

Urban or suburban? Examining the density of Australian cities in a global context

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Abstract

Australia is regularly cited as one of the most highly urbanised countries in the world. However, a significant proportion of people living in Australia's three largest cities live at relatively low 'suburban' densities. Analysis of the patterns of density in Brisbane, Melbourne, Sydney, Vancouver, Montreal and London highlights the fact that Australia's reputation as a highly urbanised perhaps belies the predominance of low density development across Australia's metropolitan areas. Australian cities have relatively lower proportion of their total populations living in areas on mid-density (between 60 and 200 pph). Instead they feature pockets of high density among a background of low density. Other comparator cities, Montreal and London in particular, have relatively low proportions of people living in very high density areas, but feature a high proportion living in mid-density areas. This raises the question as to how the densification of Australian cities has been achieved, and whether there are alternative models that might be considered as they continue to grow.

Introduction

The Australian Bureau of Statistics (ABS) defines Major Urban Areas as those cities with a population exceeding 100,000 people (ABS, 2011, p24). By this definition approximately 89% of Australia's population live in Major Urban areas (World Bank, 2015). This type of 'evidence' leads to the common claim that Australia is one of the most highly urbanised countries in the world (for example see Maher, 2015; WHO, 2015). Although a significant proportion of Australia's population does live in a small number of large cities, this fact says nothing about one of the most significant dimensions of urbanisation: population density.

In the interest of exploring these issues further, this paper compares the population density of Australian cities to those of other nations with a view to better understanding the unique qualities of Australia's specific type of urbanisation. Various analyses have been undertaken for three Australian cities (Brisbane, Melbourne and Sydney) and three international cities (Vancouver, Montreal and London). Initially, the average and weighted average densities for the cities are compared, and specific examples of areas with the weighted average are identified. We then consider the distribution of density within these cities using the concept of density thresholds where we consider the minimum densities required to support different public forms of mass public transit.¹ Finally, drawing on this analysis, we reflect on the patterns of density in Australian cities, and consider the options that Australian cities have to achieve higher average densities.

Comparator cities

Within this paper, Australia's three largest cities – Sydney, Melbourne and Brisbane – are compared to three international cities: Vancouver (Canada), Montreal (Canada) and London (United Kingdom). The two Canadian examples have been chosen due to their respective west and east coast positions and the prevalence of Canadian and Australian cities in liveability indexes. *The Economist's* 2014 Liveability Ranking had 80% of its top ten cities shared between the two countries (The Economist Intelligence Unit, 2014). London has been chosen due to its position as a top-tier global city and its historical and cultural links with Australia.

The data used within the analysis has been drawn from the official Census data for the year 2011 for each country. The metropolitan area and population are based on the official boundaries provided by the census agency for each country. The census geographies chosen were selected so that the physical size and total number of the census areas considered for each city was broadly similar (refer to Table 1).

London is the largest of the cities considered in terms of population with over eight million people distributed across an area of 157,000 square kilometres (sqkm). Sydney and Melbourne are the next largest cities, with over four million people in 1.2 million sqkm and one million sqkm respectively. Montreal is slightly smaller in terms of population but significantly smaller in area. Vancouver is smaller again on both metrics. Brisbane is the smallest of these cities in terms of population with just over two million people, however is the largest in terms of size at almost 1.6 million sqkm; more than 10 times the size of Metropolitan London.

¹ Public transport thresholds have been used as they are often assessed in urban planning literature and provide a constant metric to compare cities against each other.

TABLE 1. CITIES COMPARED: METROPOLITAN POPULATION AND AREA

	Brisbane	Melbourne	Sydney	Vancouver	Montreal	London
Total metropolitan population	2,066,660	4,000,315	4,391,214	2,313,328	3,824,221	8,173,941
Total metropolitan area (sqkm)	1,582,593	999,052	1,236,774	304,142	429,320	157,104
Data source	ABS (2011)	ABS (2011)	ABS (2011)	SC (2011)	SC (2011)	ONA (2011)
Census geography	Statistical Area 1	Statistical Area 1	Statistical Area 1	Dissemination Block	Dissemination Block	Lower Super Output Area
Count of census areas in metropolitan area	4,277	8,809	9,875	3,246	5,912	4,835
Average size of census areas (Ha)	23.8	19.5	14.8	21.8	19.6	26.1
Average population of census areas	428	424	423	677	604	1,660

