Residential intensification on a suburban fringe local government area in the Melbourne Metropolitan Area, Australia

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Abstract

Urban consolidation has featured in Australian planning policy debates, especially after the adoption of sustainability as a guiding principle in the 1990s. Recently, urban consolidation has been adopted in strategic planning policy in different states, such as the Victorian state-wide land use planning policy, Melbourne 2030, released in October 2002. This paper presents a result of mapping urban consolidation patterns in the City of Casey using Victorian Spatial Data. Increased dwelling numbers refer mainly to new residential land cover on Greenfield sites that leave most dwellings in acceptable proximity to schools but less-well served with regards to hospitals and the public transport network.

1. Introduction

Many cities and metropolitan areas are changing form due to enforcement of urban consolidation policies. These policies have been designed to reduce sprawling, and preserve farmlands and/or designated open spaces on the city fringe, to seek for efficient uses of infrastructure and less car-dependence, and to improve quality of life. They have featured in planning policy debates, especially after the adoption of sustainability as a guiding principle in the 1990s. While some researchers offer support for a certain level of higher density development (Buxton and Tieman, 2005), critics of higher density development have been able to refer to social and cultural arguments, including one about infill development in the existing urban areas threatening the status of prevailing residential streetscapes (Birrell *et al.*, 2005b). Additionally, it is noted that the adequacy of current infrastructures and services can be less than needed to accommodate increases in population and dwelling numbers (Troy, 1996, Mees *et al.*, 2008). Burton (2000, p.1970) stated that one of the main problems in advancing debate about the compact development model is a lack of empirical evidence to support either claims or counter-claims. Talen (2003) added that although "smart growth theory" (the term usually used in the United States or Canada) has emerged, there is still a lack of quantitative measurement, representation and evaluation of urban form and its associated impacts. Thus neither formulation nor implementation of urban compact city policy may be as well served as advocates would want (Talen, 2003).

Urban consolidation has prevailed in urban planning policies in major Australian cities for over 20 years (Searle, 2003). Recently, urban consolidation has been integrated in state-wide strategic plans released between 2002 and 2005 in Melbourne, Sydney, and Adelaide (Randolph, 2006). These urban planning policies have surely

been long-enough implemented for useful research results about their impacts to have emerged.

However, a detailed geography of the settlement intensification has not yet been systematically identified (Buxton and Tieman, 2004, Birrell *et al.*, 2005b, Holloway and Bunker, 2003), and therefore, spatial relationships between increased population density and local infrastructures and services, not to mention the associated social costs, are not well documented. Additionally missing, is a metropolitan scale (constituent city-by-city), appraisal of the relative significance of intensified dwelling development forms. Detailed datasets (such as at land parcel level of mapping), have been called for, so that monitoring and management of urban development can take place at local as well as at the metropolitan scale of mapping. As Phan *et al.* (2008, in press) demonstrate, integration of selected spatial datasets can offer geography of residential infill development that is detailed enough for decision support at local government level. In this paper, we present a result of applying that methodology to identify location of residential intensification in the City of Casey, Melbourne, Australia between 2001 and 2006. We chose the study period as of 2001-2006 for a number of reasons, namely:

1. the period showed an larger increase in population in Melbourne after a declined growth rate in previous period (1996-2001) (DSE, 2007a);
2. the period covers the time before and after the implementation of the recent Victorian state strategic planning policy so that implications for urban planning policy can be referred from the residential urban form changes documented.

3. the period covers two census dates: 2001 and 2006, so that many socio-economic factors from the ABS can be incorporated and integrated in the analysis.
4. previous studies (Buxton and Tieman, 2005, Buxton and Scheurer, 2007, Mitchell, 1999, Birrell *et al.*, 2005b) are old enough for the appraisal to be re-visited.

2. Literature review of residential intensification and urban form quantification

Generally, census data (the ABS census of people and housing) is the key dataset used by urban geographers in Australia. Aggregated census collection districts (e.g. to level or local government area level) (DPCD, 2007b, Randolph, 2006, Roberts, 2007, Yates, 2001) form the main analysis mapping unit. Using such aggregated datasets has three major disadvantages if urban intensification is defined as the increase in population or in number of dwellings per unit area. First, even the smallest census unit (census collection district :CCD) is aggregated from 220 dwellings (ABS, 2006), thus it does not represent the precise location of features of urban intensification. Secondly, there are problems associated with aggregated data, such as the "modifiable areal unit problem" (Openshaw, 1983). Thirdly, in the census data from the Australian Bureau of Statistics (ABS), multiple detached or attached houses subdivided from previous residential land lots are classified as "separate house". Failure to be counted as higher density developments, the lack of these developments in the dwelling count underestimates of the rate of urban consolidation (Buxton and Tieman, 2005).

Lately, a growing concern for documenting change patterns has seen recognition of the utility of temporal and spatial data of finer scale and the availability and accessibility of analysis tools such as geographical information systems (GIS) (Clifton

et al., 2008). Input data can now include the cadastre (in time series) or fine-scale land use land cover (LULC) maps generated by the research team from analysis of increasingly available image data. However, studies have been limited to (1) manual plotting of infill features (Birrell *et al.*, 2005b), (2) descriptive analysis of urban consolidation patterns, focussing on densification in existing urban areas in three municipalities in the middle and outer regions in Sydney (Holloway and Bunker, 2003, Bunker *et al.*, 2002), and (3) comparative analysis of urban consolidation patterns for four inner municipalities in Melbourne (Buxton and Tieman, 2004).

Techniques to quantify and classify urban form have been advanced from a range of disciplinary perspectives (Clifton *et al.*, 2008). Cuthbert and Anderson (2002) used a kernel estimate method to characterise residential and commercial land intensification in Halifax Regional Municipality. Song and Knaap (2007) presented an approach to characterise and classify neighbourhood for new single-family homes in the Portland area. Hahs and McDonnell (2006) used a gradient analysis approach to study landscape changes over spaces from the Melbourne CBD. Herold *et al.* (2003), using North American examples, and applied a number of landscape metrics to examine changes in the spatial-temporal urban environment. Batty and Longley (1988) used a fractal analysis technique to measure urban morphology in a UK village, land parcel by land parcel, the perimeter and area of each land parcel treated as indicators of urban form. Buxton and Tieman (2004) examined the contribution of dwelling supply from greenfield developments on the fringe of the Melbourne Metropolitan under different development density scenarios.

