R.H. Crawford and A. Stephan (eds.), *Living and Learning: Research for a Better Built Environment: 49th International Conference of the Architectural Science Association 2015,* pp.567–577.

Re-measuring density: alternative methods for assessing and progressing Australia's suburbs

Alysia Bennett
Monash University, Melbourne, Australia
alysiakbennett@gmail.com

Abstract: This paper undertakes a critical review of existing paradigms in built environment performance measurement methodologies within Australia's strategic planning processes. It argues that current density modelling, which is used to assess the effective integration of population distribution, infrastructure investment and land use strategies, is more misleading than it is revealing. This is due to a fundamental misalignment between the reality of land use capacity and its relationship to infrastructure investment, and assumptions about reality informed by existing density measurement techniques, which establish an inaccurate and problematic base for strategic planning. The paper proposes alternative modelling approaches, based on dwelling capacity per linear meter of public road network, which more accurately measure population density relative to infrastructure investment than dwelling density per hectare. The proposed models also enable density maps to become a forecasting tool, tailored to measure alternative typologies of concentrated development, and a facilitator of density strategies by enabling density modelling to direct economically realistic and culturally appropriate suburban residential development. By accurately assessing the built environment, government can realign policy to the realities of current suburban conditions to direct the evolution of Australian cities in a more appropriate, realistic and strategic manner.

Keywords: Density; mapping; Hobart, strategic planning methodology.

1. Introduction

As Australian cities face increasing population growth, the federal government, through the Council of Australian Governments (COAG) Reform Council, directed its capital cities to undertake strategic planning exercises. The task aimed to ensure that the future growth of Australia's largest settlements is realised in a liveable, productive and sustainable manner and focused on the distribution of population, and use of land, relative to infrastructure. The main measure used to determine the success of infrastructure leveraging strategies is the measurement of dwelling density per hectare. This is based on the notion that higher density housing, concentrated around key transport corridors and activity

centres, will render networks and clusters of new economic activity as viable and provide citizens with a reduced cost of living.

Although this study's genesis is in capital city strategic planning, the intended application of findings is not large urban centres but rather the suburban context predominant in both outer-metropolitan and regional cities. Whilst Australia's inner city settlements will face significant growth pressures, their property markets support development models that align with government's strategic ambitions. However in lower density contexts, which have traditionally been directed by the same strategies as high-density settlements, despite considerable economic, cultural and social differences, there is a need to create appropriate strategies relative to these realities. Although cities like Hobart, Darwin and Geelong are only expected to experience modest population growth over the next fifty years, their low-density composition is more akin to the majority of Australian settlement's composition than inner Sydney or Melbourne (West, 2013). Thus if Australia is to become a more liveable, sustainable and productive country, a tailored strategic focus should also be applied to traditionally 'underperforming' contexts like the suburbs.

Hobart exemplifies the composition of most regional and outer metropolitan settlements and the inherent failure of strategic planning to effectively direct development. The introduction of an urban growth boundary for Greater Hobart first occurred in 1964 (Tasmania, 1964). Yet despite the uncontrolled growth beyond its boundaries over the proceeding half-century, a similar border was proposed in 2011 as part of the COAG Reform Council capital city-planning directive (Tasmania, 2011). With the majority of land within the growth area currently rated at 5 dwellings per hectare (dw/ha) or less, the new targets set within the Greater Hobart Capital City Plan for a minimum of 15 dw/ha, and a best practice of 25 dw/ha, are an ambitious target.

This unquestioning adoption and repetition of processes, definitions and ambitions are the focus of recent critique by Neil Brenner (2015) and the Urban Theory Lab at Harvard. This paper will adopt Brenner's premise of critically assessing dominant paradigms and seeks to realign the ambitions of the government's strategic planning processes with the legislative mechanisms and realities of the context of Australia's lower density cities. In doing so, the paper aims to develop new methods that not only accurately *assess* the current state of Australian cities but also *progress* collective strategic development ambitions.

