Melbourne - Testing its Progression Towards a Compact City - An Urban Planning Challenge

Prem Chhetri [1], Shobhit Chandra [2], Jonathan Corcoran[3]

School of Management[1]
RMIT University, Melbourne, Australia

School of Geography & Environmental Science[2]
Monash University, Melbourne, Australia

UQ Social Research Centre[3]
Institute of Social Science Research,
The University of Queensland, Brisbane, Australia

49th Congress of the European Regional Science Association (ERSA)

Liverpool, UK

27 – 31 August, 2008

Abstract:

This paper evaluates the change in the dwelling density patterns before and after the *Melbourne 2030* Plan that promotes a compact city model for Melbourne Metropolitan area. Urban density patterns were spatially explored using a 1X1 kilometre grid that reflects the spatial variability and levels of densification within the urban growth boundary. Two techniques were employed to capture the change in dwelling density. First, a buffer analysis is used to test the difference in the dwelling density patterns between different buffer zones generated around the Melbourne CBD and the 'activity centres'. The ANOVA (Analysis of Variance) results for this part indicate that urban densities across the buffer zones around the Melbourne CBD are statistically different; while the degree of densification around the activity centres between the first two zones (i.e. less than 500 metres and 500 metres to 1 kilometre) are statistically insignificant. Second, the densification proposed in the plan to encourage more multi-level/unit developments has been measured using a spatial autocorrelation measure. The results for this part reveal a decline in the Moran's I computed for 2001 and 2006. This might suggest that densification is just not restricted to the target areas (e.g. activity centres) as the evidence of higher density housing development can be seen widely across the metropolis.

Key words: Urban compactness; housing; spatial autocorrelation; urban planning; spatial analysis.

1. Introduction

The land use planning is an integral aspect to the viability and liveability of a metropolitan area. Over the last decade, government agencies and local councils in Australia have been continually developing and adopting land use planning strategies to control and manage urban growth particularly in the outer urban fringe. This adjustment in the urban policy framework can be seen as a 'paradigm shift' whereby a radical policy shift favouring re-urbanisation over suburbanization has been evidenced. With this shift, it can be anticipated that the characteristics of future cities in Australia will be driven by urban policies that promote an urban model where cities are envisaged to be more compact and well connected to employment hubs, amenities and recreational opportunities. The progression of Melbourne towards a 'compact city' may encourage commuting behaviour that may be amenable to the use of public transport as well as walking and biking, thus eventually may help reducing the car dependence and promoting sustainable development (Burton 2000).

The notion of compact city over the decade has become a *cliché* in urban policy debate around the world. There is no doubt that the advantages offered in a compact city model are numerous. Containment of urban sprawl, better access to services and amenities, reduced car dependency and more frequent use of public transport are some of the advantages of compact city urban structure (Dieleman et al., 1999; Burton 2000). Counter-arguments against the compact city concept such as depletion of open space, overcrowding, congestion and inflated housing market (particularly around high access nodes) deter its adoption as an urban policy (Burton, 2000). Heavy investment of public funds in projects such as inner suburb renewable or urban rejuvenation (e.g. dockland developments in Melbourne and London) can be seen as geo-targeted attempts to attract people and businesses in the inner city areas.

Despite the rhetoric, the real policy implications of recent urban policy change implemented through the Regional Plans such as the 'Melbourne 2030' or 'South East Queensland (SEQ) Regional Plan' on urban form and structure is yet to be thoroughly securitised. Some of the planning constructs, such as a compact city, Transit Oriented Development (TOD), upon which the shift in urban policy framework is founded are neither adequately understood nor empirically tested despite their wider use in

regional and master plans. Often, these constructs are generically defined for the purpose of strategic direction. We argue that these constructs need to be defined and deconstructed at a micro-geographic level so that the local effects of the policy change on urban structure and processes (e.g. housing market, accessibility, commuting and employment patterns) can be better understood. The potential implication of land use changes in recent years, for example the effect of densification of inner suburbs on urban morphology, local housing market and social ecology, should be thoroughly evaluated to inform decisions based on evidence.