Research about the influence of strategic urban land use policies on local and regional development in Australian metropolitan regions have only recently emerged (Randolph, 2006). Many spatial datasets and techniques of analysis have been advanced; as a result, there is a scope for spatial data integration, analysis and visualisation of the patterns of residential intensification and its local impacts.

3. Urban consolidation- policy context in Melbourne

Previous studies (Buxton and Tieman, 2005, Birrell *et al.*, 2005a) have provided comprehensive description and analysis of the evolution of state planning policy on urban development since 1970s. To set a context for our study, we summarise the key time periods marking the changes or transitions in urban planning policies in Melbourne either at local or state level. Generally, there are four main periods of planning policy changes in Melbourne in intervening and controlling the urban consolidation policy.

First, from the early 1970s to early 1990s, urban consolidation was controlled by each municipality under its "flat codes" (in terms of type, design, location and density). These were non-statutory and varied across municipalities. However, the state planning group of the time, the Melbourne and Metropolitan Board of Works, introduced dual occupancy provisions into the Melbourne Metropolitan Planning Scheme (MMPS) in Amendment 150 in 1981 (Buxton and Tieman, 2005). Initially, dual occupancy was in the form of additional dwellings in the backyard of a suburban house, and later there were examples of house replacement by two detached houses (Birrell *et al.*, 2005a).

Secondly, the Victorian Government introduced *The Victorian Code for Residential Development (Multi-Dwellings)*, named VicCode 2, in December 1993 to control medium density developments (Buxton and Tieman, 2005). Under this policy, all metropolitan councils were required to have their provisions regarding planning permits for 3+ dwellings or dual occupancy in any urban zone or reserved land. VicCode 2 was reviewed in mid 1994 and *The Good Design Guide for Medium Density Housing* was then introduced to provide further requirements for local governments in approving of medium density development applications. Specifically, a planning permit is required for a lot for the use and development of:

- 2+ dwelling development, other than a moveable dwelling unit, not exceeding four storeys, or
- 1 dwelling on a lot less than $300m^2$

Thirdly, Rescode, a medium density code, was introduced by Victorian Government in 2001 to become a statutory tool for controlling medium density development. Requirements and standards are given for each dwelling development application category, namely

- Not required a permit
- Single dwellings
- Multiple dwellings on a lot and
- Subdivision

Rescode was developed based on previous planning tools: VicCode 1 and *The Good Design Guide* (Buxton and Tieman (2005). It added some new standards, though some of them were not statutory. Historically, the success of urban planning policy was can be little better than "mixed" due to "the discretionary nature of much content,

the use of qualitative measures and the lack of clarity" (Buxton and Tieman, 2005, p.141).

Fourthly, in October 2002, the Victorian State Government introduced its thirty-year strategic urban land use planning policy: *Melbourne 2030*. It was released as a strategic plan for accommodating a projected population increase of one million by 2030 while improving economic efficiency and the environment, and maintaining the community's liveability. This strategic plan seeks to change radically the traditional pattern of Melbourne's low density urban form to "a more compact city" model, as stated as Principle one in the *Melbourne 2030 document*. Principle one aims to (DoI, 2002. p.45):

> 1.3 Locate a substantial proportion of new housing in or close to activity centres and other strategic redevelopment sites that offer good access to services and transport

Specifically, according to *Melbourne 2030*, location of new residential housing should be (DoI, 2002, p.57):

- In or around the central activities district (CAD)
- In or within easy walking distance of Principal or Major Activity Centres
- In or beside Neighbourhood Activity Centres that are served by local public transport
- Abutting tram, train, light rail and bus routes that are part of Principal Public transport network and close to principal or major activity centres
- In or near major modal public transport interchanges that are not in principal or Major Activity Centres and/or
- In major redevelopment sites, that is able to provide 10 or more dwelling units, close to activity centres and well-served by public transport

Being a fringe city (about 40km from the CAD), it is the last five points above that apply to the City of Casey. To assess the influence of *Melbourne 2030*, in this study, increased dwelling number (per 2001 land parcel) will be identified and their relative

location *vis a vis* designated activity centres, public transportation networks and selected services will be assessed.

Although the concept of higher density development is not clearly defined in *Melbourne 2030*, it is generally agreed by researchers that higher density development relates to population intensification, and that it can be seen by the increased number of dwellings, built as (1) redevelopments on land parcels that were previously occupied by a single dwelling with a generous garden space, (2) semi-detached or attached housing in single or multiple stories. In other words, land supply for higher density development includes (1) already established residential areas, (2) brownfields, and (3) greenfields (Buxton and Tieman, 2004). The actual development pattern in terms of location, extent and dwelling types has been found to vary by each local government area (Buxton and Tieman, 2005). As such, analysis should be taken for each local government area before an attempt is made to document the metropolitan pattern of urban form change. In this study, we particularly examine the location and extent of residential intensification in the first and third form.

It is generally agreed that the decision support that is served by mapping residential urban form change refers to:

(1) monitoring the current state of urban intensification for each local government area;

(2) examining the driving forces of urban consolidation: planning policy, market influences on location, development types and housing prices, residential reactions and opposition; and historic development legacy in each local government (Bunker *et al.*, 2002); and

(3) examining need for infrastructure improvement or any risk associated (e.g. increased stormwater runoff or flooding) in areas which are subject to higher infill development.

In complement to a previous study (Phan *et al.*, 2008, in press) of part of the MMA that has long been a built-up area, this paper presents results of mapping and examining the growth in the number of dwellings in a city much closer to the MMA boundary: the City of Casey.