2. Current assessment methodology

Brenner's (2015) proposition is that a lack of agreement on a cohesive strategic direction for contemporary city planning has lead to a fall back on ideologies and definitions that were developed in the eighteenth century, and that these may prove problematic in their application to the contemporary context. In particular, he identifies the categorisation of land, as either urban (associated with human settlement) or rural (landscape that is predominantly free of settlement), as problematic. For example, land used for mining is typically categorised as rural as it does not contain the built composition associated with an urban environment. Yet its very nature as a landscape that is mined as a resource for human settlement intrinsically makes its function fundamentally urban and thus should be classified accordingly. When Brenner amended maps of human settlement to reflect this broader definition of urbanity, it revealed that almost all land is inherently urban and thus new sub-definitions are needed to understand the complexities within this expanded landscape. He proposed to shift the categorisation from 'settlement vs. non-settlement' to 'agglomeration vs. operational landscapes'. In doing so the broader social, economical and environmental consequences, inherent in the relationship between

different landscapes, are made apparent and the opportunities and implications of future strategies can be more accurately and appropriately considered.

When examining the density definitions that currently direct Australian strategic planning processes, similarly we see a clear lineage of their use in government policy development despite significant shifts in the context (Pafka, 2013). In particular, this paper will focus on the 'dwellings per hectare' (dw/ha) density metric, that Griffiths (2009) claims is the most prevalent measure for urban density in the Australian strategic planning context.

2.1. Accuracy

In the COAG Capital City policies, the dwellings per hectare metric has commonly been used for two key maps; the first recording current dwelling density per hectare and the second indicating the required density levels around potential public transport stops or local activity centers for network viability. Despite the geographic scope, the relationship between the two maps is detached; the latter disregards the former and solely communicates the density strategy related to an infrastructure proposal. Consequently, the strategic density targets are applied tabula rasa.

Even if the existing conditions were considered, the dwellings per hectare metric only records the quantitative aspects of the distribution of houses and doesn't convey social, cultural or economic factors that may be effecting development (Pafka, 2013). In order to gain an accurate picture of the influences on existing population distribution, Pafka proposed a multi-strand approach to assessment that combined the dwellings per hectare metric with other established measures such as the Floor Area Ratio and Plot Factor. Whilst this approach does provide more information, the misalignment of conventional definitions with the reality of the assessed context, as Brenner has cautioned, may not provide *accurate* information and thus may undermine the basis of research collected to inform strategic direction. Therefore the successful use of a multi-variable methodology relies on definitions that are both relevant to issues that they are assessing and the context to which they are applied.

2.2. Ambiguity

Assessing the suitability of definitions and metrics requires an understanding of both their original and contemporary contexts. The first use of the dwellings per hectare metric in Australia was in 1944 (Pafka, 2013) and coincided with the postwar ideal of the Great Australian Dream- a detached dwelling on a quarter acre plot; a notion which is now in conflict with the government's strategic ambitions to maximise the efficient use of land. Additionally, the notion of a dwelling has evolved beyond a physically defined unit, in the form of a detached house, to a plethora of typologies including row houses, apartment blocks, villas, etc. Whilst houses and even apartments can be easier to define as dwellings, the delineation of emerging typologies such as granny flats and independent sublets within traditional detached dwellings is less clear. Further, the idea of dwelling developed in relation to the concept of the nuclear family; a unit which was the social norm for the average household size and composition for the era. However, over the past seventy years, the nuclear family has receded in prevalence with the average Australian household composition falling from 4.5 people in 1911 to 2.5 in 2011 (Capuano, 2012). This has significant ramifications for strategic design, which continues to assume that each dwelling contains four to five individuals, when in reality it is likely to be two to three. Further, the average Australian household size has increased significantly over the past three decades, from 150m^2 in 1991 to 219m^2 in 2006 (ABS, 2010). Consequently the relationship between the definitions of

dwelling, household and capacity are less than clearly defined, creating a misalignment between built fabric capacity and population density. Despite contextual shifts, like Brenner's criticism of the unquestioned adoption of the urban and non-urban classification system, Australia's built environment performance is still measured with, and consequently undermined by, the dwelling density per hectare metric.