Sources: ABS, Statistics Canada, Office of National Statistics 2011

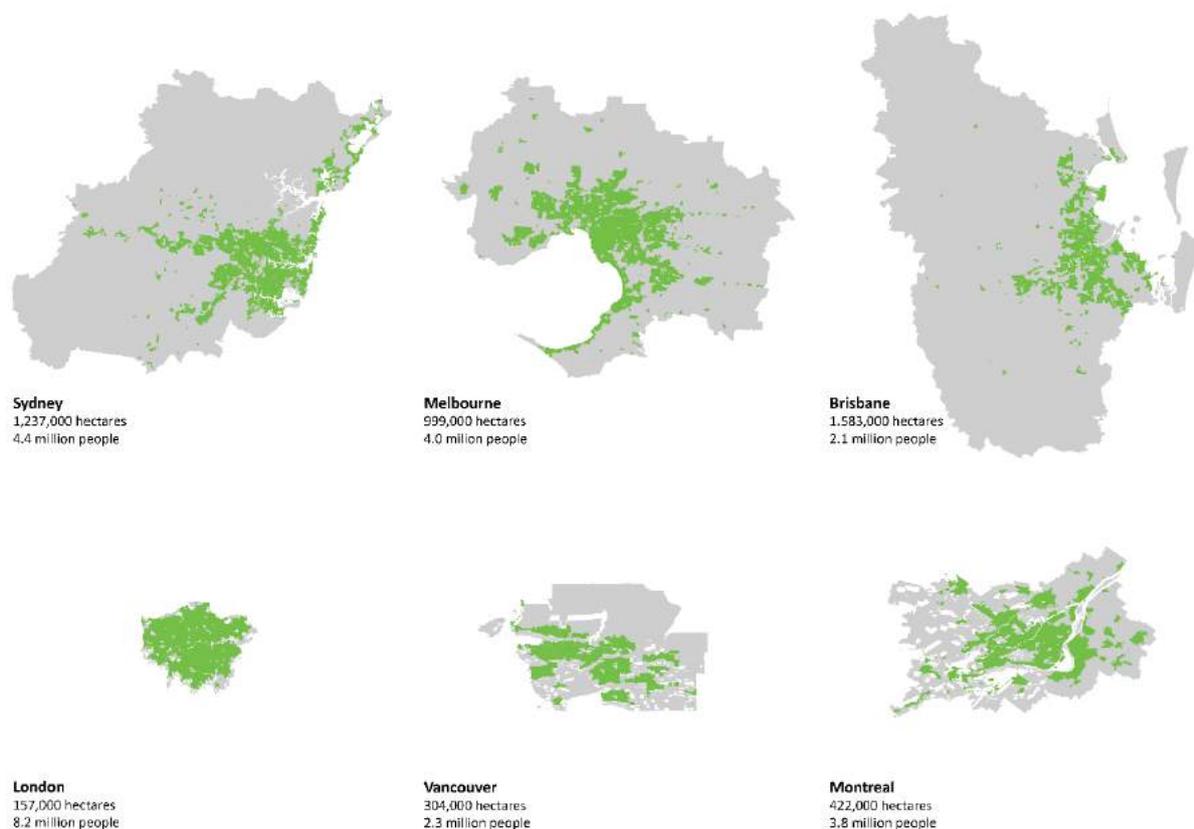
Defining urban

City boundaries can be clearly demarcated by major landforms such as rivers or coastlines or by a major piece of infrastructure, such as a ring road, as well as political boundaries such as local government areas and officially defined metropolitan boundaries. Where no such demarcation exists, urban boundaries can be loose; based on historic land ownership patterns or bureaucratic aspiration. Various organisations use density thresholds to distinguish between urban and non-urban areas (see Table 2). These thresholds are for the gross population density; the total land area divided by the population. These threshold densities represent quite low benchmarks for defining an area as urban: four persons per hectare is 2,500 square metres for each person. Presumably the choice of relatively low threshold densities to distinguish urban from non-urban is to ensure that peri-urban areas (often referred to as rural-residential in the Australian context) are included. In the analysis that follows, a gross population density of four people per hectare has been adopted to identify the urban area for each city as distinct from official definitions of the metropolitan area provided by each countries census agency (see Figure 1).