4. Study area

The City of Casey (813.3 km^2) is one of most rapidly growing regions on the fringe on the MMA (Figure 1). Early European settlement occurred in the late 1830's, at much of the same time as settlement of the Melbourne CBD (City of Casey, 2008).Over many years, pastoral activities dominated the local economy (City of Casey, 2008). Any local urban development referred to neighbouring shires, Cranbourne and Berwick (proclaimed as cities in 1993 and 1994, respectively) (City of Casey, 2008). The modern extent of City of Casey refers to a 1994 amalgamation from the former City of Berwick, the former City of Cranbourne, (formed in the late 1860s) and a small part of the City of Knox in (City of Casey, 2008).

City of Casey is one of the key growth areas in the MMA. Its population increased by 37,481 persons (21%) between 2001 and 2006 (calculated from the ABS data (ABS, 2007)). In absolute terms, Casey showed the largest Australian inter-censal population growth (2001 and 2006) (DSE, 2007a). The concomitant dwelling number increases are attributed to many factors, some of which are: strong national economy, growth in household incomes, low interest rates, population growth and increased household

information (DPCD, 2007a). Additionally, according to ABS (2001 and 2006) data, major growth and development of dwellings in the MMA occurred on the fringe and inner regions (DPCD, 2007a).

The City of Casey is located in the Southern Region in the MMA (Figure 1). Regional environmental amenity and liveability attributes include proximity to the Dandenong Ranges, bays and beaches, rural areas, and accessibility to the townships and settlements within green wedges and developments such as golf courses (Southern Regional Housing Working Group, 2006).

Figure 1: Study area location

Notes: The Melbourne Metropolitan Area (MMA) is shown together with the administrative boundaries of the constituent 31 Local Government Areas, as defined by the municipal amalgamations of 1996. The map shows City of Casey is in the South of the MMA

Figure 2 shows a gradual increase in number of private dwellings between 1981 and 2006, at a five year interval, in selected local government areas (LGAs) in the East, North and West Regions of the MMA: Casey, Moreland, and Wyndham, respectively. Casey clearly shows the highest number of new dwellings development between 2001 and 2006; but at a decreasing rate between 2002 and 2006 (Figure 3). In terms of dwelling structure, it can be seen from Figure 4 that such a rapid increase in total dwelling numbers can be attributed a big increase in the number of separate houses. Medium density development (in the form of semi-detached, row or terrace house; and flat, unit, or apartment), also shows a growth; but it is at a lesser rate.

Figure 2: Changes in total private dwellings, selected Melbourne LGAs, 1981 to 2006 (DPCD, 2007a, p.2)

Figure 3: Total dwelling units approved in City of Casey between 2002 and 2006

Source: Australian Bureau of Statistics (ABS), Time Series Dataset, Casey Local Government Area (ABS, 2007)

Figure 4: Changes in dwelling types over 2001-06 period (ABS, 2007)

5. Methodology

The primary datasets used to identify the pattern of residential intensification in the City of Casey (Figure 5) include planning scheme maps, cadastral maps, and address point data (2001 and 2006). They are provided by Department of Sustainability and Environment (DSE) and used for identification of residential land and examination of residential intensification, respectively. The 2005 aerial photo mosaic was provided by Casey City and, together with Google Maps (aerial photos were archived on 16 February 2006), was used for data quality checking and results validation.

The cadastre is a register of the precise location, extent, use and ownership of land, these being non-spatial attributes in land parcel datasets. It is maintained, for among other reasons, for taxation purposes (DSE, 2006). The Vicmap Address dataset (VADD) is a fully geocoded digital street-address dataset. The records include the spatial relationship of each address to the relevant polygon in the cadastre (DSE, 2007c). Urban addresses in the MMA are assigned 8 metres back from the property road frontage mid-point (DSE, 2007c). Unit and house number are assigned by each Local Government Area either after approval of land subdivision, plan registration at Land Registry or at the time of sale of the property (Salmon, 2008). VADD is regularly validated with local government property records with 90% of completeness and accuracy (Salmon, 2008). Because in 2006 all dwelling non-spatial attributes (for instance, unit number, house number, or street name) are in VADD, we used both the

property dataset and VADD for analysing the 2006 dwelling patterns. Other datasets, such as planning schemes and land mark datasets (including non- residential properties, such as abattoir, camping grounds, caravan parks, car parks, cemeteries, parks, recreation areas, showgrounds, and sports areas) (DSE, 2007b), were also used to differentiate residential land parcels from other non-residential land parcels.

In this study, we mapped the location of increased dwellings in each 2001 land parcel (Figure 5). Then, they were classified by the number of increased dwellings in five classes:

- 1-2 dwellings
- 3-10 dwellings
- 11-36 dwellings
- 37-76
- 77+ dwellings

The first class (1-2 dwellings) represents dual occupancy dwelling stock change while the middle class (such as 3-9 dwellings) can represent medium density development in the form of multi attached units or townhouses and apartments. The final class (77+ dwellings) represents a mix of dwelling development types. In this study, we consider urban consolidation as the process of increased dwelling density over the land parcel unit, like other studies (Birrell *et al.*, 2005b, Phan *et al.*, 2008, in press), therefore we regard the uses of primary datasets (i.e. cadastre data and VADD) to count the increased dwelling number per 2001 land parcel as reasonable.

Proximity analysis has been widely deployed in analyses of access to facilities: for example, proximity has been used as an explanatory variable to examine the

influence of transportation network on location and prices of housing stocks (Cho *et al.*, 2005) or to examine the influence of planning policy on the pattern of residential development (Buxton and Tieman, 2005). We used a proximity analysis tool (buffer in ArcGIS 9.2 (ESRI, 2007)) to analyse the extent and amount of higher dwelling density development around public transport networks and designated activity centres.

Figure 5: Overview of mapping residential intensification approach (Adapted from Phan *et al.*, 2008, in press)

6. Results and Discussion

6.1. Extent and scale of current residential intensification

Figure 6 shows the location, extent and amount of urban consolidation pattern in the City of Casey in terms of increased dwelling numbers per 2001 land parcel. Only 10.6% (970 in total) of them refer to dual occupancy or infill of residential land parcels: 55% of the new dwellings refer to Greenfield developments. The rest is of other categories, including multi attached units or multi storey dwelling complexes (Table 1). As shown in Table 1, the green field developments (resulting in subdivision of large number of dwellings: 77+) account for most of the land cover change.