2.3. Alignment

The functional and spatial evolution of residential properties has lead to a further complication: how to distribute the boundaries of each hectare in a logical manner? Dwellings per hectare measurements in Australia are based on the boundaries of the Australian Bureau of Statistics (ABS) census blocks (see Figure 1) which include whole cadastral parcels and thus enables a clear allocation of a plot's statistics to the defined study area. However the ABS blocks also contain public land, such as roads and parks, making this relationship between the ABS statistics and actual distribution more ambiguous.

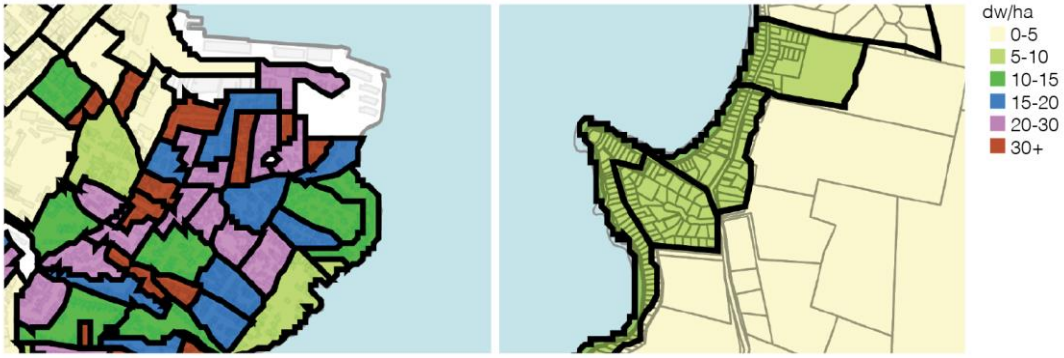

Figure 1: Battery Point (left) and Opossum Bay (right) indicating dwellings per hectare. (source: author, using Australian Bureau of Statistics data)

Additionally, the ABS blocks vary significantly in size, shape and composition. Opossum Bay, one of the Hobart suburbs that developed beyond the 1964 Hobart growth boundary, appears to have a similar level of dwelling density, at the street level, to the inner city suburb of Battery Point; each contain solid street edges of one and two storey dwellings, very minimal setbacks between, and many buildings appear to contain multiple apartments. Despite this, the dwelling density per hectare rating for Opossum Bay is at least three times lower, on average, than that of Battery Point. One of the explanations for this is due to the difference in the composition of ABS census blocks between the two suburbs. In examining the blocks for Opossum Bay in the densest area of the settlement (Figure 1), which is primarily concentrated along one linear strip of road, the majority of the large area defined per ABS block includes large plots of undeveloped farming land. This dilutes the concentration of dwelling density and makes the area appear well below acceptable levels of dwelling density. However, the actual concentration of development around the road network, like the distribution of development in Battery Point, optimises the use of the infrastructure network by connecting the maximum number of habitable space to the network within a small area of land. Thus, this example demonstrates that the ABS census blocks do not always accurately represent the relationship between land use, population distribution and infrastructure. However, if density was more objectively measured with a Cartesian

grid, the connection between ABS statistics and distribution would be even further complicated. Consequently, in the context of a parcel-based allocation of land use data, measuring density per hectare is an approximation only.

