STUDY REPORT

SR 307 (2014)

Trends in New Residential Construction in Auckland

A Case Study Based on the Auckland Atlas of Construction

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Preface

This report presents the first of a series of case studies based on the “Auckland Atlas of Construction” which was developed in the Building Research Levy-funded research project “Mapping of Auckland Construction Lifelines”. This project explored the geography of construction based on existing data sources concerning the operational structure, scale and performance of the construction industry of a single city, Auckland. This case study provides insight into the trends in construction of new residential dwellings in Auckland.

Acknowledgments

This work was funded by the Building Research Levy.

Note

This report is intended for developers, builders and suppliers in residential construction, industry advisors, policy advisors and council planners.

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Author: Johannes R. Roberti

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Summary

Auckland is struggling with housing affordability and a significant undersupply in delivery of new housing. At same time the cost for new residential construction is rising at twice the level of inflation. This is a major issue for Auckland's construction industry.

This case study is an analysis of trends in the new dwelling building consent data of the Auckland region between 2000 and 2012 captured in the building activity theme in the "Auckland Atlas of Construction". This analysis was undertaken to provide a new perspective and thereby a better understanding of factors affecting the performance of the local residential construction sector in this growing metropolitan area.

The case study is a product of the levy funded research project "Mapping of Auckland Construction Lifelines" that also developed the first atlas of the construction sector's development trends in Auckland. This atlas can be accessed on the BRANZ website through www.branz.co.nz/atlas and will provide the reader the base information used for this case study.

The case study shows that the Auckland market follows distinctively different patterns from other regions in New Zealand. During the examined period Auckland's construction market for new housing has been twice as volatile as the market in the rest of New Zealand. New dwelling consents in Auckland at the bottom of the economic downturn in 2009 were only a quarter of the volume of earlier peak new dwelling consent levels reached in 2002. Over the period from 2000 to 2012 the average dwelling total floor area of new dwellings in the Auckland region has increased by 30% to 210 m^2.

The spatial trends in the building consent data indicate that inner-city construction cost per unit area is on average 30% more expensive than construction on the urban fringes. The downturn period after 2007 has resulted in a sharp reduction in the production quantities of low cost housing. Other market segments were less affected, therefore new residential construction has become more exclusive in this period. A smaller group of clients can afford it. The analysed trends also suggest that there is little prospect for an improvement in housing affordability with current construction and population growth patterns.

The vulnerabilities of the sector's production and supply structure to rising fuel and land costs are discussed as contributing factors in the excessive rise in construction cost. Under the current traditional procurement systems, construction methods and construction management of the Auckland sector, cost increases will be transferred to the clients without mitigation

through efficiency gains. This is because of the current set up of the supply chain management of building projects paired with low sector awareness of its implications on efficiency and cost. A culture change is needed for a more integrated approach towards the sector's supply chains in order to mitigate further price rises, or rationalise current supply chain-related costs.

Opportunities to reduce unnecessary time and resource wastage have been identified. Making use of them will require industry taking a more considered approach towards the organisation of the logistics and procurement by construction projects. Optimisation of construction logistics and supply chain management are key components for the improvement of the economic and environmental performance of the construction sector in urban construction projects.

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1. INTRODUCTION

1.1 Purpose

In this report the characteristics of new residential building activity in the Auckland region are investigated in a case study that is built on information derived from the "Auckland Atlas of Construction", hereafter mostly referred to as "the Atlas".

This Atlas is a structured source of publicly-accessible regional and spatial baseline information. It has been developed, to assist the formation of shared understanding of the nature of the supply-side of construction and its issues in urban development in the Auckland region. Its audience is the local building and construction sector as well as its clients and public stakeholders with industry interactions or interests in urban development.

This case study provides an introduction, demonstration and example of how a selection of the information products in the Atlas can be sourced by users to help them identify and address industry issues. Also, the case study serves to explore the current limitations of the Atlas and how it can be combined with other knowledge resources to support evidence building around industry issues.

1.2 Background

Here an introduction to the background of the case study is set out. First, a vision and a problem definition are presented that provides a perspective on structural challenges the sector is facing in city building. Second, the reasons for developing the Atlas in this context are discussed. Last, an introduction to the content of the Atlas is given.

1.2.1 General problem definition

City building is amongst the most significant human economic activities visibly changing the planet. Therefore, the construction sector has a prominent geographical legacy comprising cities, humanity's primary habitat. New Zealand's construction sector is the second-largest landscape-changing sector after the agriculture sector according to state of the environment reporting (Ministry for the Environment, 2007).

The construction sector is the primary economic entity for growing and adapting our built environments. Therefore, obtaining a better understanding of a city's structure, capacities and development potential is central to our ability to make built urban environments in New Zealand more sustainable. Construction sector activities form an integral part of the dynamics of the urban environment of all cities.

The impact of the construction sector is not limited to its core activities on construction sites. The resource demands of construction projects are supported by a complex supply network that reaches far beyond the boundaries of the urban environment. The logistics that deliver required resources along this supply network are the lifelines that feed construction projects. The functionality of all logistic lifelines for each construction project are crucial to its final success in delivering buildings according to plan. The combined lifelines of all construction projects in a city form the essential life support system of urban maintenance and transformation. However, effective construction logistic lifelines do not necessarily mean that they are efficient in their utilisation and allocation of project resources.