Table 1: Summary of residential intensification in City of Casey, 2001-06
Notes: Residential intensification is classified by number of subdivided dwellings.

Figure 6: Residential intensification in City of Casey in 2001-06

These indicate that much residential intensification in the City of Casey occurred as urban sprawl; mostly the transformation of a Greenfield sites to residential land use featuring multi attached and detached houses or units/flats. This is a contrast to the results of an analysis of City of Monash dwelling intensification (Phan *et al.*, 2008) that showed that dual occupancy or redevelopment of old housing stock for replacement with two to seven dwelling units was the most common change. This reflects the different or even contrasting patterns of residential development between

the fringe and suburban areas. Indeed, the suburban area, City of Monash, has been developed since the 1960s, as a result, in 2001-2006; there are not many big land parcels available for further development or subdivision. In contrast, the young fringe area city: City of Casey, is far from the Melbourne CBD, relatively lacking in access to public transportation networks, and, even today, has land cover that is mostly agricultural. Thus, until recently, this area has been less preferable for settlement than areas closer to the CBD. Previous studies for municipalities in middle and outer regions of Sydney also found a similar trend: increased dwelling density mostly occur in small land parcels of mature cities whereas less mature or younger residential areas tend to have Greenfield sub-division during phases of residential densification (Bunker *et al.*, 2002).

In section 3, data analysis from the ABS, shows that the category "separate house" accounts for a big proportion of new dwellings in the City of Casey in the 2001-2006 period. It is observed on the aerial photos (in 2005, which was provided by Casey City Council and in 2006, which is viewed in Google Earth 4.3) mosaic that "separate house" class in Casey includes both detached and attached single houses. Although the method presented in Figure 5 allows defining precise location of residential intensification in terms of increased dwelling number per 2001 land parcel, currently it does not offer differentiation between detached/attached single house and medium density development (such as multiple-stories flat or apartment). In a previous study in Sydney, Holloway and Bunker (2003) could disaggregate residential intensification types: dual occupancy, small lot housing, housing for aged and disabled, townhouses and villas; and flats and units because these were the dwelling type attributes attached in their primary dataset (i.e. development applications provided by local councils).

6.2. Overview of Demographics and Housing Prices trend

Previous literature has shown association between population and dwelling growth. For this reason, a snapshot of City of Casey demographic changes over three census periods: 1996, 2001 and 2006 (Figure 7) shows that young people aged 5-14 years old and middle age people aged 35-44 years old, account for the largest proportion of population in the City of Casey. In fact, these two age groups represent young families. The dominance of young families in Casey might reflect the nature of housing affordability for first home buyers. It is reported that between 1991 and 2005, house and apartment prices in Casey increased at 137% and 149%, respectively (Southern Regional Housing Working Group, 2006, p.29). This rate is about 10-15% lower than those for the whole MMA and is much lower than those of Inner or coastal local government areas. However they are slightly higher than those of adjacent local government areas, such as Cardinia, Frankston or Greater Dandenong.[1]

Figure 7: Age group in census years, City of Casey (ABS 2006)

Being an area with no more than moderate housing price increase, and offering new houses via development of Greenfield areas, Casey City Planners have had to decide which housing density value might meet living and open space requirements. Buxton and Tieman (2004) suggested that increased development density on the fringe from 10 dwellings/ha to 15 dwelling/ha can save a substantial amount of land while at the same time giving greater density of access to the public rail network. Such theoretical analysis assumes the provision of sufficient and accessible infrastructures.

6.3. Accessibility to public transport networks

[1] Figures are derived from Southern Regional Housing Statement (Southern Regional Housing Working Group 2006, p.29).

It is generally agreed that settlement locations or transit locations should be within a walking distance of the public transport network (up to 800m, which is equivalent to 10 minute walking). In the City of Casey, there are two railway lines and a number of principal bus line networks to connect local residents to activity centres and other places of interest. Proximity analysis of new dwelling development between 2001-2006 in Casey (Table 2 and Table 3) shows that within 400m of public transport network, there is mostly a small number of increased dwellings per 2001 land lot (i.e. 1-2 dwellings). In terms of dwelling supply, larger number of increased dwelling per 2001 land parcel (77+ dwellings) provides a significant proportion of the dwellings, particularly in areas close to railway lines. In an aggregate number, the proportion of dwelling supply from areas within 400m of bus lines and railway lines accounts for only about 10-12% of the total dwelling supply in the 2001-06 period. These figures suggest that a large proportion of new dwellings are still disadvantaged in access to the public transport network. Recent study found that of major Australian cities, Melbourne saw the largest increase in car driving and the largest declines in car pooling, public transport and walking for travelling to work over the last three decades (1976-2006) (Mees *et al.*, 2008). Therefore, without improvements in public transportation networks, intensified dwelling development and corresponding likely increased population settlement in fringe city areas such as Casey might increase the number of cars involved in the journey-to-work, not to mention other activities. This subsequently threatens the success of urban compact city policy.

Table 2: Infill development within 400m of principal public transport network bus lines and its proportion of total infill development in the City of Casey in 2001-06

Table 3: Infill development within 400m of railway lines and its proportion of total infill development in the City of Casey in 2001-06

6.4. Accessibility to activity centres

Activity centres are classified under a hierarchical system, in which Principal Activity Centres (PACs) plays the more significant role than others in provision and accessibility to services for the wider extent of neighbourhood communities (Goodman and Coote, 2007). There are six local activity centre proposed in the *Melbourne 2030*, including:

- Principal Activity Centres (PAC): Cranbourne and Narre Warren, Fountain Gate
- Major Activity Centres: Casey Central, Berwick, Hampton Park, and Endeavour Hills

According to *Melbourne 2030*, the location of Activity Centres will influence and facilitate the development of different housing types, including forms of higher-density housing (DoI, 2002). Proximity Analysis (Table 4) shows that most infill development within 800m of a designated Activity Centre refers to small increased dwelling numbers per 2001 land parcel (i.e. 1-2 dwellings). It provides only about 2% of the total number of new dwellings in Casey in 2001-2006. Altogether, infill development within 800m of Activity Centres in Casey City accounts for only 6% of total new dwellings in 2001-06. This again indicates that new dwelling development is not necessarily close to designated Activity Centres as preferred in the *Melbourne 2030* objectives. In fact, dispersed infill subdivision and green field developments are the two main types of high density development in City of Casey between 2001 and 2006.