This lack of accuracy in the parameters of hectare distribution, as Pafka (2013) notes, creates ambiguity that is often politicised and makes it difficult for strategic density ambitions to be realised. Firstly, the method of distributing boundaries can significantly affect the density figure of a precinct and consequently can be manipulated to serve political needs. For example, as Figure 1 demonstrates, joining and then averaging the density of multiple hectares can significantly increase or decrease the collective density rating for an area and thus the rating for an individual plot. This may allow inappropriately scaled developments, whether they are too big or small, to be 'disguised' by the neighbouring composition, and thus be approved or rejected by government despite the objections of developers or the community. Secondly, the setting of new minimum density targets across hectares makes it difficult to enact. Government can shape the private development of the built environment via planning schemes. Whilst planning schemes include some collective strategic planning directives, such as the distribution of use zones, these align to cadastral parcels and consequently clearly define both the allowable use for an individual block and the collective strategy for a precinct. Even if there were an objective way to assess density across an area, how can an individual plot also be assessed objectively? Do all plots within the defined area need to achieve the same minimum dwelling rating, or is the composition of each individual plot taken into account? In reflecting on this misalignment between the strategic planning process and the development mechanisms of government, it is clear to see why growth boundaries have been compromised and, more broadly, why government has had very little influence over the shaping of cities.

3. Alternative assessment methodology

What is needed to accurately assess, and successfully progress, the contemporary built environment is a new metric that measures the existing relationship between land use, infrastructure and population distribution and aligns with government development control mechanisms. Three alternative approaches are outlined below.

3.1 Dwellings per 100 meters

The first alternative approach to measuring addresses the problems associated with accuracy and realisation through alignment. By shifting the density metric to a plot-scaled unit, that is also the same scale and form of the infrastructure network, the relationship between, infrastructure, land use and population can be clearly assessed. Like contemporary housing, most infrastructure is not distributed evenly across hectares within an urban settlement area but rather concentrated to linear networks and conduits that align with the road network. Thus a more accurate alternative could be to measure density not in gross land area but in a linear fashion relative to the distribution of the infrastructure network itself.

Density, in the context of planning, is traditionally considered an area based measurement unit and consequently a definition that assesses linear density seems fundamentally flawed. However in examining the broader definition of density used within science and engineering, measuring linear density is common for recording either one dimensional objects or one dimension of three dimensional objects. For example, in measuring the density of fabrics, whose composition is a network

of individual threads, a more accurate description of the composition comes from assessing the density of the individual threads and their relationship to one another. Similarly, as the aim of measuring dwelling density is based on assessing the relationship between population distribution and infrastructure networks, it is more accurate to consider the density of population relative to the infrastructure conduits, and then to assess the relative distribution of the conduits within the network, than to simply count people over a given area.

An example of measuring linear density is a tool that the Australian Urban Research Infrastructure Network (AURIN) use to assess existing and potential patronage of rail services (AURIN, 2015). Rather than measuring the catchment area of a network via a 400m radius of residences around each station, instead the 400m distance is measured linearly along roads and the houses adjacent to this path are counted as the catchment area. This realigns the potential catchment directly to the research behind the radius concept: that 400 meters is a realistic distance that most commuters would be willing to walk to a station (Daniels, 2011). Thus measuring the actual walking path and accommodating the realities of the spatial condition, rather than an assumption based on radial proximity, a more accurate picture of viability can be attained.

Figure 2: Battery Point (left) and Opossum Bay (right) indicating dwellings per 100 meters. (source: author)

Similarly, the linear approach could be used to assess the viability of other infrastructure networks, such as the number of properties that are serviced by a road or telephone line. In this instance, instead of measuring the number of dwellings per hectare, which is an area of 100m x 100m, the linear equivalent is to measure the number of dwellings per 100 meters. For example, Figure 2 illustrates the possible dwelling density figures generated for the same survey area indicated in Figure 1. However in Figure 2, dwelling density is assessed relative to infrastructure distribution- the road network- and is generated by counting the number of dwellings per length of road corridor (with roads subdivided into segments between intersections and plots allocated once according to their point of access). When re-measured in this way the dwelling density figures for Battery Point and Opossum Bay figures are much closer, reflecting reality of the built fabric composition as observed from the street. This simple shift in measurement could have significant ramifications for the assessment of the existing context as it more accurately shows the relationship between dwelling and network distribution.