This paper evaluates the change in dwelling density patterns before and after the implementation of the 'Melbourne 2030' Plan. To capture this change in urban density, two main sets of techniques will be employed.

- First, a buffer analysis will be applied to test the difference in density patterns between different buffer zones around Melbourne CBD and Activity Centres.
- Second, a spatial autocorrelation measure (Moran's I) will be used to investigate the degree of spatial concentration of dwellings at a metropolitan scale. We anticipate that the compact city model will increase the degree of clustering of dwellings around inner suburbs and activity centres as the plan encourages the development of multi-level/unit constructions.

2. Concept of a Compact City

The concept of compact city has been widely adopted as a planning tool in the developed countries. The compactness however has been conceptualised and measured in different forms. Compactness can be defined as high-density or monocentric development (Gordon and Richardson, 1997), while for Ewing (1997) it refers to some concentration of employment and housing and greater diversity of land uses. Arguably compactness has been seen as a panacea for controlling and regulating urban sprawl to promote a relatively high-density, mixed land-use city structure supported by a more efficient public transport system to encourage opportunities for walking and cycling. The land use policy changes built around the concept of compact city include the followings:

- Intensification, consolidation or densification particularly around inner suburbs

- In-fill development and redevelopment of brownfield land
- More intensive use of urban land
- Sub-divisions and conversions of existing development
- Rezoning and greater mix of land uses
- Greater dwelling density and re-urbanisation

Jenks et al. (1998) state that the compact city hypothesis combines various concepts of urban planning that potentially can be misleading. Despite the desirability of compact form, differences on its scale and intensity still prevail in the literature. Debates were not just confined to the definition of compact city but also extended to how best it can be measured. Studies have proposed numerous methods to quantify the compactness of cities around the world. Bertaud and Malpezzi (1999), for example, proposed a compactness index, called *rho*, that is defined as the ratio between the average distance from home to central business district and its counterpart in a hypothesised cylindrical city with equal distribution of development. More recently, Galster et al. (2001) defined compactness as the degree to which development is clustered that minimises the amount of land developed in each square mile. Tsai (2005) applied a range of indices to measure different aspects of urban sprawl or compactness (i.e. Gini, Geary and Moran and adjusted Geary indices) and evaluated their suitability for a number of cities in the US. Summarising the positive and negative effects of urban compactness in terms of social equity, Burton (2000) found that urban compactness improves public transport use, reduces social segregation and provides better access to facilities. On the other hand, the negative effects are the reduction in domestic living space, lack of affordable housing, increased crime levels and lowering of walking and cycling. In this paper, the focus is on the dwelling density; other reflections of the compactness, such as employment density or land use mix, are not taken into account.

3. The Context: Melbourne 2030

The purpose of Melbourne 2030 is to strategically plan and manage urban growth and economic change across metropolitan Melbourne and its surrounding region. The essence of the plan is the formulation of nine strategic ‘directions’ or desired outcomes that will determine the patterns of urban growth over the next 25 years. One

of the directions is the progression of Melbourne towards a more compact city. Three broad policies were developed to:

- Build up activity centres as a focus for high-quality development, activity and living for the whole community (Policy 1.1)
- Broaden the base of activity in centres that are currently dominated by shopping to include a wider range of services over longer hours, and restrict out-of-centre development (Policy 1.2)
- 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 (Policy 1.3)

Among other factors (e.g. local history, land use, aesthetic quality and soil condition), the urban morphology of metropolitan Melbourne has been shaped by the spatial configuration of rail network developed from 1880 onwards. This can be directly linked to the process of suburbanisation that has been strongly supported by government policies (Beed, 1981). The significance of suburbanisation in the economic growth of Australian cities cannot be refuted as the benefits of housing construction, infrastructure development (e.g. roads, public utilities) and the resultant employment, to the economy, and the land taxes for the government cannot be denied. Opportunities to live in newer houses with more space for recreation, lower land prices, family-friendly layout of neighbourhood and proximity in natural and less congested environment were among other factors driving rapid suburbanisation in Melbourne during the 60s and 70s.