TABLE 2. DENSITY THRESHOLDS FOR DEFINING URBAN AREAS

Source	Population per hectare
Organisation for Economic Co-ordination and Development (OECD, n.d)	2
Australian Bureau of Statistics (ABS, 2011)	2
Lewis, et al (2013)	4
Demographia (2015)	4

FIGURE 1. EXTENT OF URBAN AREA (AREAS WITH ≥ 4 PEOPLE PER HECTARE) COMPARED TO OFFICIAL METROPOLITAN BOUNDARIES



Sources: Australia Bureau of Statistics (2011), Statistics Canada (2011), Office of National Statistics (2011)²
 Note: green area indicates the urban area (≥ 4 people per hectare), grey indicates official metropolitan boundaries

The relative large size of the official metropolitan area for Australian cities as defined by the Australian Bureau of Statistic is evident from the data in Table 3 below and the maps in Figure 1 above. When the threshold of four people per hectare is applied, the size of the resulting ‘urban’ areas are comparable with those of the international cities (see Table 3). As might be expected, removing very low density areas from the official metropolitan areas provides a more consistent boundary to adopt for further comparative analysis.

TABLE 3. ‘URBAN’ AREA AND POPULATION COMPARED TO OFFICIAL METROPOLITAN AREA

City	Metropolitan area as defined in by census boundaries		‘Urban’ area: census areas with ≥4 people per Ha		‘Urban’ area as a proportion of metropolitan area	
	Total area (Ha)	Population	Area (Ha)	Population	Area	Population
Brisbane	1,582,593	2,066,660	101,835	1,830,157	6%	89%
Melbourne	999,052	4,000,315	171,456	3,798,882	17%	95%
Sydney	1,236,774	4,391,214	146,364	4,201,195	12%	96%
Vancouver	304,142	2,313,328	70,769	2,198,386	23%	95%
Montreal	429,320	3,824,221	115,616	3,572,124	27%	93%
London	157,104	8,173,941	126,075	8,122,564	80%	99%

Cities such as London and Montreal have physical constraints that limit urban expansion. A smaller metropolitan boundary means that a city can expand only a certain distance before it enters another jurisdiction, which can lead to issues surrounding governance and planning. Australian cities have enormous metropolitan boundaries, providing less incentive to remain contained.

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Average city densities

The average density of a city can be measured through a variety of methods. To assist with comparison, we have considered the simple average density (or area weighted average density) and the population weighted average density. The latter is derived by applying a weighting to the average density of each census area, based on its share of the city's total population. Another way to think about the difference between the area weighted average and the population weighted average is that the former is a measure of the density found in the average place, whereas the latter is the density experienced by the average person. One advantage of weighted average density is that it removes the bias that a few people living at low densities has on the average density for an entire city.

Both the area weighted and population weighted average densities for the six cities are shown in Table 4. Based on the area weighted average, Brisbane and Melbourne have about one third the density of London; Sydney, Vancouver and Montreal are all about half London's average density. The comparison of weighted average densities however reveals slightly different patterns. The population weighted average density for both Vancouver and Montreal is closer to two-thirds of that for London; whereas Sydney and Melbourne are still about a half and one third respectively of the London benchmark whereas Brisbane is one quarter. By calculating the population weighted average we find that Montreal and Vancouver are significantly more dense than Sydney and not as far 'behind' London as the more conventional area weighted average density measure suggests.

TABLE 4. AVERAGE AND WEIGHTED DENSITY ABOVE 4 PEOPLE PER HECTARE

Urban Form	Average population density (ppl/ha)	Weighted population density (ppl/ha)
Brisbane	18	25
Melbourne	22	32
Sydney	29	52
Vancouver	31	65
Montreal	31	71
London	64	97

Examples of statistical areas that displayed the weighted average densities for each city were identified using Geographic Information Systems and Google Earth to illustrate the urban forms found in an 'average' census area (Figure 2).