3.2 Households per 100 meters

Despite the increased accuracy in the relationship between dwelling and infrastructure distribution, as outlined in section 2.2, counting dwellings alone does not guarantee a clear assessment of the size of the population that is connected to the network. Several international empirical studies, in locations similar to the suburban context in Australia, observed the actual occupation of detached dwellings and discovered an interesting trend. Studies in suburban Honolulu (Lau, 2014), Vancouver (Lister, 2013), and many other North American west coast cities with Accessory Dwelling Unit (ADU) policies, found that there is a growing trend towards the dual occupation of detached dwellings in typical suburban contexts, both facilitated by and in spite of legislation. ADU policies allow two to three households per plot through the reconfiguration of buildings within each parcel, essentially realigning the capacity of each plot from the current average of 2.5 occupants to its intended 4.5 nuclear family configuration. ADU typologies include the addition of small freestanding dwellings, such as granny flats; extensions and additions, such as the construction of an apartment above a garage on or top of an existing dwelling; and the internal horizontal and vertical subdivision of existing dwellings (Brown, 2013).

If Australian legislation shifted to allow two to three households per plot, which is the common allowance for residential plots in cities with ADU policies, meeting minimum density targets in suburban contexts could be easily achieved. The small scaled, plot based densification of individual parcels is more suited to the scale of the construction industry in suburban settlements like Hobart, is more economically viable for the market and, facilitates development that is in keeping with the existing character. Local studies have shown that ADU development would be suitable for the Australian context and could significantly assist in the realisation of government's ambitions to increase residential density within existing serviced areas, to address housing supply issues and improve the cost of living for the community (Faulkner, 2009).

Based on the way that Australian census data is collected, and the continuously shifting nature of residential occupation, accurately assessing existing households occupancy per plot is difficult. However, if assessment is instead focused on *potential* household capacity, it could have significant benefits for strategic planning. Assuming that each existing suburban plot is considered to be accommodating one independent household (in accordance with current planning laws), but plots over a certain size are capable of housing two or three, mapping the difference between existing and potential occupation could provide a more productive insight: the capacity of a suburb

Figure 3: Battery Point (left) and Opossum Bay (right) indicating household capacity. (source: author)

Further, measuring the capacity of an individual parcel establishes an objective development density target per plot and an assessment of the ability of a precinct to appropriately accommodate more households. For example, Figure 3 illustrates that although the combination of conjoined cottages and apartment blocks in Battery Point have lead to higher dwelling per hectare ratings, the detached dwellings in Opossum Bay have greater capacity to leverage infrastructure if an ADU based approach to densification were applied. This is because many of the plots within Battery Point already meet or exceed the allowable ADU density of two households per plot, and thus have no further capacity for growth. Shifting the focus of mapping from existing density and illustrations of proposed density to a visualisation indicating the capacity of a suburban precinct to accommodate appropriate and realistic levels of density, bridges the gap between reality and strategic potential. Simultaneously, by mapping the household capacity per 100 meters, the viability of supporting infrastructure networks can also be assessed.

3.3 Entries per 100 meters

Allowing individual plots to accommodate additional households may encourage such development to occur, but can the planning scheme be used to facilitate this shift? What the initial alternative studies in Figure 3 begin to suggest is that the way to optimise the relationship between infrastructure and population is to ensure that there are more households per linear meter of road. Thus a street composed of narrow plots, each of which with the potential to accommodate two households, is a more optimal relationship than a single household on a wider plot. One existing typology that supports this relationship is the row house or terrace house model. These traditionally operate on very narrow plots typically with a side entry which can allow multiple levels to be accessed and occupied independently. Whilst this model is exceptional from a strategic point of view it's lack of uptake in the suburban context indicates that it isn't highly desired by or viable for the property market, particularly in suburban contexts, and it's introduction would mark a significant shift in the character and composition of regional and outer metropolitan suburban settlements.