Table 4: Infill development within 800m of Activity Centres and its proportion of total infill development in the City of Casey in 2001-06

6.5. Proximity to other services:

Place of interest database (e.g. church, schools, or shopping centres) is not available in the current Victorian Spatial Dataset. However, they are freely viewed in Google Earth. These datasets are provided by TrueLocal™. We selected all places of interests in City of Casey (schools and hospitals) and then transformed them to a ArcGIS format. The Hawth's Analysis Tool (Beyer, 2004), an extension of ArcGIS, was then used to calculate the nearest distance between each address point in areas of new dwelling developments to those places of interest. Table 5 shows that nearly half of the new dwellings (48%) are within 1 km of their nearest schools in the City of Casey. Locations of hospital or medical centres are further from new dwellings than schools: about 35% of new dwellings are outside the 2km buffer of any nearest hospitals or medical centres.

Although our analysis currently does not disaggregate the proportion in terms of school types or medical centre or hospital types, these figures still provide a certain measure of infrastructure provision to serve the increased dwelling density To improve accessibility to these services by walking or using public transport, infrastructures need to be upgraded or improved in areas of those residents living outside 2km buffer of any nearest hospitals or medical centres.

Table 5: Nearest distance between new dwelling developments to places of interest

7. Conclusion

Integration of spatial datasets: cadastres, planning schemes, and aerial photos allow identification and visualisation of patterns of residential subdivision between 2001

and 2006., This case study from the expanding MMA fringe, shows a marked contrast to the pattern of urban residential densification that characterised another city (Monash) twenty km closer to the CBD but responding to the same urban development/re-development policy. Proximity Analysis: 400m buffer of the public transport network (railway lines and bus routes) and 800m buffer of Activity Centres in proximity analysis showed that between 10% and 6% of new (2001 and 2006) dwellings developed within buffers of the public transport networks and Activity Centres, respectively. Additionally, nearest distance analysis found that 95% of high density developments are within 1km of the nearest schools while about 35% of them are outside 2km buffer of the nearest hospitals. There is clear scope to bring policy and practice closer together by improving access to infrastructure. Part of any programme to bring this about could involve encouragement for infill development near existing infrastructure.

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Figure 1: Study area location

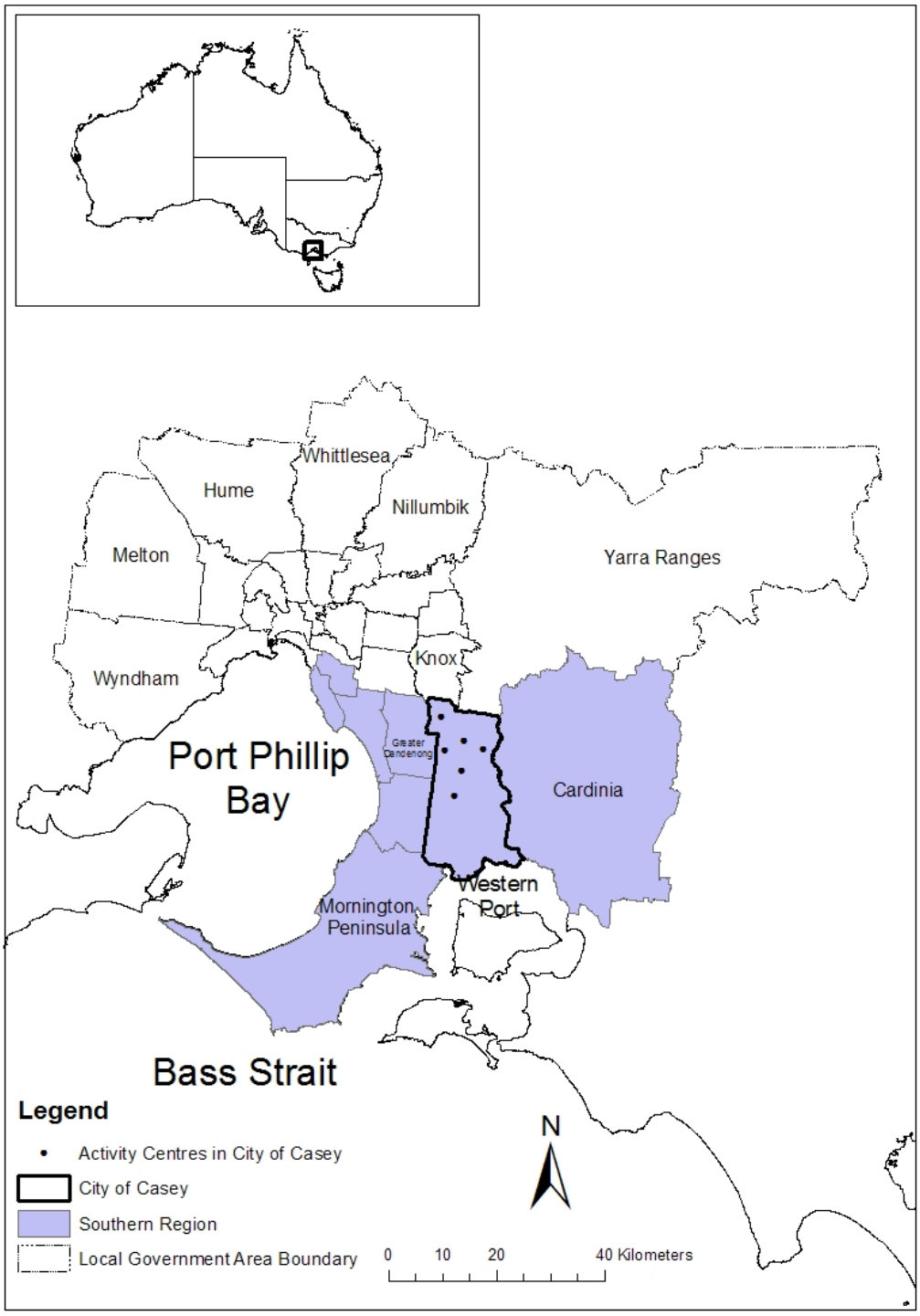


Figure 2: Changes in total private dwellings, selected Melbourne LGAs, 1981 to 2006
(DPCD, 2007a, p.2)