International and New Zealand researchers and policy advisors report that construction in cities is hampered by a persistent low performance of the construction sector (Egan, 1998; New Zealand Construction Sector Taskforce, 2008; New Zealand Productivity Commission, 2011). Concerns around the sector's inability to significantly raise productivity leads are not new (Bishop, 1972; Allen, 1985). Work processes in the sector

both on and off construction sites are reported to be wasteful with plenty of opportunities for improvement (Vrijhoef and Koskela, 2000; Bankvall et al, 2010).

Competition between firms under current market conditions should result in the survival of those with the most efficient work processes. However, given the apparent endurance of widespread systemic wastefulness in the execution of construction projects, the market mechanisms seem to fail in pushing the sector to work more efficiently. Therefore, it appears efficient work processes are only of secondary importance to business survival in construction. This implies that business selection is more sensitive to other factors. Suggested reasons for persistence of low productivity levels and an inefficiency in the production process in construction include the essential mobility and scalelbility of the production system, the lack of homogeneity in the demand for products requiring a project-based production system and the maturity, deep specialisation and fragmented nature of the industrial organisation of the sector (Dubois and Gadde, 2002; Dainty et al, 2001). These apparent sector characteristics are also found in the New Zealand construction industry (Price Waterhouse Coopers, 2010; Wilkinson and Scofield, 2010).

The persistence of low productivity and its underlying associated issues is a phenomenon that is not unique to the New Zealand construction sector. It is therefore valuable to better understand which problems are common internationally, which are unique to New Zealand and even which are unique to specific regions in New Zealand. Globalisation of markets, Government and local regulation in combination with regional differences in demography, economy and topography can result in very specific regional construction market conditions. The nature of the sector's productivity problem is complex and justifies a systematic approach to research that increases understanding of the underlying conditions, issues and their interrelations that define the sector productivity performance. Any change on this scale will not come easy requires a continued effort and commitment from stakeholders.

In recent years, New Zealand has started to take a more widely-supported interest in construction supply issues. This interest is mainly driven by demand issues with housing, such as decreased affordability and the transition to a higher density built environment especially in larger cities, such as Auckland. The public wants to know why the sector is not producing more houses to release some of the pressures in these urban property markets. The frictions in urban growth put the performance of the local industry under additional scrutiny. This attention, the associated concerns with construction costs adding to rising land prices and the inherent complexity of issues barring productivity growth in the sector have resulted in the formation of a Construction Industry Productivity Partnership between public and private stakeholders. Clarity and consensus on the nature and regional specificity of the perceived productivity problems is essential for finding appropriate solutions that are acceptable to wide variety of the stakeholders involved. In New Zealand the evidence base around productivity is sparse which hinders the development of solutions. Therefore, there is an obvious need for shared information and shared evidence base development to facilitate industry and stakeholders in New Zealand to clarify and contextualise their issues with productivity.

1.2.2 Building an Atlas on construction in Auckland

Given these identified needs a research project was initiated to develop a baseline information resource for the sector and an underlying evidence base using existing data sources. This new resource provides a starting point for exploring the relation between urban growth characteristics of a single New Zealand city and the temporal and spatial trends in the local industrial structure of the construction sector.

Auckland was chosen because of its importance to the New Zealand construction sector which is anchored in the following facts:

- It is New Zealand's largest city with a current population of about 1.4 million people.

- It is a city with a growing population.
    - Over the last decade Auckland's annual population growth rate has been 1.9% which is 2.5-times higher than the average population growth rate of the remainder of New Zealand.
- According to the city's long-term plan this growth is expected to continue at a similar rate for the next 30 years.
- This prospect would require an increase in the residential building stock from 470,000 dwellings now to more than 800,000 thirty years from now.

Not surprisingly Auckland is the single-largest regional construction market in New Zealand and given the expected continuity of the growth it will be for the foreseeable future.

However, Auckland is also in the middle of a worsening housing crisis, because the growth rate of the built environment has been lagging behind population growth for some years. This has resulted in a significant housing shortage and decreased affordability. Debates on how to deal with this issue are prevalent (Productivity Commission, 2011).

Auckland Council's planning objective is to direct a substantial part of future growth inwards to existing urban areas to prevent excessive urban sprawl. Current urban areas would face more intensified land use and higher building densities. Land use regulation is and will be an important planning tool to guide Auckland urban development in the planned direction.

There is a substantial amount of international research on the risk of land use regulation having a negative impact on housing affordability in cities (Somerville, 1998; Glaeser and Gyourko, 2006; Ball, 2013) that is fuelling debate on the issue. This is combined with the concerns of current communities about the prospects of living in or near higher density areas.

A newly created baseline information resource called the "Auckland Atlas of Construction" has been developed in a research project "Mapping of Auckland Construction Lifelines". The new Atlas provides baseline information which is presented in graphic form, such as maps and graphs. It is available on the BRANZ website. (www.branz.co.nz/Atlas).

One of the main objectives was to create a publicly-accessible information resource on the web with carefully produced user-friendly content that would allow stakeholders to acquire strategic insight into temporal and spatial trends in Auckland construction.

1.2.3 The Auckland Atlas of Construction

The first generation of the Atlas has been developed. It is accessible to online users free of cost through the BRANZ website. The Atlas provides ready-to-use baseline content in the form of downloadable maps and graphs of data from the period between 2000 and 2012. Currently the Atlas has two main themes:

- Building activity.
- Trends in industry structure.