How then can typical volume housing models be encouraged to facilitate the accommodation of multiple households without impacting on the character of the streetscape? Hawaii, a state which has had an Ohana (Hawaiian for 'family') ADU dwelling policy in place since 1982, allows single plots to accommodate multiple households as long as they are related. However, as Lau (2014) discovered, many households are illegally and independently accommodating unrelated households to financially benefit from the high rental rates created by a significant housing shortage. Lau's studies found that illegal occupations were facilitated through the devious configuration of architectural elements and floor plans to facilitate dual independent occupation within a single building without being detected by inspectors. Whilst this is problematic in terms of compliance with health and safety legislation, it offers a suggestion as to how Australia's large volume housing market may be directed to encourage multiple household configurations.

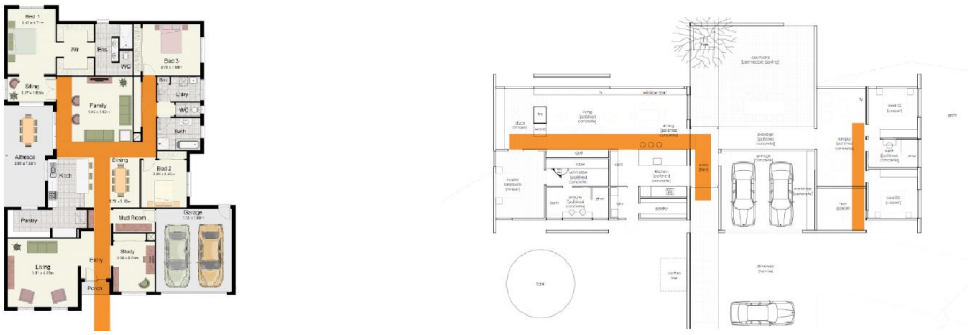

Figure 4: Typical volume housing circulation (left) and alternative volume housing configuration intended for multi-household occupation (right) (source: author)

In comparing the attributes that Lau identified in the illegal multi-household configurations on the island of Oahu with the typical Australian volume housing market offerings there are many similarities. Illegal ADUs contain two food preparation areas (one referred to as a kitchen, the other as a bar), two bathrooms (a main and an ensuite) and multiple bedrooms and living areas. The inclusion of multiple living spaces and bathrooms are also common in many contemporary Australian volume-housing models and thus the attributes of typical market housing are very much aligned with the typologies of multi-household configurations. However Lau identified a further common attribute: the inclusion of at least two entrances from the dwelling to the street, and two independent circulation paths within each dwelling, that enabled each 'set' of minimum household amenities to operate independently.

The floor plan on the left in figure 4, which is typical of contemporary Australian volume housing plans, demonstrates circulation based around a singular access point which makes it impossible for multiple households to occupy the space independently. The plan on the right, however, contains similar spaces but is designed to be occupied by either one or two households independently. If each new build and renovation to an existing property was required to ensure that each dwelling had a minimum of two independent entrances, and configured the internal spaces accordingly as demonstrated in the second plan in Figure 4, dwelling targets could be met within existing residential typologies. As the planning scheme can define the minimum requirements for an individual building, the government could use the planning process to guide the community to further leverage infrastructure investment. Simultaneously, it could facilitate the realignment of housing stock to household sizes whilst also directing the volume housing market to produce more adaptable and resilient suburban housing.

4. Conclusion

The three alternative linear measurement methodologies address the issues related to the use of the dwellings per hectare metric in contemporary strategic planning processes. The shift towards a linear metric can be used to more accurately assess the organic development activity that the community is undertaking and how this might be leveraged. Further, adjusting the focus of strategic planning mapping from abstractions of existing and potential conditions to one map that concretely indicates the capacity of an established suburb, facilitates a more efficient use of existing land and infrastructure resources. Finally, by aligning the metrics of the strategic planning process to the attributes of the planning scheme, strategic ambitions can align with the mechanisms that enable their realisation.

