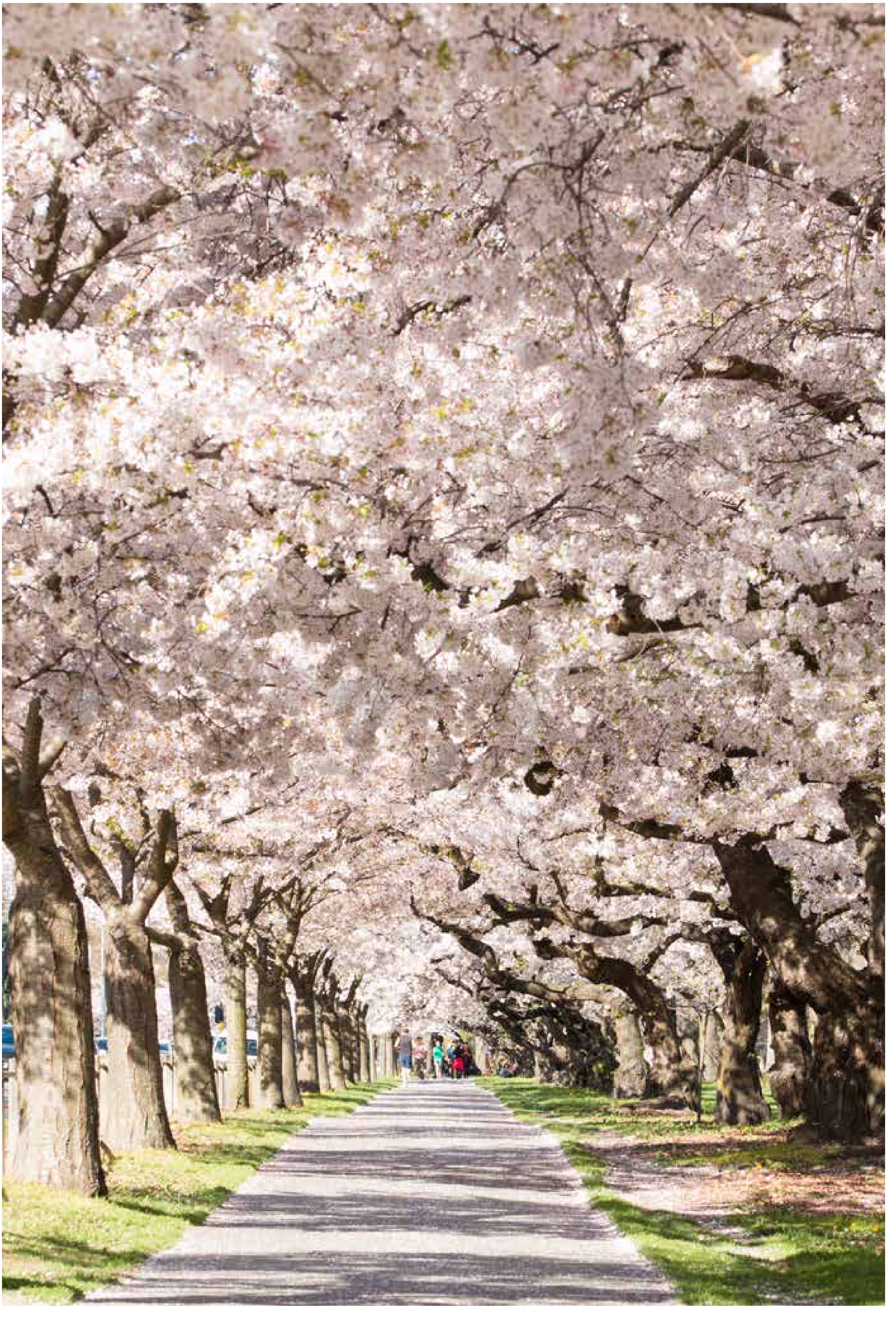
Tree Canopy Cover in Christchurch, New Zealand 2018/19

Report prepared for the Christchurch City Council
by Justin Morgenroth, University of Canterbury
04 February 2022





Executive Summary

Tree canopy cover (TCC) is an important way of describing urban forest extent and distribution and can be used to assess the ecosystem services they provide. Tree canopy cover was mapped for Christchurch, New Zealand by Orbica Ltd. Their deep-learning approach identified and delineated tree cover from aerial imagery and LiDAR data acquired over Christchurch during 2018/19. Using this tree cover map, canopy area and cover were determined for various geographic boundary types, including wards, District Plan zones, publicly- and privately-owned land, street catchments, water body setbacks, and parks.

The mapped tree canopy cover in Christchurch for 2018/19 was 13.56%, ranging between 6.51% in Hornby to 27.6% in Coastal. Tree cover in each of the District Plan's zones ranges from 2.01% in Mixed Use zones to 23.24% in Open Space Zones. Tree cover on publicly-owned land comprises 42.96% of the total tree cover in Christchurch (publicly-owned land has 18.95% canopy cover), with the remaining 57.04% being on privately-owned land (privately-owned land has 11.17% canopy cover). Canopy cover within street catchments was 9.22%, within water body setbacks was 20.86%, and within parks and reserves was 25.07%.

The tree canopy cover map has an overall accuracy of 97.8%. However, the accuracy assessment identified an omission error rate (10.2%), roughly double that of the commission error rate (5.04%) for trees. A point sample-based approach to estimating canopy cover, suggests that 2018/19 canopy cover in Christchurch is 14.7% with a 95% confidence interval of between 12.51% - 16.90%. Taken together, the relatively high omission error rate and the 14.7% canopy cover estimate from the sample-based approach, suggest that the tree cover map resulting from the deep-learning approach may have slightly underestimated tree canopy cover. Despite this, the mapped tree cover is well within the calculated 95% confidence interval, so should be viewed with certainty.

Suggested citation: Morgenroth, J. (2022) 2018/19 Tree Canopy Cover in Christchurch, New Zealand. Prepared for the Christchurch City Council. http://dx.doi.org/10.26021/m6sm-mr11

Background

The Christchurch City Council (CCC) is developing an Urban Forest Plan to guide policy and management decisions related to planted- and naturally-regenerating trees within the Christchurch city area. Understanding the extent and distribution of existing tree canopy cover in the city is integral to developing such a document. Tree canopy cover (TCC) is the total area of tree crowns projected onto the ground, expressed as a percentage of total ground area.

Tree canopy cover is the most widely used descriptor of urban forest structure. Because of this, knowing Christchurch's tree canopy cover will allow decision makers to compare TCC in Christchurch with other cities in New Zealand and abroad. It will also allow decision makers to monitor TCC changes in Christchurch over time to ensure desirable levels of TCC exist throughout the city. A previous canopy cover mapping report[1] for Christchurch, representing TCC in 2015/16, provides a baseline for any temporal comparisons of TCC.