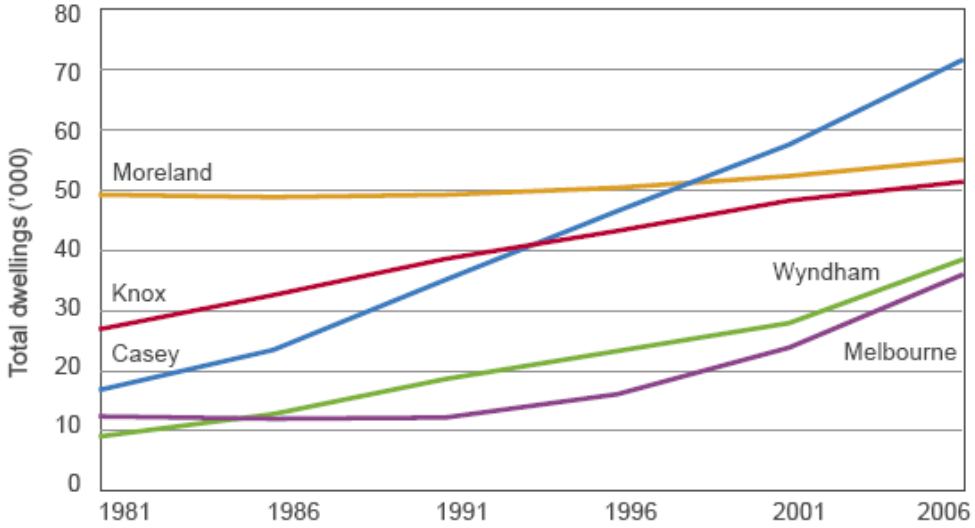


Figure 3: Total dwelling units approved in City of Casey between 2002 and 2006 (ABS, 2007)

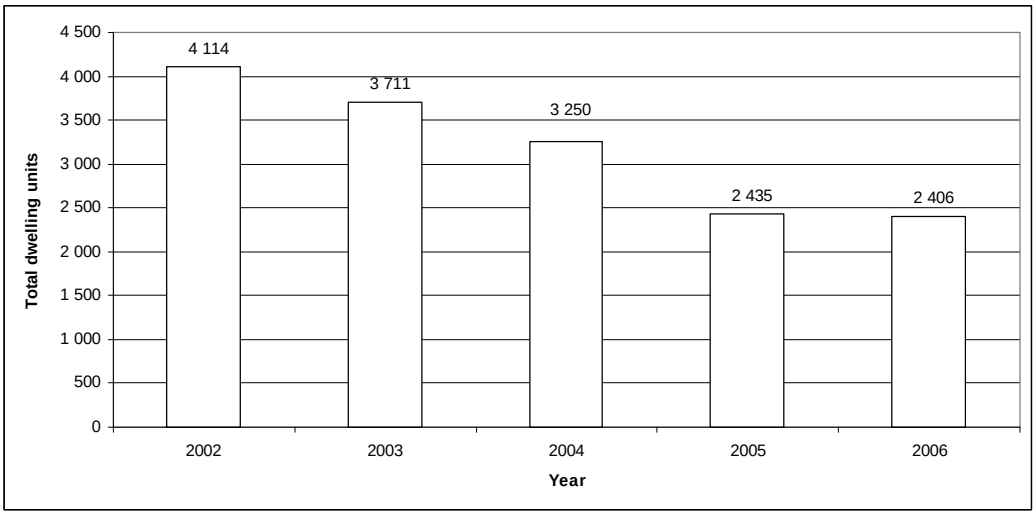
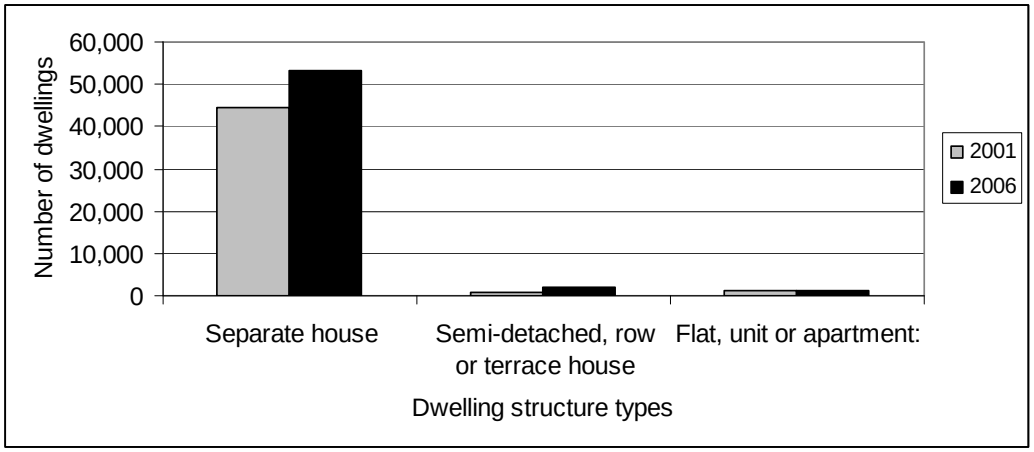


Figure 4: Changes in dwelling types over 2001-06 period (ABS, 2007)