Whilst this alternative methodology has the potential to shift the metric from operating simply as a measurement device to a facilitator of a strategic policy, further research is needed to assess its broader applicability. In particular, the current lack of available data on existing household and dwelling compositions, which are often masked due to the restrictive nature of the current regulatory condition, may limit the applicability of this approach beyond concentrated study areas until new ways to assess existing capacity are developed. Further, more complex metropolitan configurations may require alternative assessment attributes that take into account existing hierarchies such as the compositional nature of different road types, the varying models of housing typologies and a broader range of infrastructure such a rail based public transit.

This example of re-measuring density relative to contemporary issues, in this case housing affordability and infrastructure investment, is just one example of the importance of questioning the validity of metrics relative to the actual issues that they are being deployed to address. As such, this methodology itself, if applied to other misalignments between strategic planning and built environment legislation, could have a significant impact on the way that government is able to guide the development of cities.

Acknowledgements

This paper was produced as part of the PhD project 'Stealth Negotiation' which is currently in progress at Monash University's Department of Architecture, Melbourne. The author would like to thank thesis supervisor Ari Seligmann and the peer-reviewers for the guidance and feedback provided during the development of this paper.

References

Australian Bureau of Statistics, ABS (2010) *Feature Article: Average Floor Area of New Residential Dwellings*, Retrieved 17 Jun, 2015, from <http://www.abs.gov.au/ausstats/abs@.nsf/%20featurearticlesbytitle/8BB3F6B866BC35CECA2578A000153026?OpenDocument.>

AURIN Portal (2015) Available from: Australian Urban Research Infrastructure Network < http://aurin.org.au/> (accessed 17 Feb 2015)

Brenner, N. (2015) The urban age in question: towards a new epistemology of the urban. MSD Dean's Lecture Series. Melbourne, Melbourne School of Design.

Brown, M. (2013). Accessory dwelling units: what they are and why people build them. Available from: Accessory Dwellings <http://accessorydwellings.org/what-adus-are-and-why-people-build-them/>

Capuano, G. (2012) 2011 Census- Our Expanding Households. Available from: .id the population experts blog <http://blog.id.com.au/2012/housing-analysis/australian-housing-trends/2011-census-our-expanding-households/> (accessed 17 June 2015)

Daniels, R. and Mulley, C (2011) Explaining walking distance to public transport: the dominance of public transport supply, in *World symposium on transport and land use research*, Whistler, Canada.

Faulkner, D. and Paul, M. (2009) Scoping the Opportunities for Accessory Dwelling Units (ADU) to Contribute to the Supply of Affordable Housing, Southern Research Centre - Australian Housing and Urban Research Institute, 43.

Griffiths, D. (2009). Density targets: Measuring everything except that which makes life worthwhile? . 10th International Cities Town and Centres & Communities Society Conference. Deakin University, Geelong.

Lister, G. and Irwin, D. (2013) Learning from Vancouver: Gentle Density. Auckland, Isthmus Research.

Lau, Q. (2014) Black boxes and gray spaces: how illegal dwellings find regulatory loopholes, *Beyond Architecture: New Intersections & Connections*, University of Hawai'i at Manoa, Architectural Research Centers Consortium European Association for Architectural Education.

Pafka, E. (2013) Nothing Gained by only Counting Dwellings per Hectare: A hundred years of confusing urban densities, *State of Australian Cities Conference*, Sydney: 9.

Tasmania (1964) Southern Metropolitan Area: a survey map of town planning policies [cartographic material], Southern Metropolitan Master Planning Authority

Tasmania (2011) H.30: Greater Hobart Capital City Plan (Draft), Tasmanian Planning Commission.

West, J. (2013) Obstacles to progress: What's wrong with Tasmania, really? Griffith REVIEW 39, Autumn 2013(39): 9.