This report provides a snapshot of tree canopy cover in Christchurch during the summer of 2018/2019, corresponding to the dates of acquisition of both aerial imagery and LiDAR data used in the analysis.

1 Morgenroth, J. (2017) Tree Canopy Cover in Christchurch, New Zealand. Prepared for the Christchurch City Council.

Methodology

Study Area

The study area was defined by the overlapping areas of aerial photography and LiDAR data (Figure 1). This included 15 of 16 wards, excluding only the Banks Peninsula ward.

Tree Cover Mapping

Tree cover mapping was undertaken by Orbica Ltd. using a deep-learning approach. Semantic segmentation identified individual trees as well as groups of trees from the aerial imagery. LiDAR data were used to exclude tree objects that were shorter than 3.5 m in height. Methodological details of the mapping were not provided, but are assumed to be correct.

The threshold of 3.5 m height was selected for two reasons. Firstly, the ecosystem services provided by trees generally increase with tree size, so including smaller trees in this analysis would not contribute further to an understanding of the ecosystem services provided by Christchurch's urban forest. Secondly, this is the same height threshold used in the 2015/16 tree canopy cover mapping for Christchurch, so comparisons between the two time periods can be made more readily.

All tree cover areas reported are inclusive of all tree and forest types, unless otherwise stated. This includes, but is not limited to, park and reserve trees, street trees, trees on private property, orchards, remnant patches of native forest, hedgerows, and trees in commercially-managed, forestry plantations.

Imagery Used in the Analysis

The aerial imagery used for this analysis is the 'Christchurch 0.075 m Urban Aerial Photos (2018-2019)' available on the LINZ Data Service (https://data.linz.govt.nz/layer/104499). The aerial LiDAR data used in the analysis is the 'Canterbury - Christchurch and Ashley River LiDAR 1m DEM (2018-2019)' and the 'Canterbury - Christchurch and Ashley River LiDAR 1m DSM (2018-2019)', both available from the LINZ Data Service (https://data.linz.govt.nz/layer/104499-canterbury-christchurch-and-ashley-river-lidar-index-tiles-2018-2019/).

Ancillary Boundaries Used in the Analysis

In order to produce tree canopy cover estimates for areas of interest, geographic boundaries for these areas were needed. The areas of interest and the corresponding geographic boundaries used are:

- Wards – 'Ward 2019 Clipped (generalised)', sourced from Stats NZ https://datafinder.stats.govt.nz/layer/98740-ward-2019-clipped-generalised/
- District Plan Zones – Updated on January 12, 2018 and sourced from Canterbury Maps, https://opendata.canterburymaps.govt.nz/datasets/district-plan-zones/explore
- Parks – 'CorporateData/Park', sourced from ArcGIS REST Services Directory, facilitated by Spatial Information Team, CCC
- Street catchments – 'CorporateData/Transport/AssetStreetCatchment', sourced from ArcGIS REST Services Directory, facilitated by Spatial Information Team, CCC
- Waterbody setbacks – 'CorporateData/DistrictPlanOperative / DistrictPlanWaterBodySetback', sourced from ArcGIS REST Services Directory, facilitated by Spatial Information Team, CCC
- Publicly- and privately-owned land – Boundaries for land parcels within Christchurch City that are owned or controlled by Christchurch City Council, the Crown or Utilities were sourced from the Spatial Information Team, CCC

Accuracy Assessment

The quality of the tree canopy cover boundaries produced by Orbica Ltd. was determined by means of a formal accuracy assessment. The accuracy assessment uses a standardised approach, comparing what has been mapped as tree canopy cover with what can be seen in the aerial photographs and LiDAR data.

One thousand sample points were randomly distributed within the study area and each of these was assigned a 'reference' land cover based on what was observed at the location defined by each point in the aerial imagery. The 'reference' land cover is the true land cover. Each point was also assigned a 'classified' land cover based on the tree cover polygon mapping at the location defined by each point.

The result of the accuracy assessment is an error matrix (Table 1) that quantifies the overall accuracy of the tree cover classification as well as the errors of commission (land that was classified as tree cover, but shouldn't have been) and errors of omission (land that was not classified as tree cover, but should have been).

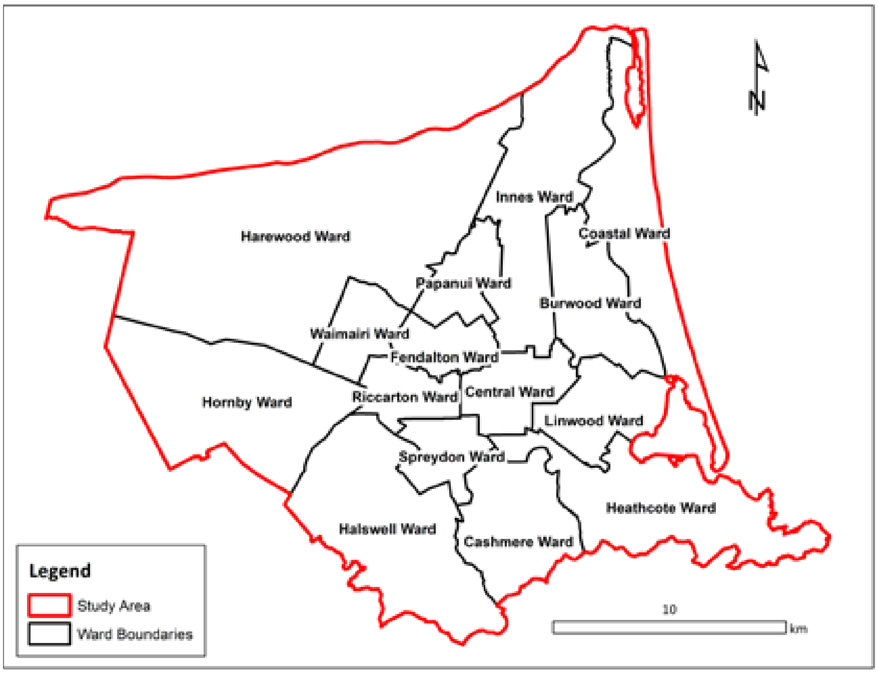


Figure 1 – The study area and ward boundaries used to determine tree canopy cover in this study.

Results

Accuracy of Tree Cover Classification

The error matrix shown in Table 1 shows that the classification, undertaken to identify and map tree cover within Christchurch, had an overall accuracy of 97.8%. While overall classification accuracy was high, the omission error rate (10.20%) was roughly double the commission error rate (5.04%). This suggests that tree cover was under-estimated.

The under-estimation of tree canopy cover is further supported by the fact that 147 out of 1000 random sample points, distributed in order to perform this accuracy assessment, corresponded to trees. This sample-based approach suggests that canopy cover in Christchurch is 14.7% with a 95% confidence interval of between 12.51% - 16.90%.