Figure 1 shows a screenshot of the current homepage of the Atlas with these two themes. The Atlas is an extensive spatial information resource with downloadable content of more than 1600 ready-to-use information products. These allow users to access and examine the complexity of value chains in Auckland's construction sector.

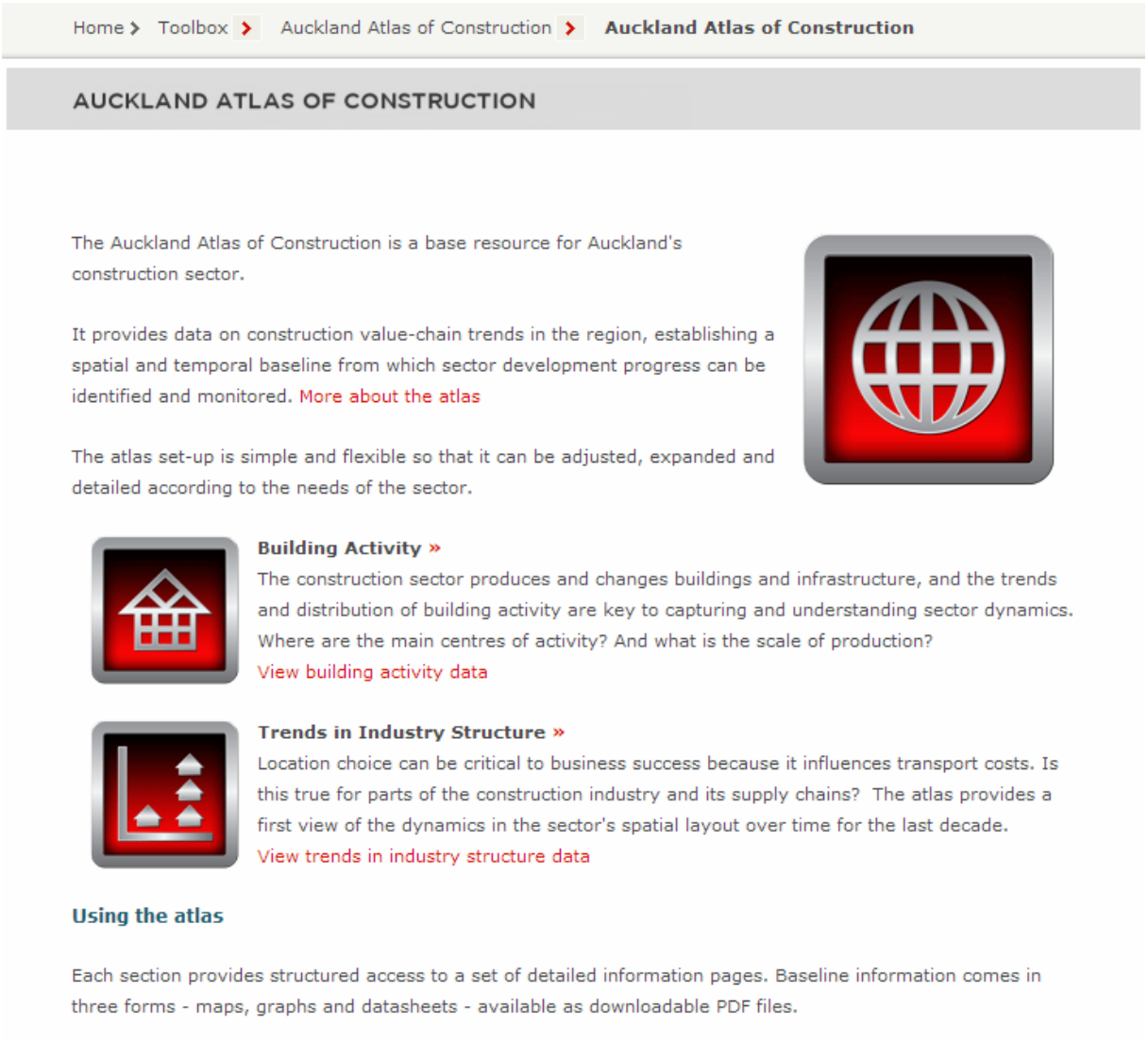


Figure 1: Screen shot of homepage of the Atlas

2. REVIEW OF BASELINE FOR NEW RESIDENTIAL BUILDING ACTIVITY

In the case study the content of a specific topic in the Atlas is explored. The topic is new residential building activity. It is covered within the Atlas by one separate webpage under the building activity main theme. A general overview of structure, topics and content of the building activity theme is provided in Appendix B.

The research objective of this case study was:

- To describe the structure and major trends of new residential construction in Auckland based on a selection of material from the Atlas.
- To examine and contextualise observed patterns and trends in Auckland in relation to current understanding of urban development and construction.
- To find Auckland-specific construction sector issues.
- To demonstrate the value of the Atlas to users by showing how the information can help to better understand construction in Auckland.

The case study examines if Auckland has features that sets the region apart from the remainder of New Zealand. This part of the study uses material in the Atlas representing regional and national building consent data from Statistics New Zealand. This covers 13 years of building consent data from the years 2000 to/and including 2012.