The three Australian examples feature similar patterns of subdivision. The mix of housing types appears more diverse in the Melbourne and Sydney examples compared to the Brisbane example. Despite their higher densities, the predominantly detached built form character persists in the Melbourne and Sydney examples. With the introduction of more medium density housing typologies the dwellings remain 'set back' from all lot boundaries and stretch towards the centre of the block.

By contrast, the examples of the average densities for Vancouver, Montreal and London are generally organised in a row configurations with narrow or no side setbacks and more consistent patterns of built on areas within the each block. These forms are somewhat more similar to the perimeter block urban form more common in European cities. Despite the range of densities shown in the international cities they have many similarities. The street and block pattern is typically a grid or near grid configuration. All appear to have some significant vegetation and pervious open spaces. Although it is difficult to determine from an aerial view, the scale of buildings is for the most parts between one and three storeys.

FIGURE 2. AREAS OF THE POPULATION WEIGHTED AVERAGE DENSITY COMPARED
Brisbane (25 people per hectare)



Vancouver (65 people per hectare)



Melbourne (32 people per hectare)



Montreal (71 people per hectare)



Sydney (52 people per hectare)



London (97 people per hectare)



Source: Google Earth (2015)

FIGURE 3. EXAMPLES OF BUILT FORM IN LOCATIONS OF THE POPULATION WEIGHTED AVERAGE DENSITY

Brisbane (25 people per hectare)



Vancouver (65 people per hectare)



Melbourne (32 people per hectare)



Montreal (71 people per hectare)



Sydney (52 people per hectare)



London (97 people per hectare)



Source: Google Earth (2015)

Distribution of density across metropolitan areas

Comparing the average densities and weighted average densities is instructive, however this doesn't reveal anything about the spatial distribution of density across the city. Although rarely expressed as an explicit focus, shaping and changing the distribution of population density is one of the core concerns of strategic land use and transport planning. This section provides a comparison of the distribution and mix of density within the six cities with a view to better understanding the pattern of density that contributes to the overall average density.

Literature on public transport viability and patronage often identifies threshold population densities required to support various forms of mass transit. A review of selected literature on this subject identified a number of thresholds for the viability of different mass transit options (see Table 5). It was evident from this review that there is little agreement within the literature concerning specific threshold densities for specific modes of mass transit. More contemporary sources tend to cite higher density thresholds than earlier works.

TABLE 5. MASS TRANSIT THRESHOLDS FROM PLANNING LITERATURE

Transport mode	Minimum population per hectare (gross) required to support mass transit*	Source
Bus	19	Pushkarev and Zupan (1977)
Public transport	30	Newman and Kenworthy (1991)
Rail	58	Pushkarev and Zupan (1977)
Bus	93	Chakrabarti (2013)
Bus	100	CABE (n.d)
Urban transit centres	100	Zahavi (1976), cited in Newman and Hogan (1981)
Bus	100	English Partnerships (2007)
Rail	185	Chakrabarti (2013)
Tram	240	CABE (n.d)
Tram	240	English Partnerships (2007)

* In some cases thresholds have been converted from dwellings per hectare to population per hectare using a household size of 2.5 people per dwelling.

In order to establish a range of meaning full density thresholds for the subsequent analysis, common thresholds from those identified in Table 5 were used as set out below in Table 6.

TABLE 6. DENSITY THRESHOLDS

Density	People per hectare
Very low	<4
Low	4
Moderate	30
Medium	60
High	100
Higher	200
Very high	400

Every city has a different distribution of density, as a result of topography, natural features such as rivers and harbours, historical development patterns and transport networks. Using the census data for each city the distribution of density was mapped using the density thresholds identified in Table 6 (see Figure 3). Summary data from this analysis is also provided in Table 7.

Several key themes are evident in the comparison between Australian and international case studies. Significant proportions of the population of Australian cities, in particular Brisbane and Melbourne, live in areas with densities between 4 and 30 people per hectare (75% and 55% respectively). In Sydney the proportion is slightly lower at 38%. The benchmark of 30 people per hectare is often cited as the lowest density that supports any form of mass public transit.

Considering the cumulative proportion of the population above 60 pph is also revealing. For Brisbane the proportion of the population that lives above this density threshold is just 2%. For Melbourne it is 5%. In 2011,

20% of Sydney's population lived in areas of 60 pph or above. By contrast, this threshold was exceeded by 34% of Vancouver's population and 39% of Montreal's population.