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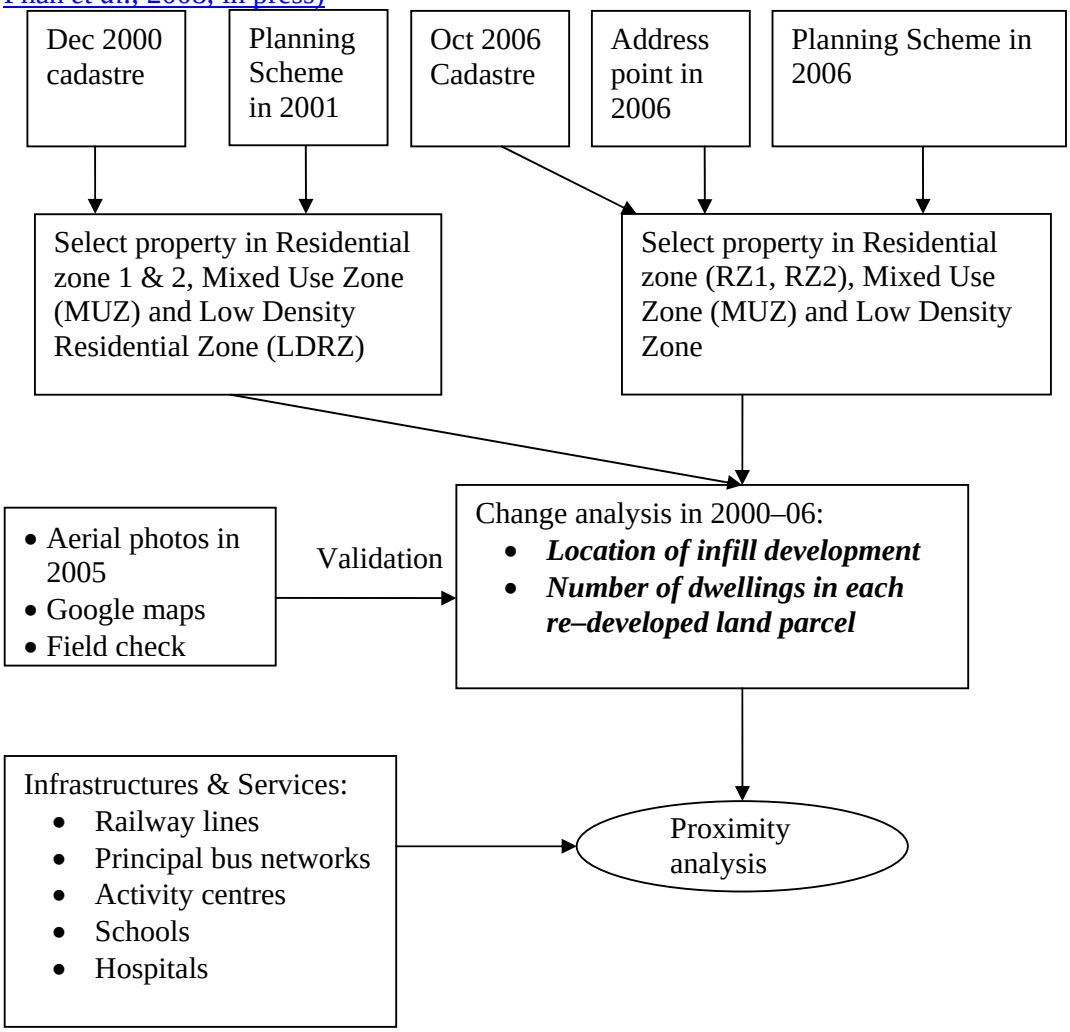

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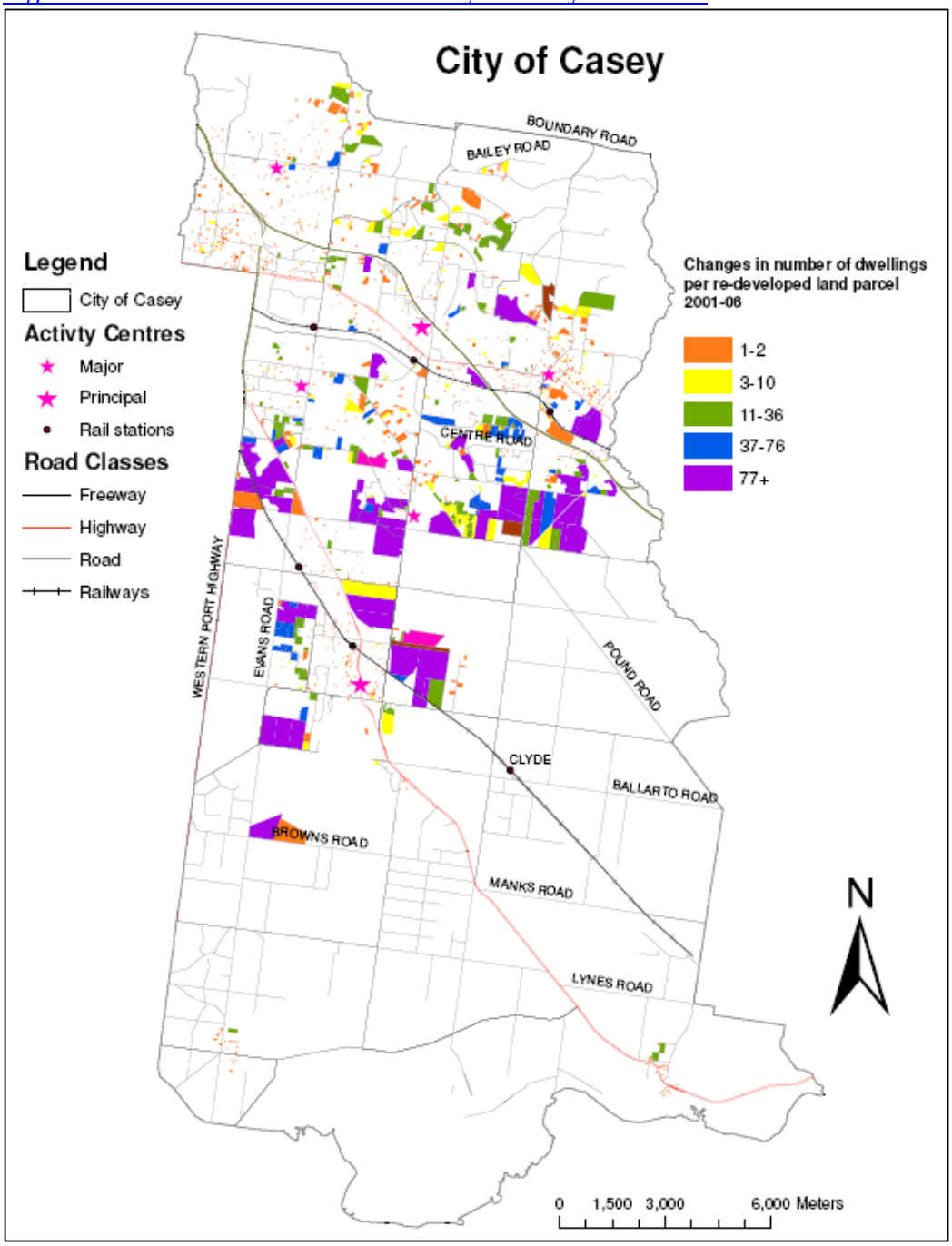