In the following part, trends in the spatial patterns of building activity are investigated in the context of regional and national trends that were identified in the first stage. Atlas information presented here was developed with data on individual building consents as registered by local building authorities, because it was important to pinpoint building activity in building consents to the right spatial location for this analysis. For more details on the Atlas see Appendix B1.1.

All graphs and maps in this section are available for download from the topic page in the Atlas (www.branz.co.nz/atlas_cnrb).

2.1 Regional trends

The Auckland region forms a substantial fraction of the New Zealand market for new residential construction. In this section the distinctive trends of several aspects in new residential building activity in the Auckland region and its scale are examined against the background of developments in the wider New Zealand market identifying the unique characteristics of the Auckland market.

2.1.1 Number of consents

Construction of new residential buildings is sensitive to economic business cycles (Leamer, 2007). Over the period of 13 years covered in the regional trends graphs in the Atlas (see Figure 2) it is clear that the Auckland new housing market went through a boom (2000-2005) and a subsequent bust period (2006-2012). This has not yet ended with current building consents by 2012 still far below the average of 7100 consents for the full period shown. The lowest number of building consents issued in 2009 of 3475 is 29% of the peak in 2002 of 12,182.

Subtracting Auckland numbers from the national numbers which are also given in Figure 2 provides the corresponding numbers of building consents for the remainder of New Zealand. Building activity in Auckland followed a subtly different pattern from activity in the remainder of New Zealand. The remainder of New Zealand experienced the peak of the boom in 2004 and the bottom of the low in 2011 almost two years later than Auckland. The low for the remainder of New Zealand was not as pronounced at 51% of the

maximum when compared to the Auckland figure of 29%. Therefore it appears that the Auckland market is almost twice as volatile. The reasons for these differences are not clear.

The bust period was at least partially caused by the global economic downturn that followed the global financial crisis in the latter part of 2007 (Murphy, 2011). However, in Auckland there might have been some other factors at work. For instance a change to the Building Code in 2004 that was triggered by the leaky homes problems could also have had a subduing influence on building activity in Auckland, which went down by 37% from 12,115 in 2004 in to 7707 in 2005. The scale of the drop in building consents at the national level indicates that over the same period the observed early downturn is almost exclusively linked to Auckland. The numbers of consents in Auckland appeared to stabilise at a new production level of around 7000 in the second part of the boom period ending in 2007. This was when the global downturn started to hit the New Zealand economy.

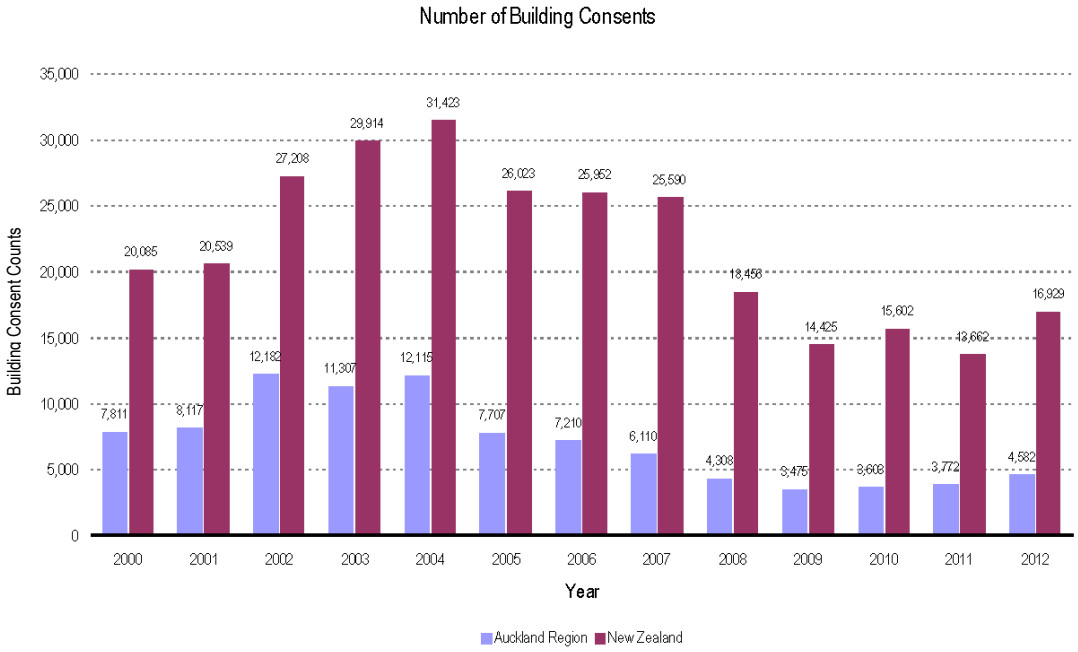


Figure 2: Trend in number of residential building consents from 2000 to 2012

In order to meet Auckland's population growth predictions, the number of housing consents will have to return to peak boom period levels of more than 12,000 dwellings per year (Auckland Council, 2012). The past years might contain lessons on the structure and responsiveness of housing supply under different market conditions. The industry has already shown that it can scale up to required production level if demand is real, but given the depth of the downturn in Auckland the skill base of the local industry might have been impacted and will take longer to recover.