Taken together, the relatively high omission error rate and the 14.7% canopy cover estimate from the sample-based approach, suggest that the deep-learning approach has slightly underestimated tree canopy cover. Despite this, the mapped tree cover is well within the calculated 95% confidence interval, so should be viewed with certainty.

Tree Cover in Christchurch

The study area covers 44,231.09 ha, of which 13.56% (5,998.56 ha) is covered by tree canopy (Figure 2). Tree canopy cover is highly variable within Christchurch's 15 wards, ranging between 6.51% in Hornby to 27.6% in Coastal (Table 2, Figure 3). Five wards had tree canopy cover exceeding 15%, including Coastal ward (27.6%), Cashmere (21.19%), Fendalton (19.11%), Innes (18.97%), and Waimairi (15.18%). In contrast, four wards had canopy cover lower than 10%, including Heathcote (9.86%), Halswell (9.81%), Linwood (8.92%), and Hornby (6.51%).

The study area covers 44,231.09 ha, of which 13.56% (5,998.56 ha) is covered by tree canopy.

Table 1 - The error matrix showing the results of the classification accuracy assessment.

		Classified land cover		Producer's Accuracy
		Tree cover	Other land cover	
Reference land cover	Tree cover	132	15	89.90
	Other land cover	7	846	99.18
	User's Accuracy	94.96	98.26	

- Overall Accuracy = 97.8%
- Commission Error $_{(Trees)}$ = 1 – User's Accuracy = 5.04%
- Omission Error $_{(Trees)}$ = 1 – Producer's accuracy = 10.20%

For a definition of these terms, see the Glossary

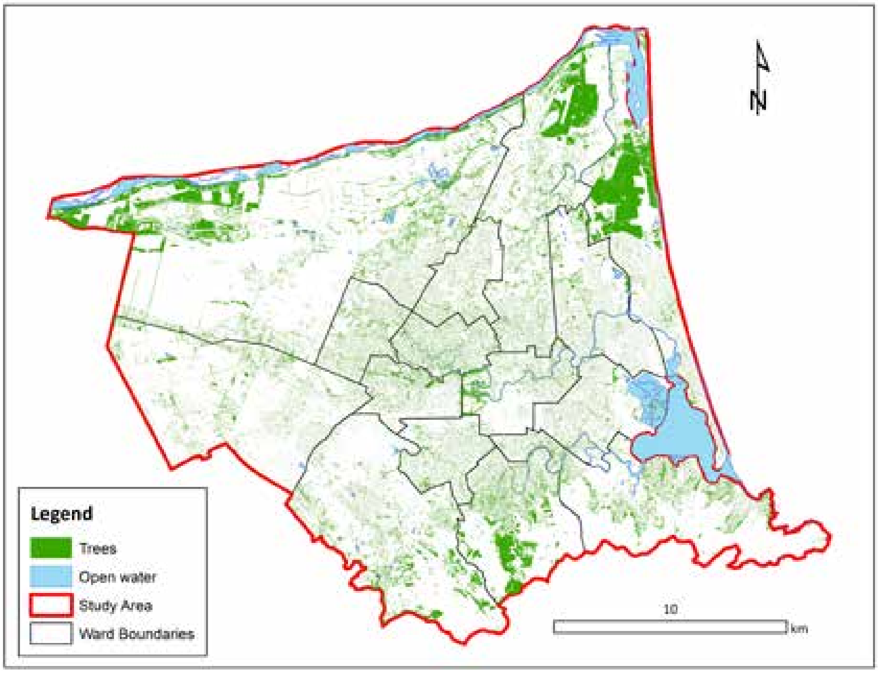


Figure 2 – Tree cover in Christchurch.

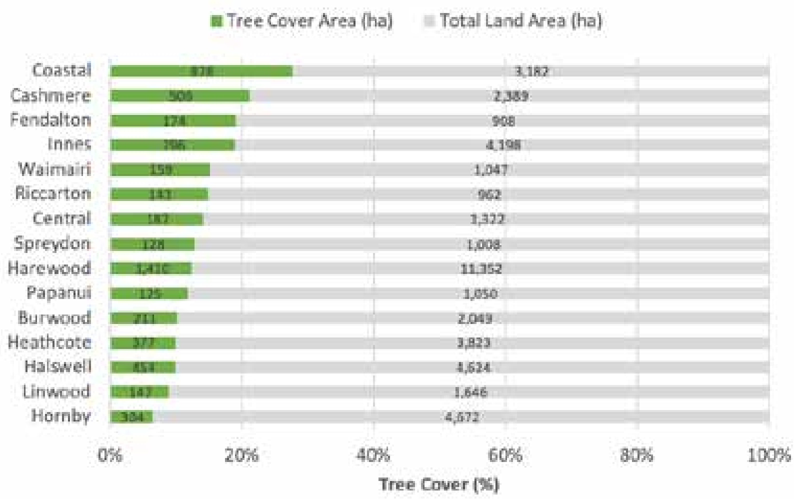


Figure 3 – Tree cover (%) within wards. Tree cover area and total land area within wards are also shown as labels on the bars.