The developments around these transportation nodes have occurred to avail the opportunities for better access to public transport. These nodes along with other functional nodes such as shopping centres and specialised facilities are identified as activity centres that “provide the focus for services, employment and social interaction” (Melbourne 2030, 2006). These centres are usually well connected with public transport as well as they represent ideal social environment for people to shop, work, meet, relax and live. Often the purpose of these centres is multi-functional. Some of them are local neighbourhood strips, while others are regional shopping centres or more specialised clusters of high-tech companies.

Over the last few decades, significant development of higher-density housing has occurred around Central Melbourne and the inner suburbs (Department of Sustainability and the Environment, 2006). Activity centres particularly as functional nodes attract a large number of commuters, and generate a significant volume of trips in metropolitan Melbourne. It has been argued in the Plan that middle and outer suburban activity centres have potential to accommodate higher density development, which would maximise access to public transport, jobs and services. This might also encourage greater containment where people work and live within the same locality (Corcoran et al. 2008). The purpose of the plan is to spatially integrate suburbs and localities in a hierarchical order to promote greater access, connectivity and social interactions across the metropolis as shown in figure 1.

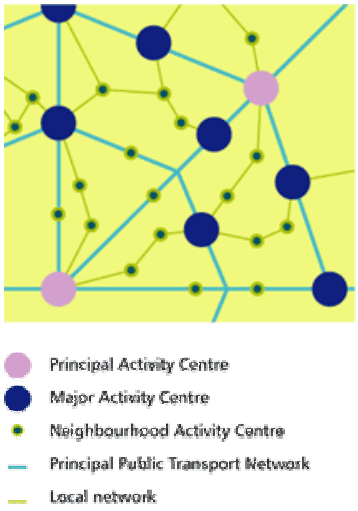

Figure 1: Spatial Configuration of Activity Centres (Source: Department of Sustainability and the Environment, 2006)

4. Data sets used and data processing

Urban density mapping is based on a number of spatial digital databases of Victoria. These include four core datasets. **First**, the State Digital Property layers for August 2001 and October 2006. The layer contains details for each property for Victoria in Australia. The time intervals selected for investigation enable the evaluation of the implication of the policy change before and after the release of *Melbourne 2030*. **Second**, the VicMap Planning Schemes obtained for July 2001 and August 2006. Planning Schemes for Melbourne metropolitan region were used to exclude non-residential zones to compute the net dwelling density. Four zones were identified to

reflect various combinations of residential zones where dwellings for residential purposes can be built. These zones include:

i) R1Z: Residential Zone 1;

ii) R2Z: Residential Zone 2;

iii) LDRZ: Low Density Residential Zone; and

iv) MUZ: Mixed Use Zone.

Third, the Urban Growth boundary (UGB) released in October 2006 by the Victorian State Government as a tool to help manage outward growth. The boundary clearly defines the areas where development can be permitted or restricted to protect Melbourne's highly valued open spaces, farming, conservation and recreation areas (Department of Sustainability and Environment, 2007). **Fourth**, the Principle and Major Activity centres as identified by the Victorian Government were amalgamated to generate a new GIS layer so that the dwelling density patterns around all activity centres can be computed.