2.1.2 Value of consented work

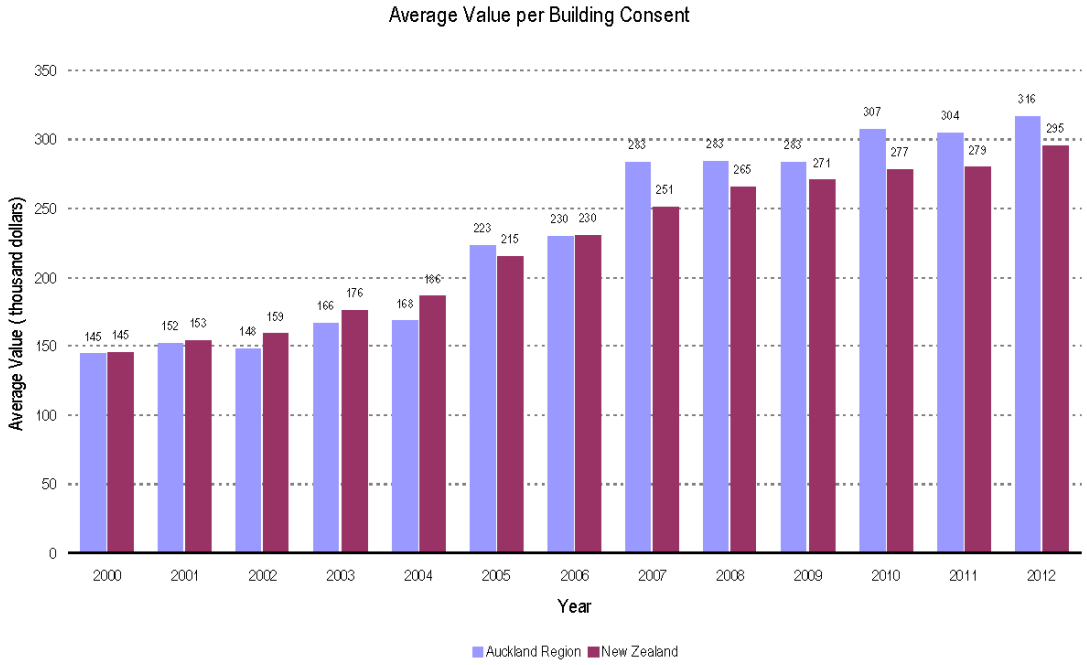


Figure 3: Trend in average nominal value per consent of work as indicated by applicants

Figure 3 shows how the average nominal value[1] of construction work on new residential building projects as indicated by applicants in their building consents has changed over the period from 2000 to 2012 for Auckland and all of New Zealand (including Auckland). During this 13-year period, building costs have more than doubled. At first sight the downward trend explored in Section 2.1.1 does not seem to have any substantial impact on this trend of increasing cost.

In 2012, the value of building projects in Auckland was priced 7% above the all-of-New Zealand average, compared to similar or lower values for Auckland ten years earlier. The average cost of new housing projects is increasing 8% per year in Auckland. According to Reserve Bank figures inflation was on average around 2.6% per year over this period. Therefore, the cost increase was 3.1-times the rate of inflation. From 2004 to 2005 and from 2006 to 2007 there appears to be jumps in the prices in Auckland that are not visible in the national figure. The first jump could be a result of changes in the Building Code in 2004 that also possibly ended the initial boom period in Auckland as discussed in Section 2.1.1. The events that coincide with the second jump are a change in the acceptable solution for insulation in the Building Code and the start of the global financial crisis.

For the whole of New Zealand the increase in value of consented work was 6.6%. This rate is 18% lower than Auckland, but it does include the contribution of Auckland. For clarification the average value of building consents for the remainder of New Zealand separate from the contribution of the Auckland market was calculated using data from Figures 2 and 3. This found an increase in the nominal value of building consents outside Auckland was 6% per year, which is also well above the inflation level, but significantly lower than Auckland.

[1] Nominal value is the dollar value not corrected for inflation.