If we consider the threshold density of 100 people per hectare the difference between the international and Australian cities is even starker. Brisbane (1%), Melbourne (2%) and Sydney (10%) have very few people living above this threshold. Coupled with their relatively large metropolitan areas, the distribution of density in Australian cities does not appear conducive to making a viable network of mass public transit infrastructure. Vancouver, a city held in high regard as a model city for other to emulate also has a relatively modest proportion of its population living at higher than 100 pph (at just 15%). Montreal, with 24%, and London, with 41% both have significantly higher populations living above this particular density threshold.

TABLE 7. POPULATION BY DENSITY THRESHOLDS

Density range	Brisbane		Melbourne		Sydney		Vancouver		Montreal		London	
	Pop'n	%										
0 – 4	236,503		201,433		190,019		114,942		252,097		34,293	
4 – 30	1,367,200	75%	2,103,287	55%	1,593,636	38%	637,334	29%	1,046,611	29%	731,761	9%
30 – 60	423,223	23%	1,468,669	39%	1,724,258	41%	821,987	37%	1,152,793	32%	1,758,539	22%
60 – 100	29,361	2%	161,652	4%	442,269	11%	400,469	18%	530,177	15%	2,332,275	29%
100 - 200	7,230	0%	37,692	1%	343,992	8%	238,322	11%	672,124	19%	2,836,892	35%
200 - 400	2,707	0%	18,339	0%	70,587	2%	84,854	4%	149,776	4%	473,224	6%
400+	436	0%	9,243	0%	26,453	1%	15,420	1%	20,643	1%	6,957	0%
TOTAL (>4 pph)	1,830,157		3,798,882		4,201,195		2,198,386		3,572,124		8,139,648	

Note: in some instances % totals do not add to 100% due to rounding.

Australian cities have much lower proportions of their population at between 100 and 200 people per hectare when compared to Montreal and London. The proportions for Brisbane (<1%), Melbourne (1%) and Sydney (8%) are all significantly lower than those of Montreal (19%) and London (35%). Interestingly, of the three highest density cities, Vancouver, Montreal and London, the proportion of people living at very high densities (200 people per hectare and above) is similar for all three cities.

Sydney has 3% of its population at these higher densities while London, the most dense and populous city by some margin, has 6%. In fact, we also find that London has less than 1% of the population living above a density of 400 people per hectare, while Sydney has over 1%. This suggests that cities with higher overall densities don't necessarily achieve this by having a higher proportion of the population living at very high densities. Rather their higher average density is the result of more significant proportions of their populations living in areas that with 'mid-range' densities between 60 and 200 pph. This is evident in the density threshold maps where both Montreal and London exhibit much larger areas of these mid-range densities than the other cities (these are the yellow, orange and red areas in Figure 3).

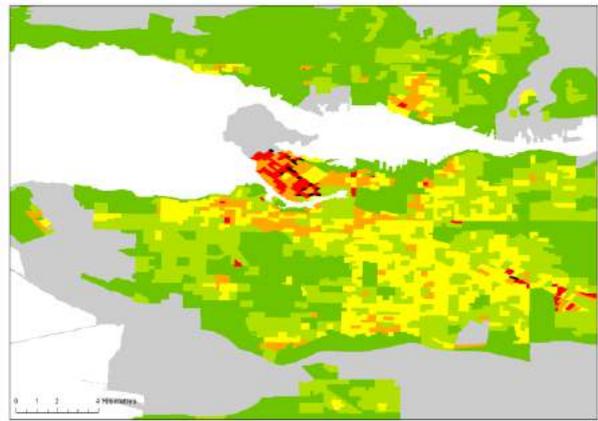
London's density pattern demonstrates its ability to deliver significant public transport infrastructure right throughout the city. In the Australian cities and Vancouver, the radial lines of mid and high density reflect transport corridors interspersed with lower density areas that are without significant mass transit infrastructure. Montreal and London's more even spread of mid and high density enable mass transit to operate more effectively and widely.