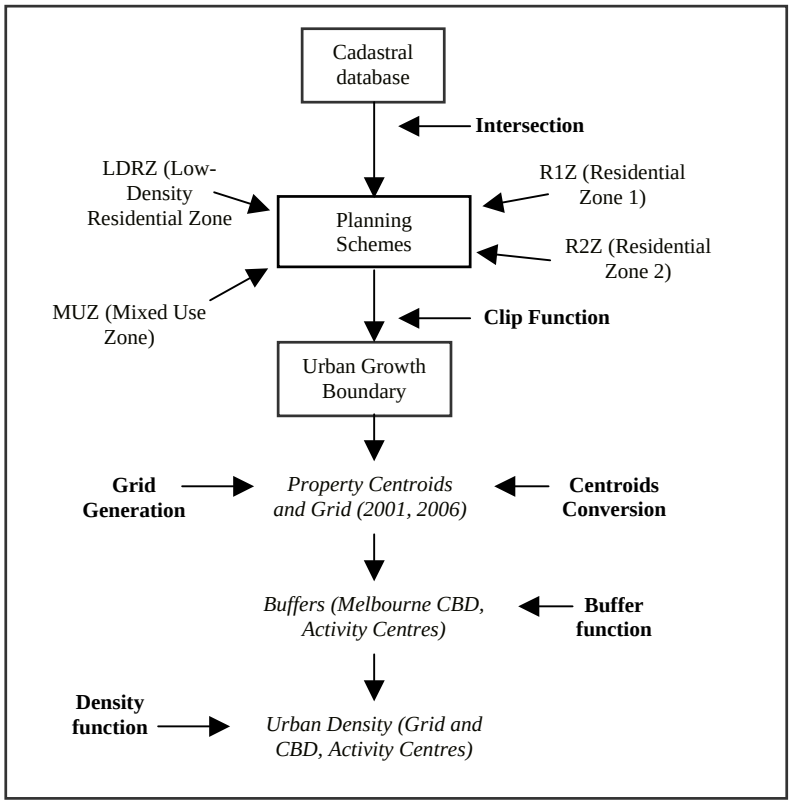

Figure 2: Data Pre-processing - Inputs, Outputs and Operations

The mapping has been undertaken using a grid format with 1x1 km grid cell. The extent of Melbourne Metropolitan area has been restricted to urban growth boundary (UGB) so that areas outside the growth boundary are excluded from the analysis. The urban growth boundary indicates the long-term limits of urban development and where non-urban values and land uses should prevail in metropolitan Melbourne, including the Mornington Peninsula. Data were then pre-processed for errors and for deriving a refined layer representing only the residential properties within the urban growth boundary. A number of GIS operations were applied to process the data as depicted in Figure 2. The bold labels indicate the operations applied on processing the input data (core data) and for generating the output data (italics in box).

3. Data Analysis

There are three parts of the data analysis. First relates to urban density mapping at a grid level; second part applies buffer analysis to evaluate differences between different zones from Melbourne CBD and Activity Centres and third part deals with spatial clustering of dwelling density patterns.

3.1 Urban Density Mapping

Urban density mapping has been conducted on a grid with 1x1 km grid cell. The grid was generated for Melbourne metropolitan area within the urban growth boundary. It was centred on the centroid of the Melbourne CBD and the grid cells were then generated to cover the entire metropolis. Using centroids generated for every property, the total number of points within each cell has been counted. The count is then attributed to the grid for the purpose of mapping. Since there are a number of cells that are clipped out from the urban growth boundary, thus their shape has come out as irregular rather than square in some cases. The density in terms of total number of dwellings per square kilometres has been computed to represent the size of the area that a grid cell contains. Within the UGB, the cells that are designated for non-residential purposes are eliminated in addition to cells where the total count was less than 50 dwellings to avoid the inclusion of non-urbanised area or the errors in the data processing.

From the density maps in figure 3, a number of observations about spatial patterns of dwelling densities can be made.

First, dwelling density across the metropolis tends to vary quite substantially. Eastern parts of Melbourne due to the historical and geographical factors are densely populated than the western and northern suburbs. Most grid cells along the eastern corridor within the 20 km radius tend to accommodate more than 1,000 dwellings per square km. At this stage, it cannot be concluded that whether these areas have reached their capacity to accommodate more dwellings on a detached housing neighbourhood. But it can be argued that the Australian dream of owning a house on a large block of land with a big backyard around these areas might have started to disappear as more demand for land supply for medium density housing has been evidenced.

Second, the dwelling density generally tends to decline from the CBD, although a number of other hotspots and cold spots can be identified. A lot more opportunities still exist on the western parts of Melbourne where some of the overdevelopment of eastern and southeastern suburbs can be redirected at a reasonable cost.

Third, there is a clear indication that transportation network particularly along the railway line and associated railway stations, has a strong bearing on dwelling density pattern. It can be implied that better access to public transport could be a driver encouraging higher dwelling density.

Fourth, areas along the coast exhibit higher density patterns particularly along the Nepean highway. This might suggest that aesthetic quality and proximity to water might have a direct effect on urban form.