2.1.3 Size per building consent

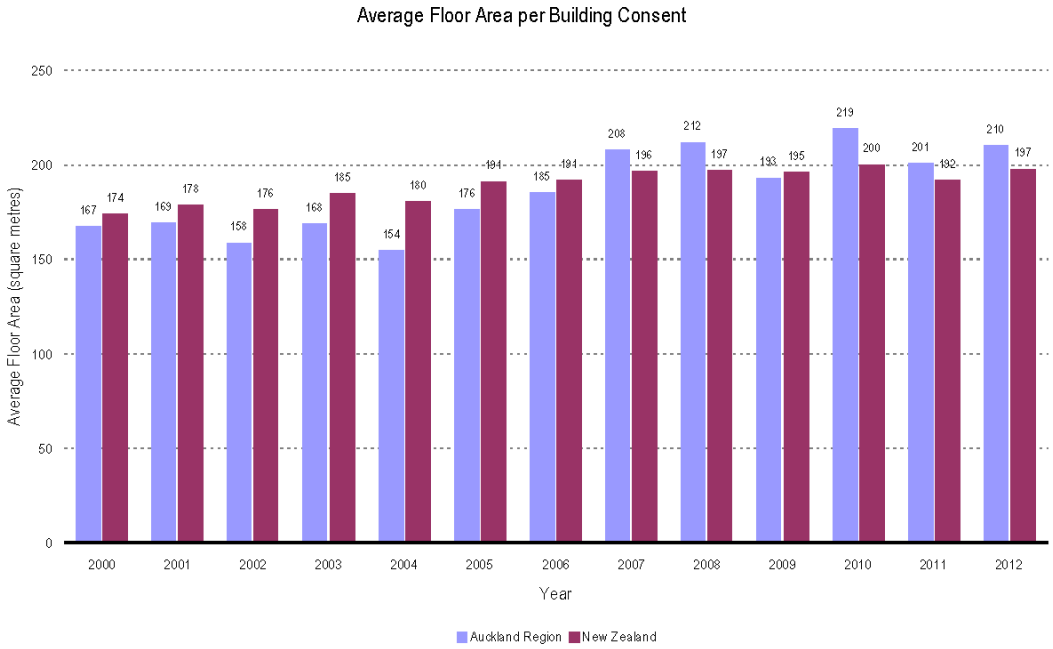


Figure 4: Trend in average floor area per building consent

If consumers developed an appetite for larger houses over time, there would be an expected increase in cost equivalent to the increase in floor area assuming construction productivity does not change significantly. Using the Atlas we can evaluate the trend in the average floor area per building consent (Figure 4).

The physical size of new dwellings has increased 30% in Auckland from 167 m^2 in 2000 to 210 m^2 in 2012. The average annual increase over the period was 4.9 m^2 per year. There appears to be a rapid increase in demand for larger houses between 2004 and 2007.

The national increase is about 15% over the same period from 174 m^2 in 2000 to 197 m^2 in 2012. In 2000, new buildings in Auckland were smaller than the national average, whilst currently they are substantially larger. Therefore, an appetite for larger residences is at least partially responsible for the increased investment per building consent.

The size increase in Auckland coincides with the observed decrease in consents in the local housing market after 2004. This particular combination of trends could be an indication that the decrease in consents might have disproportionately affected the lower income end of the market, which is responsible for most of the demand for smaller properties. More affluent clients that demand larger properties would continue to build during the observed downturn skewing the consented floor area towards larger property sizes.

2.1.4 Cost per unit size

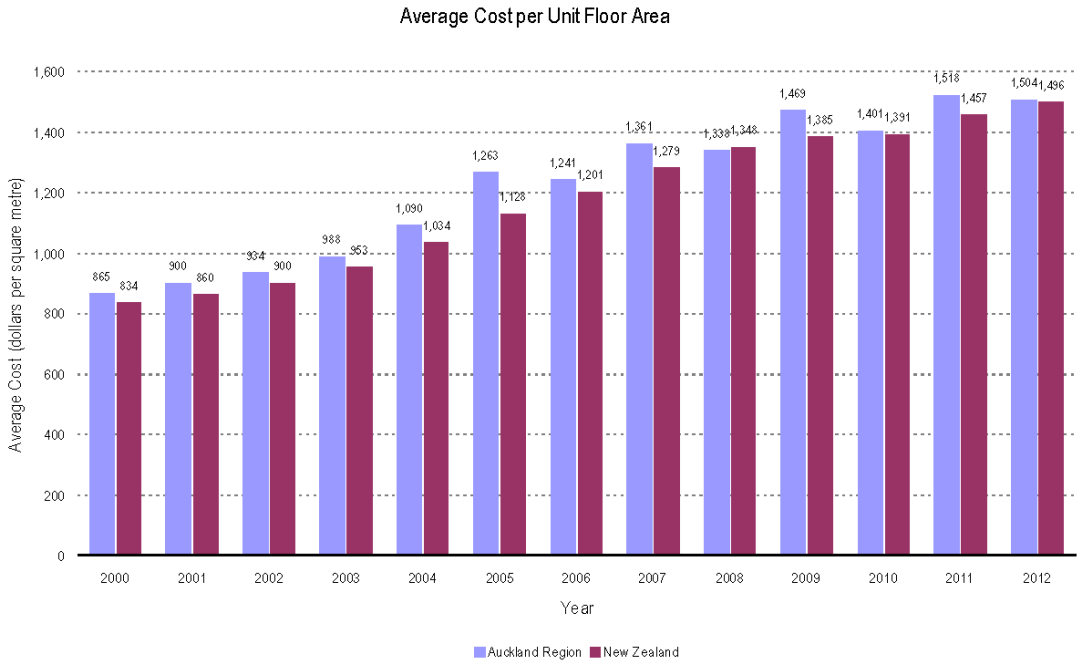


Figure 5: Trend in unit construction costs

Looking at the cost per unit floor area takes out the impact of increased floor areas in new dwellings on the trend in costs. This is showed in Figure 5. It indicates that the building cost per unit area in Auckland is slightly higher over the observed period than the national average. The difference fluctuates slightly from year to year, however it is reasonably steady at around 4.2% on average. Separation of Auckland from the remainder of New Zealand results in an average difference of 6.1%.

In Auckland the annual cost increase per unit floor area is 5.2% between 2000 and 2012. The annual cost increase for the remainder of New Zealand was 5.7% which is higher than Auckland, therefore the price gap appears to be closing.

New build residential construction costs in Auckland have increased at a rate that is two-times the average national inflation level of 2.6% over the period, which is slightly lower than the 2.2-times inflation cost increase found for the remainder of New Zealand. Over the same period average real gross domestic product has risen at rate of 2.7% per year, therefore average household incomes have grown only just a fraction above inflation levels. Under these conditions New Zealanders will have to spend a larger fraction of their household income on new residential construction to pay for the construction cost increase and the additional square metres of their larger residences. A reaction could be to start to build smaller dwellings, however the trend in consented floor-areas of new dwellings points in the other direction. Another reaction is to simply not build, if people cannot afford it. This would result in a market shift where residential construction would become more exclusive, only accessible to clients with high disposable incomes and substantial savings or professional property investors.