FIGURE 4. DENSITY ANALYSIS OF CASE STUDY CITIES

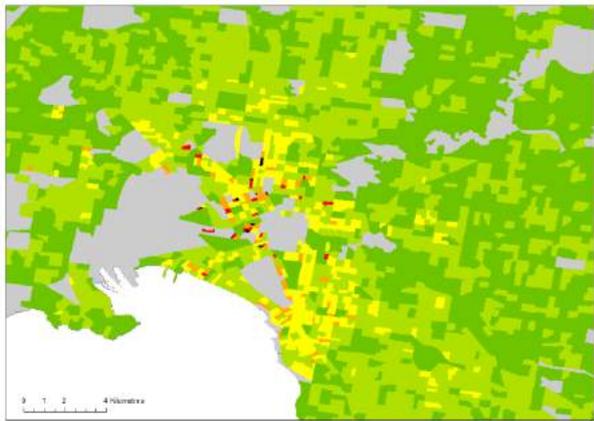
Brisbane



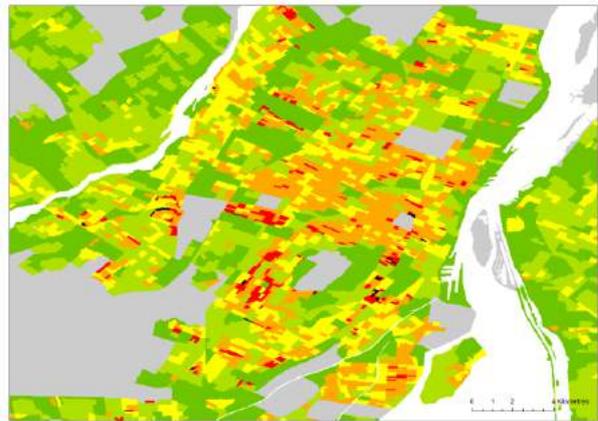
Vancouver



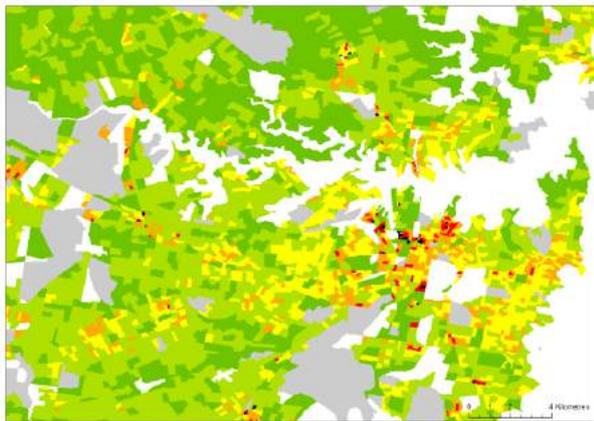
Melbourne



Montreal



Sydney

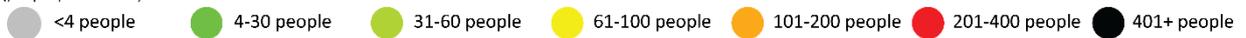


London³



Population density

(people per hectare)



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City comparisons

As Australian cities plan for future growth, patterns of urban development from other more dense cities can be instructive.

Although smaller in both area and population, Vancouver has a higher weighted average density and higher proportion of the population living above 60 people per hectare than Melbourne or Sydney. Vancouver's higher density core appears larger than those of either Sydney or Melbourne and extends to a ring of mid-range densities adjacent to the high density centre.

A common feature of the distribution of density in Melbourne, Sydney and Vancouver is the presence of significant areas of 'no density' in relatively close proximity to the city centre. Harbours, open space and significant employment-only areas in close proximity to the city centre are distinct from the more even patterns observed for Brisbane, Montreal and London.

Although Montreal's population is also smaller than both Sydney and Melbourne's, its higher population weighted average density and more even distribution of density are notable. Montreal also has a higher proportion of people living in areas with densities above 100 people per hectare (24% as compared to Sydney's 11%). Interestingly, it also has a similar lot and built form structure as seen in Figure 2. This snapshot of an 'average' suburb in Montreal shows small-scale two to three storey apartments on relatively small lots. Built forms like this might be deployed within Australian cities given the similar lots patterns.