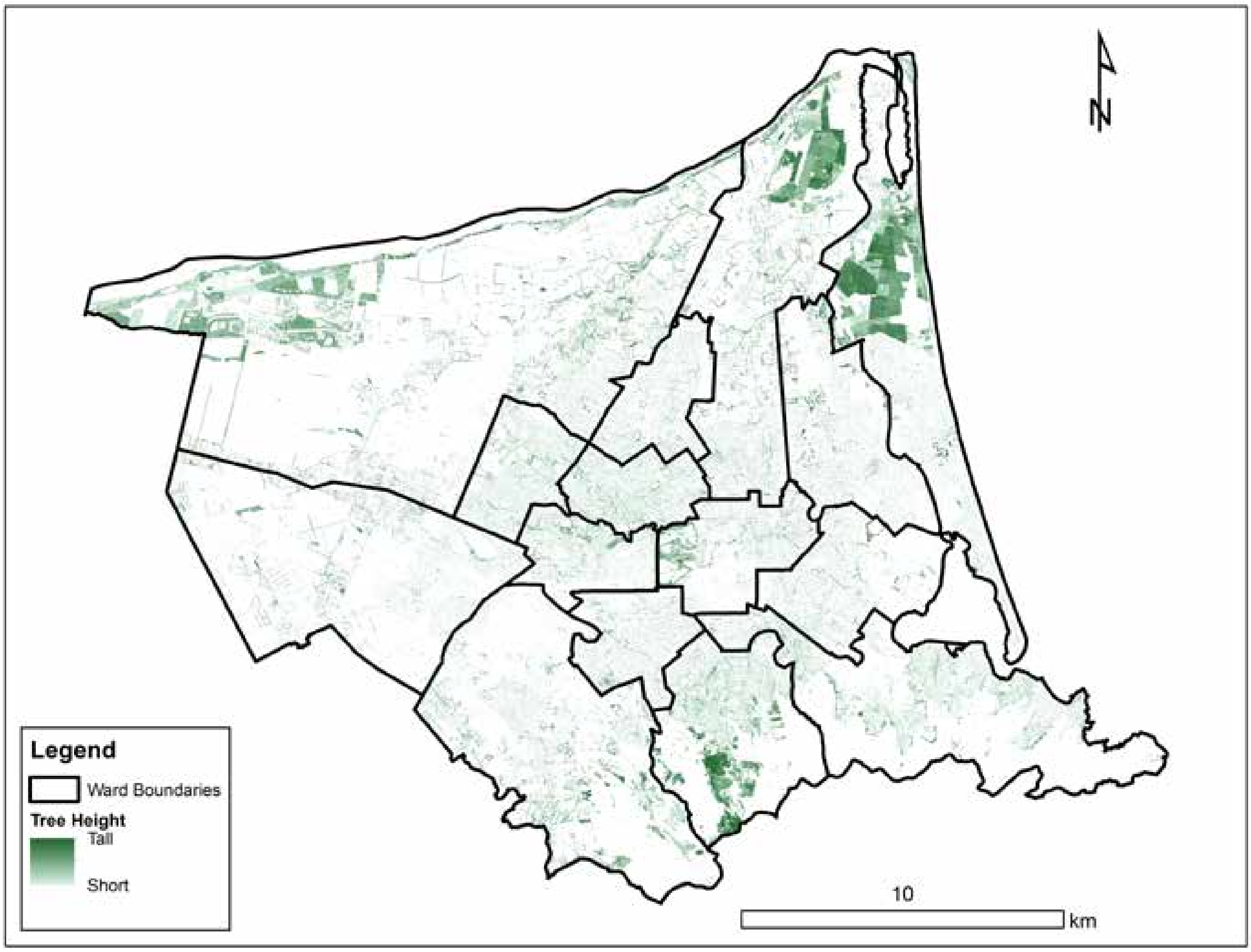


Figure 4 – Tree canopy height distribution throughout Christchurch. Ward boundaries are shown for context.

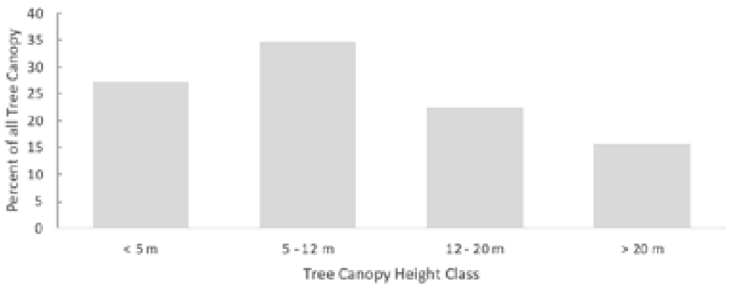


Figure 5 – Tree canopy height distribution in Christchurch.

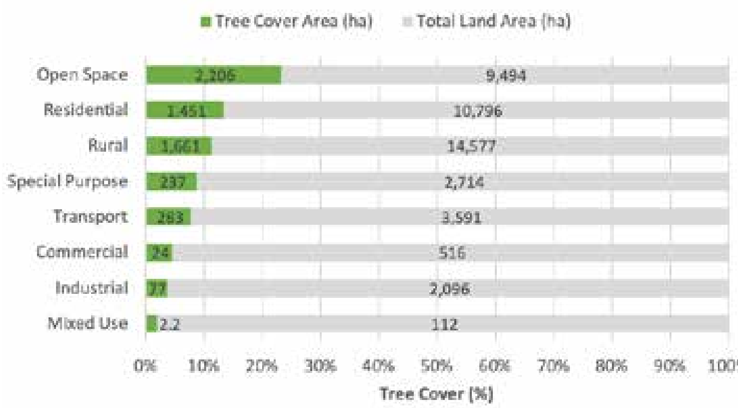


Figure 6 – Tree cover (%) within different District Plan zone types. Tree cover area and total land area within District Plan zone types are also shown as labels on the bars.

Tree Canopy Height Distribution

The LiDAR data allow for an understanding of the height of tree canopy throughout Christchurch. Tree heights varied between roughly 3.5 m to over 45 m, with the vast majority of tall trees found in clusters (e.g. plantation forests, Pūtaringamotu/Riccarton Bush, shelterbelts, parks) throughout the city (Figure 4).

Canopy height distribution across isn't entirely evenly distributed (Figure 5), but it does not show any particular height class dominated the urban forest. The percentage of all canopy having heights less than 5 m was 27.24%, increasing to 34.69% for canopy between 5 and 12 m. Canopy heights between 12 and 20 m comprised 22.44% of all canopy, and finally heights exceeding 20 m were found in 15.62% of all canopy.

Tree Cover by District Plan Zone Type

The study area can be subdivided into eight zone types according to the District Plan. These include, in order of decreasing land area: Rural, Residential, Open space, Transport, Special purpose, Industrial, Commercial, and Mixed use. Open space zones include parks, but also other land uses, so should not be compared directly to park canopy cover. Full descriptions of zone types can be found in the District Plan.

Tree cover in each of these zones ranges from 2.01% in Mixed Use zones to 23.24% in Open Space Zones (Figure 6, Table 3). Roughly 89% of all tree canopy area in Christchurch is distributed throughout Open Space (37%), Rural (28%), and Residential zones (24%) which are, incidentally, the three zones with the greatest land area (Table 3). It may be of interest to understand tree cover in the areas of Christchurch with relatively high population densities. As such, if we consider District Plan zone types, excluding Rural, then Christchurch has 14.6% canopy cover (4,280 ha of trees in 29,318 ha of non-rural land).

Tree Cover on Privately- and Publicly-owned Land

Tree cover on publicly-owned land comprises 42.96% of the total tree cover in Christchurch, with the remaining 57.04% being on privately-owned land (Figure 7). Publicly-owned land was determined to be all land under Council or Crown ownership. The total area of land within the study area that is publicly owned is 13,595.95 ha, of which 18.95% (2,577.21 ha) is covered by tree canopy (Table 4). Publicly-owned land was broken down into 4 ownership types, each of which comprised differing proportions of the total tree cover on publicly-owned land: Council (65.1%), Council Controlled (0.09%), Crown (33.99%), and Utility (0.82%).

Privately owned land was determined to be all land not under Council or Crown ownership. The total area of land within the study area that is privately owned is 30,635.14 ha, of which 11.17% (3,421.35 ha) is covered by tree canopy (Table 4).

42.96% of tree cover in Christchurch is on public land.