At this stage the regional trends in the Atlas contain no additional evidence to explain this rising trend in construction cost. Possible causes for the trend may be rising cost of resources such as energy, fuel and materials, decreasing productivity, regulation or taxes. However, the trend is gradual with slightly more volatility after 2004 in Auckland, but there appears to be no major shocks in cost development.

It is evident that the Auckland market follows a different pattern to the market in the remainder of New Zealand, which justifies a regional approach towards sector analysis.

2.2 Regional distribution

Building activity is not distributed evenly over the Auckland region. This section seeks to draw out the characteristics and trends of the regional distribution of building activity in Auckland and check whether they are in line with current understanding of the supply of new residential urban development of cities.

2.2.1 Building activity density

The Atlas shows specific areas in the Auckland region that experience increased building activity of new residential construction. Peaks in new residential construction activity are found in areas mostly located on the outskirts of the city (see Figure 6). This is a typical pattern for city growth by greenfield development. Auckland is growing outward and is sprawling beyond its planned urban metropolitan limits (ARC, 2012; Auckland Plan, 2013; Grimes, 2010).

Peak building activity during the period from 2007 to 2011 is located on the urban fringes of Auckland around 20 km from the Central Business District (CBD) (see A in Figure 6). This includes areas such as:

- Flat Bush in the south east of the Manukau area (see C in Figure 6).
- Fairview and Greenhithe in the North Shore area (see D in Figure 6).
- Ranui and Massey in the Waitakere area (see E in Figure 6).

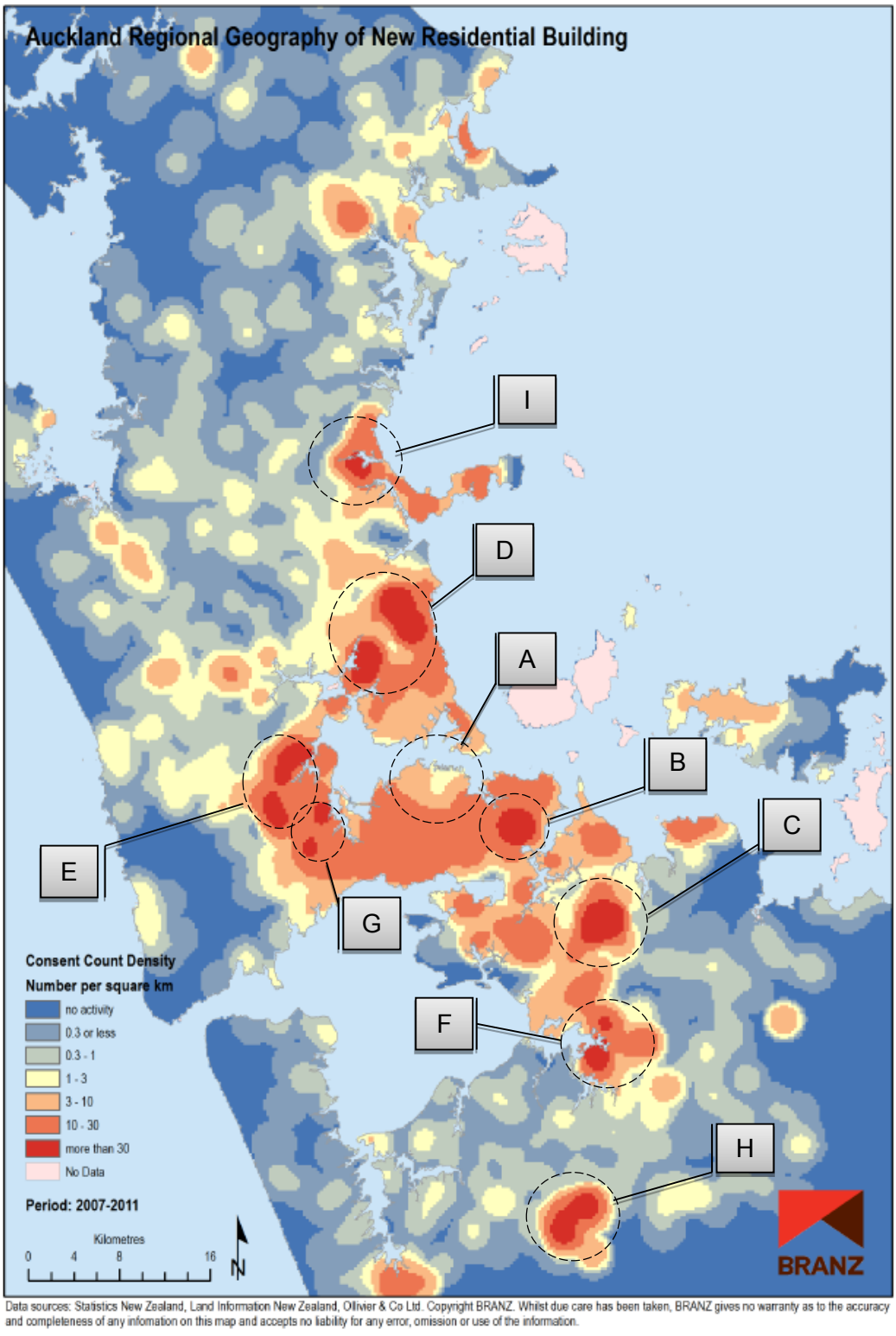
There is also development 25 km south of the CBD such as around Papakura (see F in Figure 6).