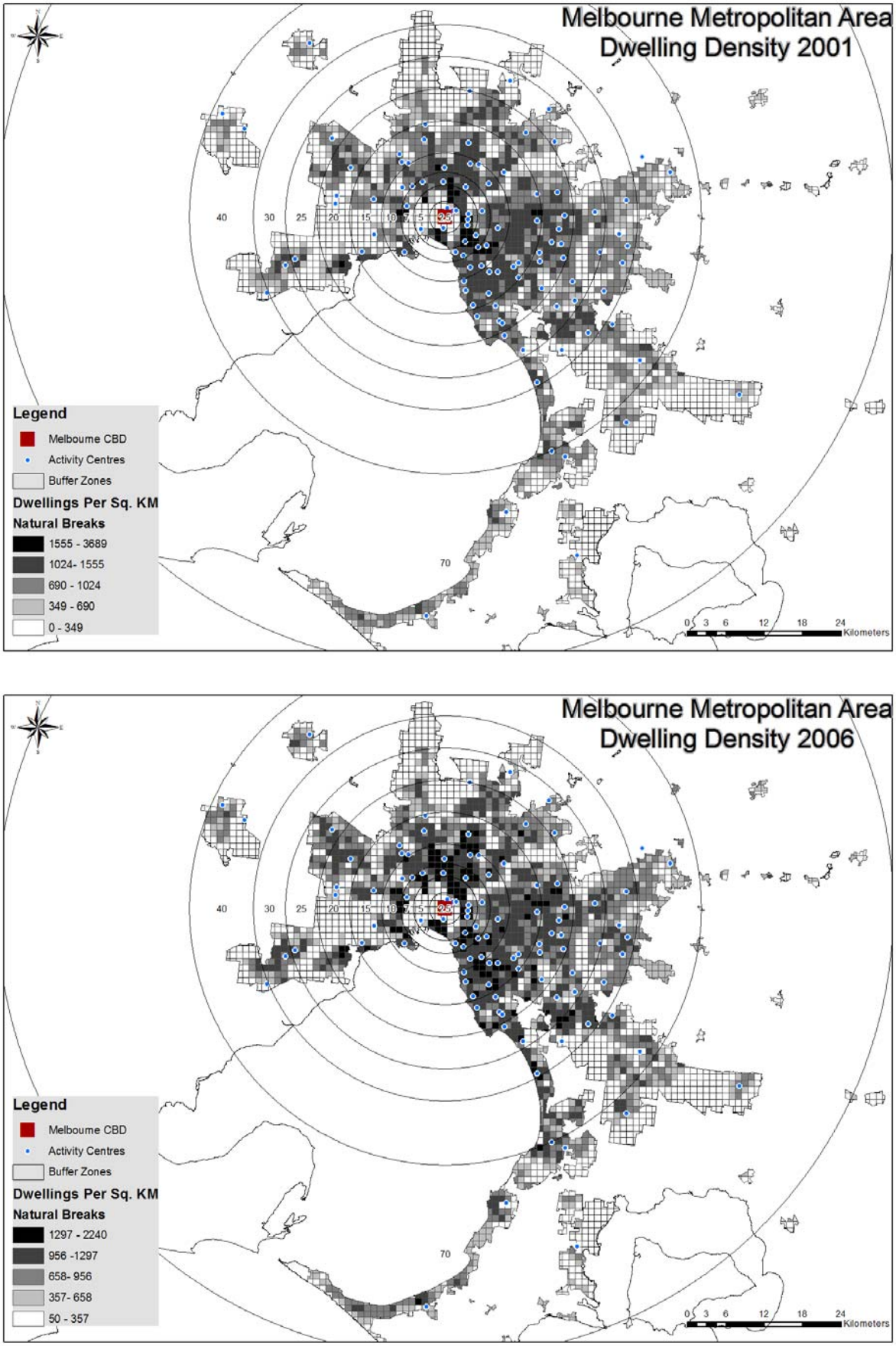

Figure 3: Urban density maps of the Melbourne Metropolitan Area for 2001 and 2006