Figure 7: Age group in census years, City of Casey (ABS, 2007)

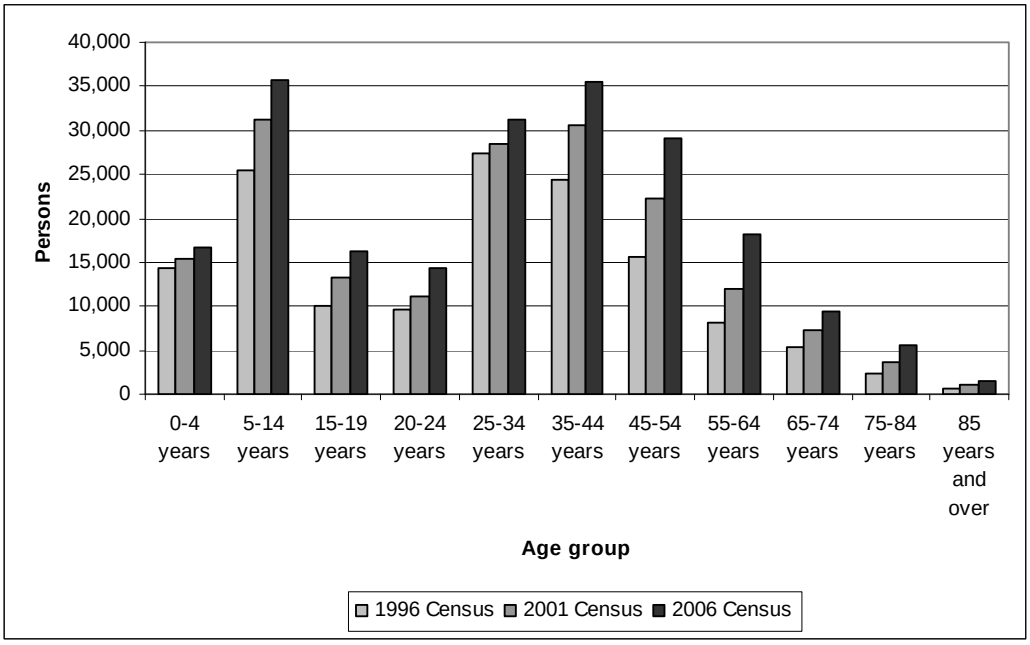

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Table 1: Summary of residential intensification in City of Casey, 2001-06

Class	Count	% of occurrence of subdivision	Dwelling Supply	% of total dwelling supply	Total block size (ha)
1-2 dwellings	970	69.3	2104	10.6	392.4
3-10 dwellings	201	14.4	1260	6.3	332.7
11-36 dwellings	130	9.3	2908	14.6	448.8
37-76 dwellings	50	3.6	2751	13.8	255.4
77+ dwellings	48	3.4	10862	54.6	1356.8

Table 2: Infill development within 400m of principal public transport network bus lines and its proportion of total infill development in the City of Casey in 2001-06 .....

Class	Count	% of occurrence of subdivision	Dwelling Supply	% of total dwelling supply
1-2 dwellings	299	21.4	659	3.3
3-10 dwellings	55	3.9	306	1.5
11-36 dwellings	22	1.6	424	2.1
37-76 dwellings	5	0.4	280	1.4
77+ dwellings	4	0.3	760	3.8
Sum	385	27.5	2429	12.2

Table 3: Infill development within 400m of railway lines and its proportion of total infill development in the City of Casey in 2001-06..... **Error! Bookmark not defined.**

Class	Count	% of occurrence of subdivision	Dwelling Supply	% of total dwelling supply
1-2 dwellings	107	7.6	238	1.2
3-10 dwellings	12	0.9	70	0.4
11-36 dwellings	2	0.1	50	0.3
37-76 dwellings	4	0.3	201	1.0
77+ dwellings	8	0.6	1412	7.1
Sum	133	9.5	1971	9.9

Table 4: Infill development within 800m of Activity Centres and its proportion of total infill development in the City of Casey in 2001-06..... **Error! Bookmark not defined.**

Class	Count	% of occurrence of subdivision	Dwelling Supply	% of total dwelling supply
1-2 dwellings	164	11.7	369	1.9
3-10 dwellings	17	1.2	93	0.5
11-36 dwellings	4	0.3	71	0.4
37-76 dwellings	3	0.2	167	0.8
77+ dwellings	3	0.2	478	2.4
Sum	191	13.7	1178	5.9

Table 5: Nearest distance between new dwelling developments to places of interest 20

Distance	Hospitals/Medical Centres	%	Schools	%
<500m	1401	6.3	3823	17.3
500m-1km	3066	13.8	6955	31.4
1km-2km	9866	44.5	10327	46.6
2+km	7819	35.3	1047	4.7

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