Density distribution typologies

From the analysis of a limited number of cities presented here, two general patterns of density distribution are evident (Figure 5). The first features modest background density with concentrated areas of higher densities, some of which are very high. This is typical of the patterns of density in the Australian cities examined. Australian cities feature a high proportion of people living at low densities yet still support areas of densities of 400 pph and above. This pattern might be the expected outcomes when a low density city evolves to accommodate growth through high density mixed-use developments around transit nodes and in former inner city industrial lands. This process produces a more uneven pattern in the distribution of density.

The second pattern features a more even distribution of density that includes a higher proportion of the population living in areas with mid-range densities. London and Montreal demonstrate this pattern. These cities feature more expansive mass transit networks and in both cases are hemmed in at the fringe by a green belt and a major river respectively. Compared to Sydney and Melbourne, London has a lower total number of people living at either low or very high densities. The majority of London's population lives in areas of mid-range densities that are evident across a wider area.

Presenting the density analysis as a population density histogram provides another perspective on the distribution of density in the six cities (Figure 6). The three Australian cities exhibit very similar characteristics with large proportions of the population at densities below 50 pph. Sydney does support a higher proportion of its population in areas with population densities of between 50 to 150 pph when compared to Melbourne and Brisbane. Vancouver, Montreal and London all feature higher proportions of their population at densities higher than 50 pp. London displays a unique distribution with a relatively even distribution when compared to the other five cities.

FIGURE 5. DENSITY TYPOLOGIES

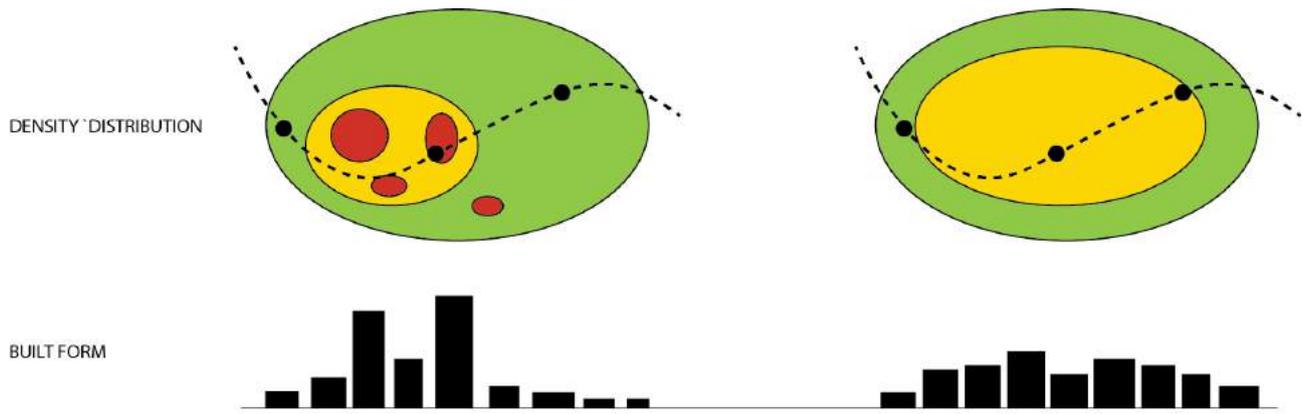
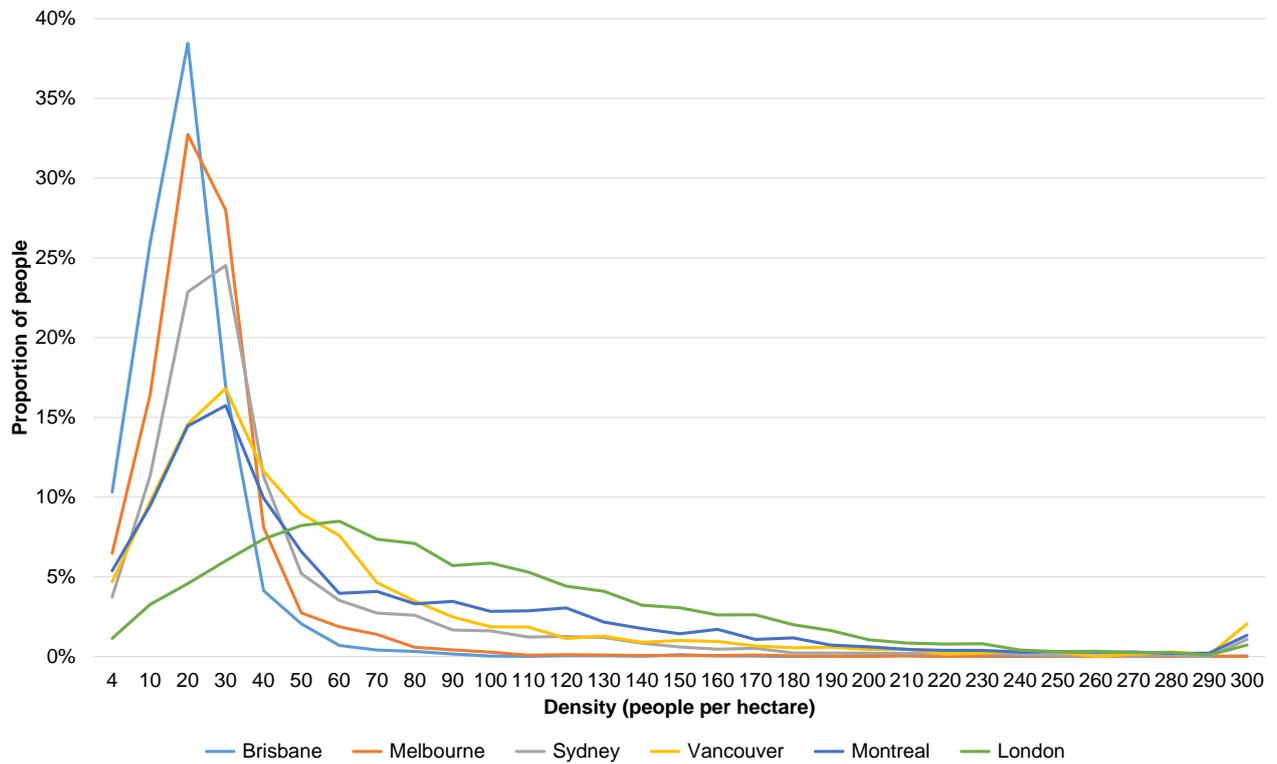