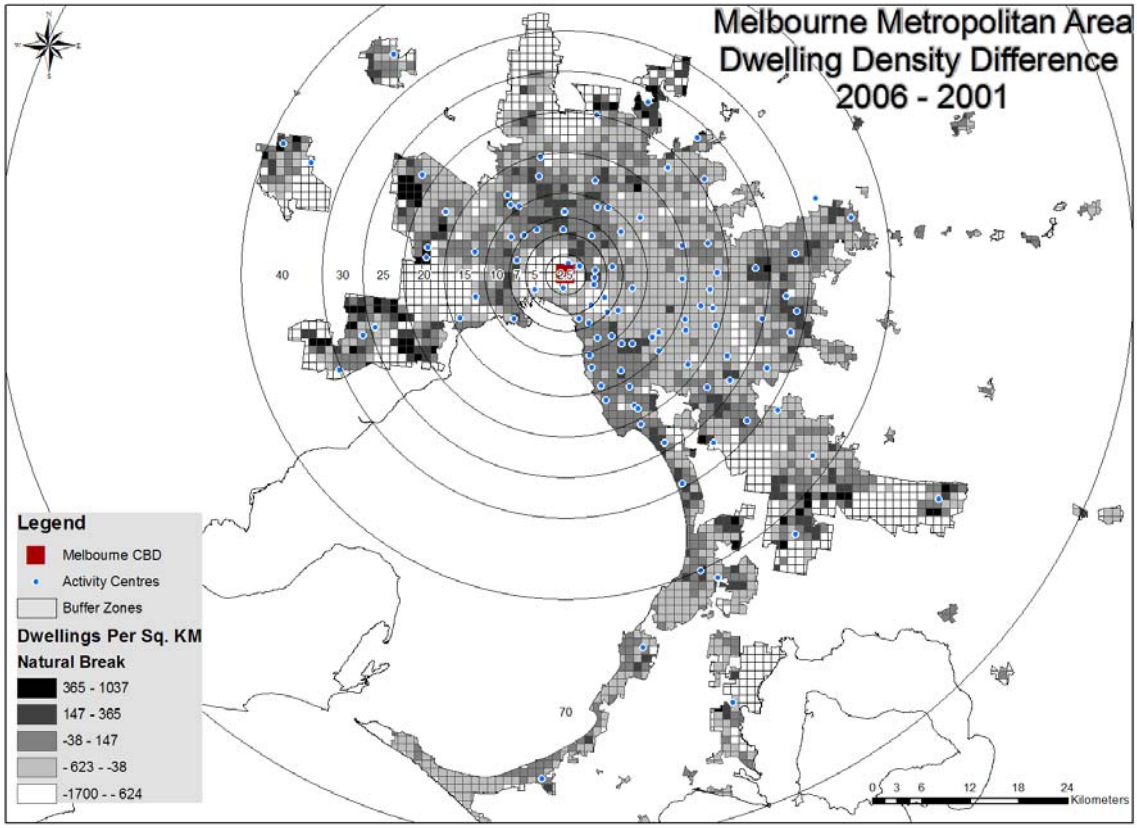

Figure 4: Dwelling density difference map for the Melbourne Metropolitan area

3.2 Buffer Analysis

One of the objectives set out for this paper is to evaluate whether the areas targeted under the Melbourne 2030 Plan have become denser after the change in urban policy. To investigate this, buffer analysis has been used to identify zones surrounding the Melbourne CBD and activity centres. A GIS routine has been used to generate a buffer, a zone of a specified distance, around geographic features of interest. Using these buffers, features in other layers can be identified, selected or merged on the basis of the spatial relationships in terms of whether they fall inside or outside the boundary of a buffer.

Growth around the Melbourne CBD

The overlay routine when combine with the count function in GIS calculates the number of properties in each zone radiating from the CBD. The distance zones for buffers were determined based on the Street directory (called Melway). Six buffers centred on the Melbourne CBD were generated to represent the commuting zones based on the Euclidean distance. The innermost zone (0-2.5 km) was deliberated

excluded from the analysis because the cadastral data do not adequately store the multi-level properties as spatial (graphical) objects to be counted correctly.