Tree Cover in Street Catchments

The total area of street catchments within the study area is 4,046.47 ha, of which 9.22% (373.16 ha) is covered by tree canopy. Tree cover area within street catchments comprises 6.22% of the total tree cover in Christchurch. Tree canopy area is correlated with street catchment area, and tree cover is generally consistent across different street catchment hierarchies, with all but one having values between 6.65% - 10.54% (Figure 8, *Table 5*). Pedestrian streets were the exception, having roughly twice the canopy cover of other street hierarchies (16.25%).

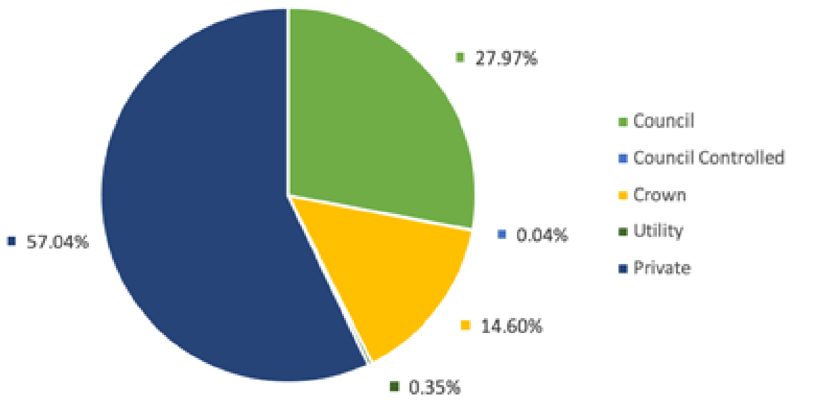


Figure 7 – Proportion of the city's total tree cover on privately- and publicly-owned land. Public land includes Council, Council Controlled, Crown, and Utility.

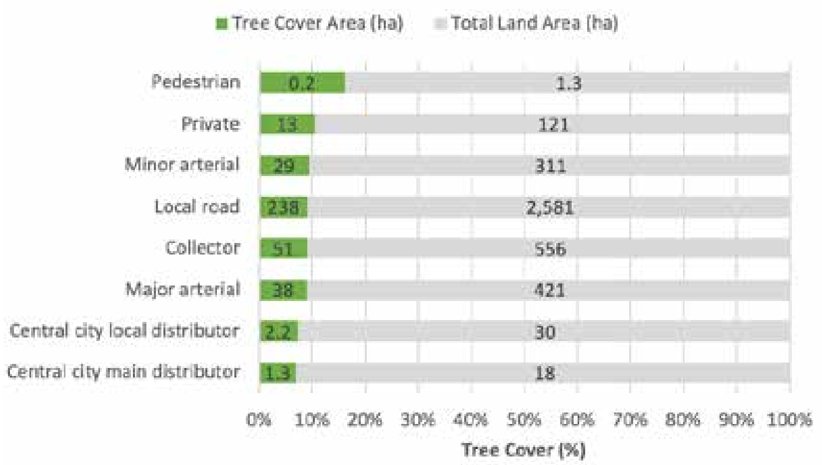


Figure 8 – Tree cover (%) within different street hierarchies. Tree cover area and total land area within street hierarchies are also shown as labels on the bars.

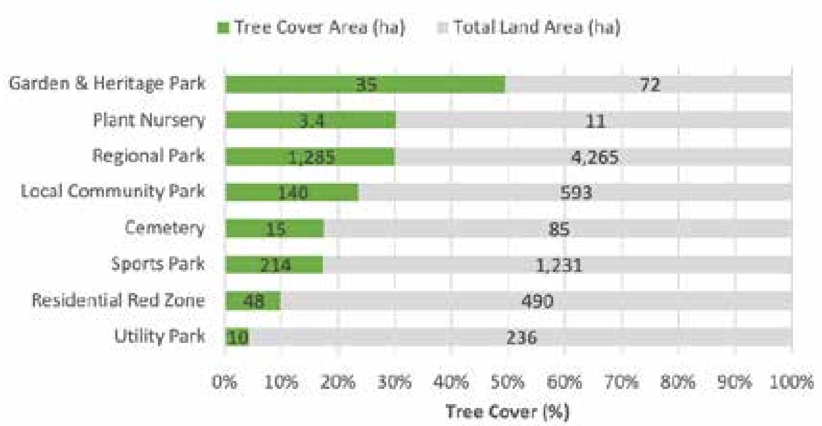


Figure 9 – Tree cover (%) within different park types. Tree cover area and total land area within parks are also shown as labels on the bars.