FIGURE 6. DENSITY HISTOGRAM OF CASE STUDY CITIES



Discussion

Despite the claim to being one of the most urbanised countries, it is clear that Australian cities are, for the most part, relatively low density. Although approximately 89% of the Australian population live in cities (World Bank, 2015), very few live at densities considered 'urban' across the world. Relatively few Australians live in mid-to-high density environments. The construction of Australia as an urban nation – particularly in popular discourse – overshadows the fact that the majority of Australia's urban areas feature relatively low densities. Australia could perhaps lay claim to being the most *sub*-urbanised country in the world.

Two large and seemingly similar Canadian cities have slighted higher area-weighted average densities than Sydney and Melbourne, but by considering the population-weighted average density we find the Canadian cities are significantly denser. They also feature larger proportions of their populations living at above 60 people per hectare.

Sydney, Melbourne and Brisbane might be characterised as having generally low densities with pockets of high and very high density development focused in particular areas. It is perhaps a symptom of larger scale urban renewal being a dominant delivery mechanism for density increases in Australian cities.

International comparison cities appear to have been less reliant upon opportunistic high density development as they have more people living in mid-range densities than Australian cities. This enables them to sustain higher overall weighted average densities which better support mass transit systems, housing diversity and other benefits of increased density.

Further analysis comparing in more detail the weighted average density places of the different comparator cities would be valuable particularly in identifying lessons for achieving more mid-density in Australia cities. This could include detail on dwelling mix, parking provision and the planning context within the 'average' areas of each city.

The comparisons undertaken in this paper lead us to question the virtue of our reliance on high rise and high density transit-oriented development around rail stations to accommodate growth in Australian cities. Should planning strategies seek to provide more housing at intermediate densities, over a larger area, rather than high densities in relatively few, concentrated areas? The analysis of comparison cities suggests such an alternative approach to increasing densities might be worthy of consideration, however implementing such an approach comes with significant challenges. It is also reliant on a better appreciation of the value that mid-range densities present to the future of Australian cities.

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