Table 1: Dwelling density around the Melbourne CBD

Buffer Distance (km)	No of dwellings 2001	No of dwellings 2006	Change in the dwelling (2001-06)	Number of activity centres
2.5-7	114687	109049	-1561	14
7-10	128392	133809	5216	11
10-20	494074	513541	19098	38
20-30	265360	312721	47595	22
30-40	140549	161147	20603	8
40-70	143279	166077	22674	7

In table 1, interesting patterns in the distribution of dwellings across different buffer zones have emerged. As expected, the dwelling density in Melbourne declines outward from the city centre. Dwelling counts over this period has gone up across all zones except the innermost zone (2.5-7 km). Over the last 5 years, the inner zone started to show a sign of de-densification, the middle zones getting stagnant and in contrast the outer zones are becoming more compact than what we expect. The inner zone has lost 1,561 dwelling. The dwelling count in the 2.5-7 km buffer has declined from 1,146,87 to 1,090,049 dwellings during 2001-2006 despite the government policy favouring densification of inner suburbs. The zone (10-20 km), with the largest number of activity centres, which we expected to attract more multi-dwelling developments after the policy change at least failed to densified in relative terms. In contrast to our expectation, the impact of densification has been felt most in the inner-outer zones (20-30 km). A total of 47,595 new dwellings were constructed in the 20 to 30 km buffer zone. The middle-outer and outermost zones have accommodated 20,603 and 22,674 more dwellings respectively between 2001 and 2006. It can be surmised from the results that the policy of densification and compact city has produced a mixed results where the dwindling dwelling counts in the inner suburbs and a rapid densification of inner outer zone is surprising. The urban development seems to depict contrasting patterns to what we anticipated to emerge after the policy change.

Growth around the activity centres

The dwelling density patterns around the activity centres were also examined to ascertain whether different zones have different dwelling densities. Three buffers

were generated: 500 metres, 1 km and greater than 1 km. It has been envisaged the first two zones represent the areas that are within the walkable distance. Arguably high-density developments are supported around the activity centres by the government to encourage people to walk to train stations and shopping centres and that in turn promotes healthy lifestyle. The results produced from buffer analysis (see Table 2) indicate the dwelling densities in the first two zones are not substantially different. In 2001, there were 928 dwellings per square km within the 500 metres buffer, which in comparison to 1km buffer is marginally high (941 dwellings per sq km). The ANOVA results indicate that urban density across different zones is statistically significant at the 0.05 level, however the bonferroni test suggests that urban densities for the first two innermost zones are statistically insignificant. Similar patterns were noted for dwelling densities for different buffers where the difference between the first two buffer zones was not significant.

Table 2: Dwelling density around activity centres

Buffer Distance (metres)	No of dwellings 2001	Dwelling Density 2001 (per sq km)	No of dwellings 2006	Dwelling Density 2006 (per sq km)	Change in the dwelling (2001-06)	Change in the dwelling density (2001-06)
< 500	928	946	943	962	15	16
500-1000	911	941	905	938	-6	-3
> 1000	604	675	627	706	23	31
Melbourne	**648**	**713**	**667**	**739**	**19**	**26**

3.3 Measure of Spatial Autocorrelation

The purpose of applying the spatial autocorrelation measure is to evaluate whether the pattern of dwelling density has become more spatially dependent and clustered. We anticipated that higher density housing in the inner suburbs and around the activity centres will accelerate the degree of spatial clustering, that is, the suburbs with high dwelling density are surrounding with similar values and vice versa. The Moran's *I* (1950) statistic is a commonly used measure of spatial autocorrelation that could be based on binary contiguity between spatial units (Anselin, 1988). In the binary weight matrix spatial connectivity is expressed as either a 1 or 0. That is, if two spatial units have a common border of non-zero length then they are considered to be 'neighbours' and assigned a value of 1, otherwise attributed a value of 0 (not neighbours).

The value of Moran's I is positive when there exists a positive correlation between sites, negative for a negative correlation and zero when no spatial autocorrelation exists. The Moran's I computed for the Melbourne metropolitan area is 0.538 for 2006. The significant Moran's *I* index evidenced the presence of positive spatial autocorrelation for the dwelling density across the metropolis. The Z scores indicate that there is less than 1 percent likelihood that these clustering could be the result of random chance.