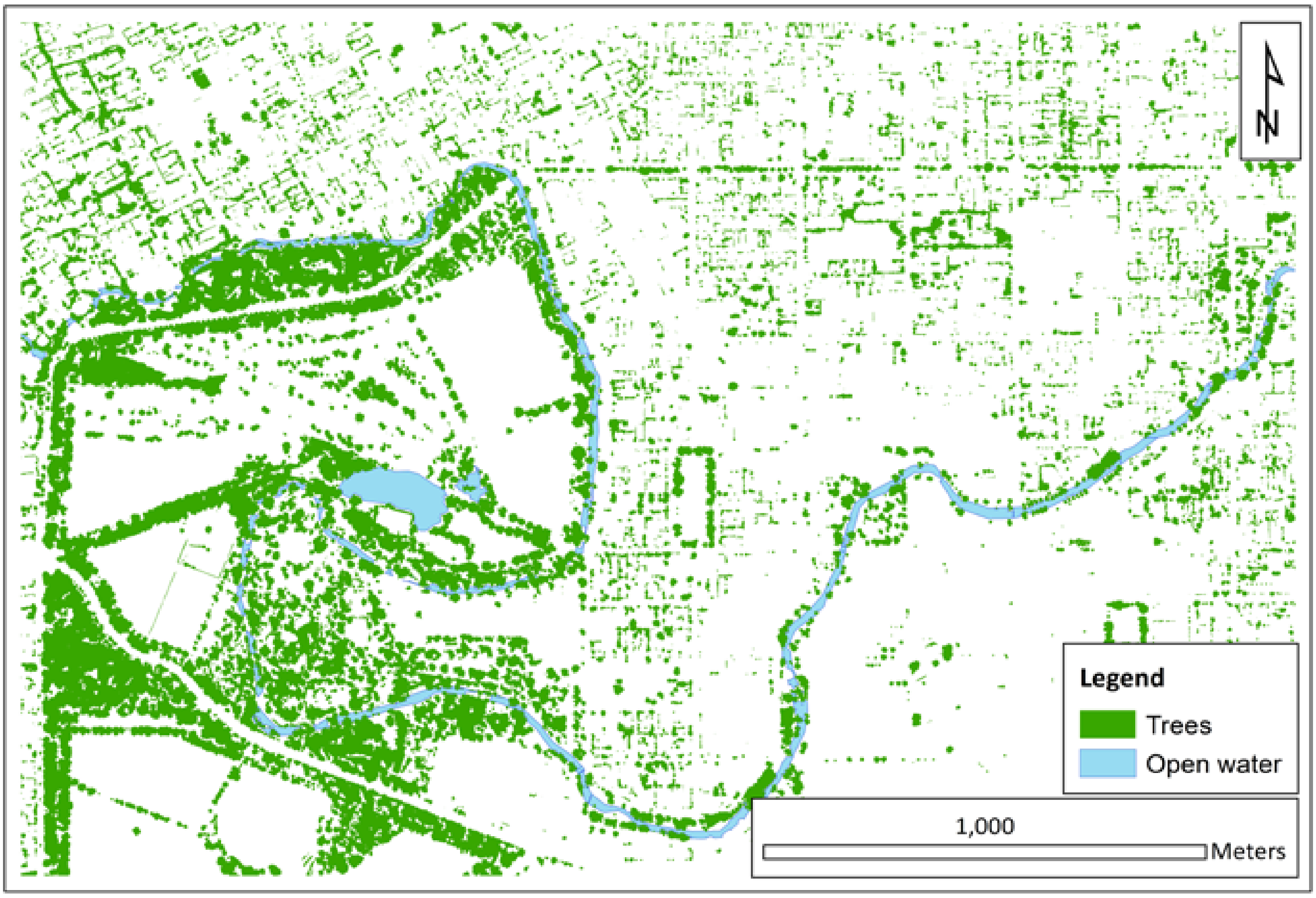


Figure 10 – Tree canopy cover in Hagley Park is a major contributor to the overall tree canopy cover in the Central ward. Parks and reserves play an important role for maintaining and enhancing tree cover in areas where tree cover is low.

Tree Cover in Parks and Reserves

The total area of parks and reserves within the study area is 6981.99 ha, of which 25.07% (1,750.14 ha) is covered by tree canopy. Tree canopy cover varies across different park types, ranging from 4.19% in Utility Parks to 49.42% in Garden & Heritage Parks (Figure 9, Table 6). Trees in parks and reserves are an important contributor to Christchurch's urban forest, comprising 29.18% of Christchurch's total tree cover. This is especially true in areas with otherwise low tree canopy cover (Figure 10).

Tree Cover in Water Body Setbacks

Water body setbacks are areas of defined width running parallel to the bank of a water body. They overlay various District Plan zone types across public and private property. The total area of water body setbacks in the study area is 2,698.06 ha, of which 20.86% (562.78 ha) is covered by trees. The tree cover area within water body setbacks covers a range of different private and public property types, roughly half of which is in Open Space (268.62 ha), while roughly one-fifth is in Residential and Rural zone types (Table 7).

Christchurch's parks are important contributors to the city's canopy cover. Roughly one-quarter of their area is covered by trees.

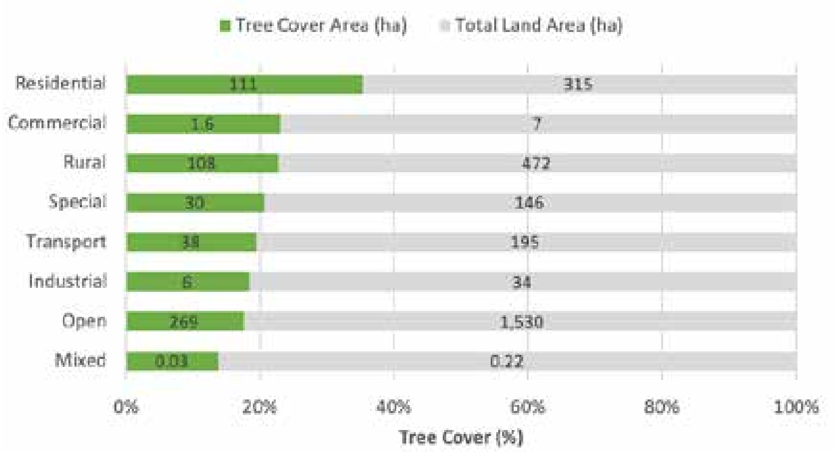


Figure 11 – Tree cover (%) within water body setbacks, split by different District Plan zones. Tree cover area and total land area within water body setbacks are also shown as labels on the bars.

Changes in Christchurch's Tree Canopy Cover

There are some areas where obvious tree cover losses can be seen between 2015/16 and 2018/19. The main areas of large-scale tree cover loss result from plantation forest harvesting in Bottle Lake Forest, Chaney's Forest, and McLeans Forest, as well as harvesting or salvage logging following the Port Hills fire in 2017 (Figure 12). Importantly, many of these areas have already been, or will be replanted.

Apart from these large-scale tree cover losses, many individual trees and small groups of trees were removed during the two time periods. While the reasons for this were not specifically considered for the purposes of this report, previous research suggests that development activities, largely a consequence of rebuilding due to the 2010/11 Canterbury Earthquake Sequence, play a role[1,2,3].

Canopy cover gains were also evident, with large areas of plantings visible in Chaney's Forest, Bottle Lake Forest, and McLeans Forest (Figure 12). There are also extensive restoration plantings throughout Christchurch that will undoubtedly be identified by future canopy cover mapping undertakings, but were too short to be captured in 2018/19 (due to the 3.5 m threshold used to identify trees).

Detailed changes in canopy cover for parks, streets, and publicly- and privately-owned land are provided in Table 8.