The Moran's *I* index calculated for dwelling density for 2001 is 0.561 indicating the spatial structuring and patterns of urban form. For 2006, the Moran's I computed for the region has slightly declined to 0.5282. From the results, two main conclusions can be drawn about the territorial expression of dwelling density for the region. First, the densities across the region are not randomly distributed as the spatial patterns emerged to be spatially correlated. In other words, suburbs with higher dwelling densities are surrounded by high values; whilst suburbs with low values have neighbours with low dwelling densities. Second, the strength of spatial clustering has marginally declined over the period between 2001 and 2006. This might suggest that densification is not just restricted to areas around activity centres and the inner suburbs but its impact seems to spread out across a wider area. Sub-divisions of larger block of land for multi-unit housing developments might be have occurred outside the immediate surround of activity centres, however more analysis would be required to investigate this further.

4. Conclusions

The analysis presenting in this paper provides insights into the spatial implication of a policy change at a much finer spatial granularity using the cadastral database for the City of Melbourne. It provides evidence to assess the difference between the rhetoric and reality to help filling the gap. The empirical analysis of the database that contain details of every property within the urban growth boundary may enable urban planners and policy practitioners to either formulate a new policy or adjust the current policy based on evidence. The results reported in this paper reveal some expected and other unexpected outcomes. Of course, caution must be exercised in interpreting the results as the analysis was based on cadastral database that might have topological

and processing errors. A decline in dwelling counts within the innermost zone (2.5 to 7 km) needs to be further investigated to reconfirm the results reported in this paper. For example, we found many instances of urban consolidation whereby multi-properties were amalgamated to form a new single property that then might have been developed as multi-storey apartments. Such developments could not be captured in the database that we have used. Nonetheless we still argue that this research would initiate dialogue and discussion to measure some of the concepts and outcomes of a policy change that potentially affect our society and the environment. It presents a unique opportunity to probe the strategic directions (e.g. a compact city) propagated for the 21st century Australian cities so that the rhetoric and reality can be compared.

Acknowledgement

The author would like to thank the Design Institute and School of Management particularly A/Professor Sandra Martin at RMIT University for providing financial support for this project.

References

Anselin L. (1988) Spatial Econometrics: Methods and Models. Dorddrecht. Kluwer Academic Publishers.

Beed C.S. (1981) Melbourne's Development & Planning, Clewara Press, Melbourne.

Bertaud A. and Malpezzi S. (1999) The Spatial Distribution of Population in 35 World Cities: the Role of Markets, Planning and Topography. *Centre of Urban Land Economics Research.*

Burton, E. (2000) The compact city: Just or just compact? A preliminary analysis, *Urban Studies*, 37 (11): pp. 1969 - 2001.

Chhetri, P., Corcoran J. Stimson, R., Bell M., Pullar, D. and Cooper J., (2007) Subjectively weighted development scenarios for urban allocation – a case study of South East Queensland, *Transactions in GIS*, 11(4): 267-289.

Corcoran, J. Chhetri, P. and Stimson R. (in press) Using circular statistics to explore the geography of the Journey-To-Work, *Papers in Regional Science*.

Dieleman, F.M., Dijst, M.J. and Spit T. (1999) Planning the compact city: the Randstad Holland experience, *European Planning Studies*, 7 (5): pp. 605-621.

Ewing, R. (1997) Is Los Angeles-style sprawl desirable? *Journal of the American Planning Association*, 63 (1), pp. 107-126.

Galster G., Hanson R., Ratcliff, M.R. (2001) Wrestling sprawl to the ground: defining and measuring an elusive concept, *Housing Policy Debate* 12 (4), pp. 681-717.

Gordon, P. and Richardson H.W. (1997) Are compact cities a desirable planning goal? *Journal of the American Planning Association*, 63 (1), pp. 95-106.

Jenks, M., Burton, E. and Williams K. (1998) The Compact City: A Sustainable Urban Form? E & FN Spon: London.

Moran, P. A. P. (1950). Notes on continuous stochastic phenomena. *Biometrika* 37, pp. 17-23.

Tsai, Y-H. (2005) Quantifying urban form: Compactness versus 'sprawl', *Urban Studies*, 42 (1): pp. 141-161.