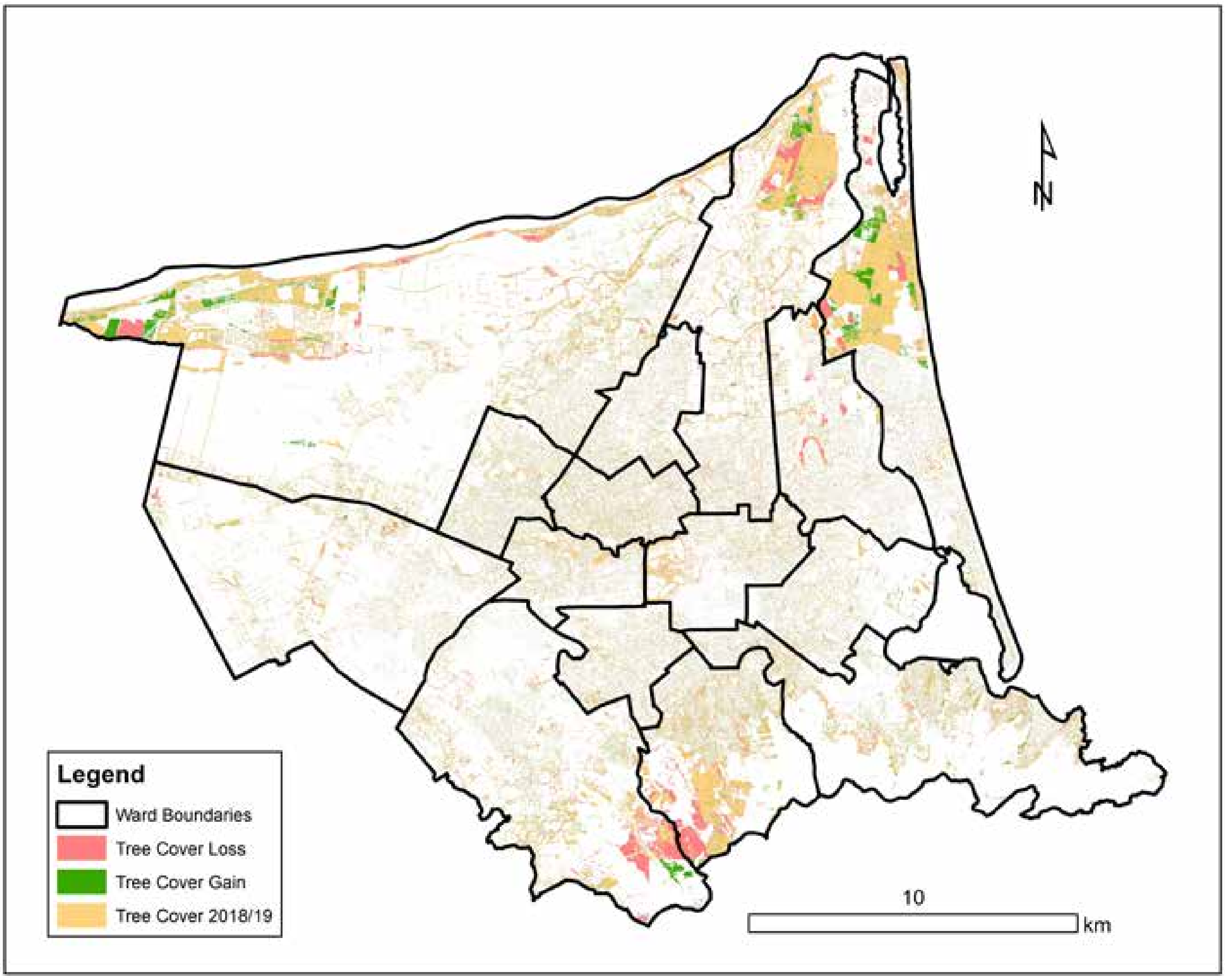


Figure 12 – Tree losses and gains between 2015/16 and 2018/19.

1 Morgenroth, J., O'Neil-Dunne, J., & Apiolaza, L. A. (2017). Redevelopment and the urban forest: A study of tree removal and retention during demolition activities. Applied Geography, 82, 1-10.

2 Guo, T., Morgenroth, J., & Conway, T. (2018). Redeveloping the urban forest: The effect of redevelopment and property-scale variables on tree removal and retention. Urban Forestry & Urban Greening, 35, 192-201.

3 Guo, T., Morgenroth, J., Conway, T., & Xu, C. (2019). City-wide canopy cover decline due to residential property redevelopment in Christchurch, New Zealand. Science of the Total Environment, 681, 202-210.

Interpreting Differences in Canopy Cover Between 2015/16 and 2018/19

Comparisons between the data presented in the 2015/16 tree canopy cover report and this 2018/19 tree canopy cover report should be made with caution and with a full understanding of the differences in geographic boundaries used, as well as the methods used to map tree cover in both years.

While tree cover is presented for many of the same geographic boundaries (e.g. wards, parks, streets) in both 2015/16 and 2018/19, the boundaries or the descriptions of those geographies changed between the two time periods in many cases. Those changes include, but are not limited to:

- Changes to ward boundaries were implemented in 2016
- Park types were altered (e.g. a new type called 'Residential Red Zone' was added)
- Street catchment hierarchies were altered (e.g. a new hierarchy called 'Central city local distributor' was added)
- Boundaries defining privately- and publicly-owned land were considerably altered

In addition to boundaries and descriptions of geographic areas, the methods used to generate tree cover extents and distributions differed. As previously detailed, the 2018/19 tree canopy cover mapping, upon which all the results are based, likely underestimates the actual by tree canopy cover in the city. The point-sampling approach used for accuracy assessment, suggested that canopy cover in Christchurch was 14.7% with a 95% confidence interval between 12.51% - 16.90%. Meanwhile the tree canopy cover mapping in 2018/19 yielded a canopy cover of 13.56%, towards the bottom of that 95% confidence interval. Given that the accuracy assessment also identified that the tree class' omission error was double the commission error, it's probable that the tree canopy area and cover number presented throughout the results is a slight underestimate.

As a consequence of the differences in conditions between the 2015/16 and 2018/19 tree cover reports, direct comparisons between the two time periods should be made cautiously, with due consideration given to the effects of the changes detailed herein.

Summary of Key Results

This report has identified a number of key results that will help the Christchurch City Council develop their Urban Forest Plan. These include:

- 13.56% of all land in Christchurch, excluding Banks Peninsula is covered by trees
  - Hornby has the lowest canopy cover (6.51%), while Coastal has the highest canopy cover (27.6%)
- Tree cover on publicly-owned land comprises 42.96% of the total tree cover in Christchurch, with the remaining 57.04% being on privately-owned land
  - 18.95% of the publicly-owned land in Christchurch is covered by trees
  - 11.17% of the privately-owned land in Christchurch is covered by trees
- 9.22% of the land within Christchurch's street catchments is covered by trees
- 25.07% of the land within Christchurch's parks and reserves is covered by trees
- 20.86% of the land within Christchurch's water body setbacks is covered by trees

Next Steps

This canopy cover assessment should be considered as the first step towards improving the policy and strategic management of Christchurch's urban forest. Future work could include:

- **Manual editing**
  As evidenced by the accuracy assessment, there are small errors in the tree cover classification. These errors can only be corrected via manual editing. Depending on future uses of this data, manual correction may be desirable or necessary.

- **TCC comparison**
  Tree canopy cover in Christchurch could be compared with relevant cities worldwide. Knowing what tree cover is in cities with comparable characteristics (e.g. climate, population), could help Christchurch set tree canopy cover targets.

- **TCC comparison within Christchurch**
  Comparing tree canopy cover across different wards (or other spatial units of interest) could lead to prioritising planting programs in wards with low tree canopy cover, or prioritising tree maintenance budgets in wards with high tree cover.

- **Determining Christchurch's potential tree cover increase**
  By quantifying available planting space within Christchurch that is not currently covered by trees, it is possible to determine the maximum potential tree canopy cover. This will help in establishing achievable tree canopy cover goals.

- **Quantifying tree species diversity**
  Understanding tree species diversity is used by many councils globally to inform planting strategy and to mitigate risk from climate change, pests, or disease.

- **Regular monitoring**
  Tree canopy cover should continue to be monitored regularly. Using an approach comparable to that undertaken in this report relies on the regular acquisition of aerial photography and LiDAR. Should aerial photography and LiDAR be unavailable in the future, a ground-based approach (e.g. using a NZ version of i-Tree) could be employed. Regularly monitoring of changes in tree cover can help to assess whether current policies/management are effective, and inform future policies/management.

Appendices

The appendices below provide the data tables used to produce the graphs and maps in the Results sections in this report.

Ward by Ward Tree Cover

Table 2 - Tree canopy cover description within Christchurch's wards. Wards are ordered alphabetically.

Ward Name	Ward Area (ha)	Tree Cover (ha)	Tree Cover (%)
Burwood	2,049.09	210.84	10.29
Cashmere	2,389.46	506.43	21.19
Central	1,321.75	186.71	14.13
Coastal	3,181.81	878.06	27.60
Fendalton	907.99	173.54	19.11
Halswell	4,623.75	453.66	9.81
Harewood	11,352.22	1,410.00	12.42
Heathcote	3,822.62	377.09	9.86
Hornby	4,672.41	304.10	6.51
Innes	4,198.05	796.22	18.97
Linwood	1,645.55	146.74	8.92
Papanui	1,049.93	124.59	11.87
Riccarton	961.80	143.09	14.88
Spreydon	1,007.50	128.50	12.75
Waimairi	1,047.19	158.99	15.18

Tree Cover by District Plan Zone Type

Table 3 – Tree area and cover in the District Plan zones within Christchurch.

Zone Type	Zone Area (ha)	Tree Cover (ha)	Tree Cover (%)
Commercial	515.53	23.74	4.60
Industrial	2,095.77	77.19	3.68
Mixed Use	111.71	2.25	2.01
Open Space	9,493.73	2,206.30	23.24
Residential	10,795.75	1,450.56	13.44
Rural	14,577.16	1,660.74	11.39
Special Purpose	2,714.04	236.97	8.73
Transport	3,591.10	282.58	7.87

Tree Cover on Privately- and Publicly-owned Land

Table 4 – Canopy cover for trees on publicly- and privately-owned land.

	Description	Land Area (ha)	Tree Cover (ha)	Tree Cover (%)
Public	Council	7,161.09	1,677.72	23.43
	Council Controlled	22.79	2.20	9.67
	Crown	5,485.89	876.05	15.97
	Utility	926.18	21.23	2.29
	Private	30,635.14	3,421.35	11.17

Tree Cover in Street Catchments

Table 5 - Tree canopy cover description within Christchurch's street catchments, broken down by hierarchy.

Street Hierarchy	Hierarchy Area (ha)	Tree Cover (ha)	Tree Cover (%)
Central city local distributor	29.93	2.18	7.28%
Central city main distributor	18.41	1.30	7.05%
Collector	556.09	51.03	9.18%
Local road	2,581.47	238.47	9.24%
Major arterial	421.09	37.89	9.00%
Minor arterial	310.63	29.24	9.41%
None	1.13	0.08	6.65%
Pedestrian	1.32	0.22	16.25%
Private	121.18	12.78	10.54%

Tree Cover in Parks and Reserves

Table 6 - Tree canopy cover description within Christchurch's parks and reserves.

Park Type	Park Area (ha)	Tree Cover (ha)	Tree Cover (%)
Cemetery	84.81	14.82	17.48%
Garden & Heritage Park	71.66	35.42	49.42%
Local Community Park	592.61	139.53	23.54%
Plant Nursery	11.24	3.40	30.25%
Regional Park	4,265.02	1,285.00	30.13%
Residential Red Zone	489.66	48.08	9.82%
Sports Park	1,230.77	213.99	17.39%
Utility Park	236.23	9.89	4.19%

Tree Cover in Water Body Setbacks

Table 7 – Tree cover and area within water body setback areas, broken down by District Plan Zones.

Zone Type Within Water Body Setbacks	Zone Area (ha)	Tree Cover (ha)	Tree Cover (%)
Commercial	6.84	1.57	23.01%
Industrial	34.25	6.30	18.39%
Mixed Use	0.22	0.03	13.76%
Open Space	1,529.65	268.62	17.56%
Residential	314.78	110.97	35.25%
Rural	472.19	107.56	22.78%
Special Purpose	145.61	29.97	20.58%
Transport	194.53	37.77	19.42%

Detailed Changes in Tree Canopy Cover

As described previously, many of the boundaries used in the 2015/16 Christchurch tree cover analysis have changed. This makes direct comparisons between the two timeframes invalid. A partial solution to this issue is to compare tree cover between 2015/16 and 2018/19 using only one set of boundaries. The comparison of tree cover areas for both 2015/16 and 2018/19 in Table 8 uses only the 2015/16 boundaries to allow for a comparison.

Table 8 – A comparison of tree cover area in 2015/16 and 2018/19 within publicly- and privately-owned land, street catchments, and parks and reserves.

Boundary	Boundary Area (ha) 2015/16	Tree Cover Area (ha) 2015/16	Tree Cover Area (ha) 2018/19	Tree Cover Change (ha)	Tree Cover Change (%)
Privately-owned land	38,271.73	5,030.38	4,370.40	-659.98	-13.12%
Publicly-owned land	6,827.17	1,691.66	1,627.55	-64.11	-3.79%
Street catchments	3,839.95	421.29	373.92	-47.37	-11.24%
Parks and Reserves	6,098.57	1,752.40	1,681.32	-71.08	-4.06%

Glossary

Commission error: objects that were classified as a particular land cover (e.g. tree), but should not have been (e.g. the object was actually a building). Commission errors are calculated separately for each land cover class. See figure below for an example.

Omission error: objects that were not classified as a particular land cover, but should have been. For example, a tree in the imagery was not classified as a tree, but instead as a building. Omission errors are calculated separately for each land cover class. See figure below for an example.

From the perspective of tree cover accuracy, the image at left shows a commission error – an object that is not a tree (it is a building) has been classified as a tree. The image at right shows an omission error – an object that is a tree has not been classified as a tree, it has been classified as a building.

95% confidence interval: a range of values defining an upper and lower limit, such that there is a 95% probability that the value of a parameter lies within.

Associate Professor Justin Morgenroth

T: +64 3 369 5966
E: justin.morgenroth@canterbury.ac.nz

School of Forestry | Kura Ngahere
University of Canterbury
Te Whare Wānanga o Waitaha
Private Bag 4800
Christchurch 8140
New Zealand

www.canterbury.ac.nz/engineering/contact-us/people/justin-morgenroth.html

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