A different kind of feature is the residential development in Mt Wellington (see B in Figure 6) in the middle of existing neighbourhoods. This is a redevelopment of an exhausted quarry of construction materials. It is a good example of how essential resource extraction for the construction industry will slowly be pushed out of the urban areas of the city, because any new quarries to replace the old ones will have to be found outside the city boundaries in rural areas. Therefore, the haulage routes for this type of heavy construction material will get longer over time and at pace that is linked to Auckland's urban expansion.

In addition to the larger greenfield developments there is a significant amount of distributed new residential construction in the inner urban areas. This type of infill development uses land that was previously underutilised or rezoned. It results in a densification of the urban area. Prominent examples are developments in Te Atutu around McLeod Park and near Oratia on the boundary of Parrs Park (for both see G in Figure 6). There are also large areas with more diffuse developments that add up to 10-30 consents per square km for instance in the area just south of the Auckland CBD (between the areas marked by A, B and G in Figure 6).

The building activity density map also indicates the significant development of urban satellite settlements such as for example in Pukekohe (see H in Figure 6) south of Auckland and around Orewa along the coast north of Auckland (see I in Figure 6).

The Auckland CBD (see A) does not experience any significant residential building activity. This absence might be enhanced by the fact that mixed-use developments, such as apartment blocks above shops, are mostly classified as consents for non-residential buildings.



Neighbourhoods: Central Business District (CBD) (A); Mt Wellington (B); Flat Bush (C); Fairview and Greenhithe (D); Massey and Ranui (E); Papakura (F); Te Atutu and Oratia (G); Papakohe (H)

Figure 6: Map of building activity density by consent numbers

2.2.2 Distance to CBD

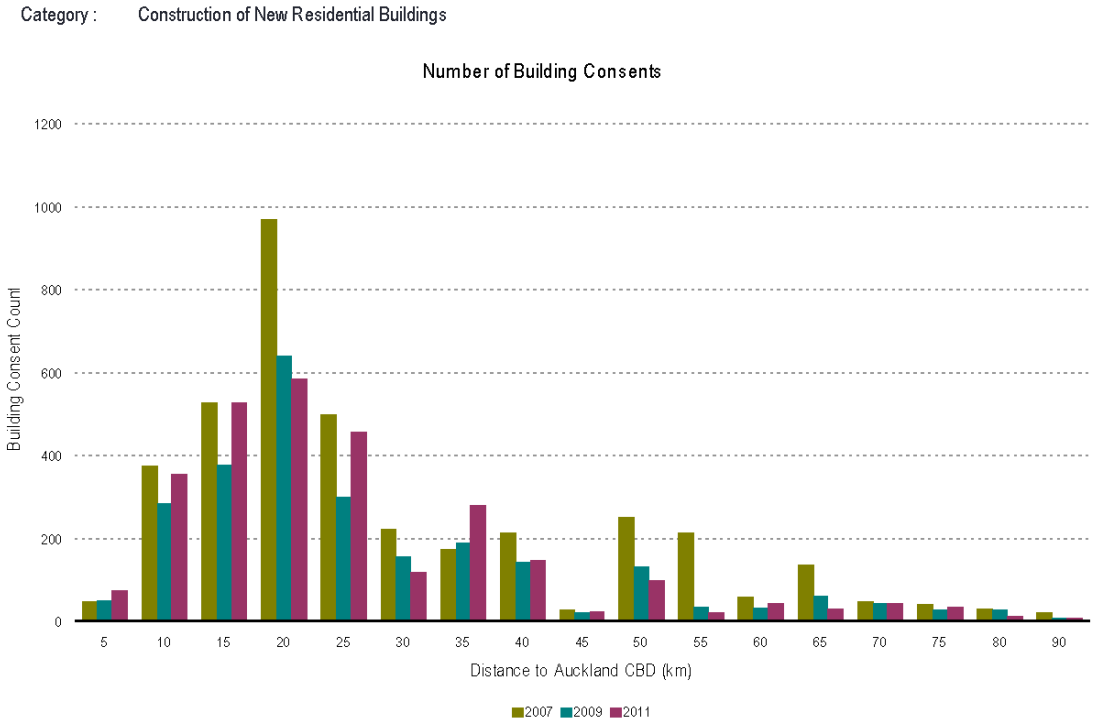


Figure 7: Urban/rural profile for consent numbers for 2007, 2009 and 2011

The urban/rural profile of building consent numbers in Figure 7 gives an indication of building activity measured by road distance to the CBD. Moving away from the centre, the number of consents rises until it reaches its peak at 20 km after which activity decreases to lower levels with smaller peaks at 35, 40 and 50 km corresponding to the contribution of Auckland's urban satellites, i.e. Papakura, Orewa and Pukekohe. Figure 7 shows building activity is substantially lower in the centre of the city than on the fringes, however the counts have not been normalised for the area they represent, so are not reflected as building intensity per unit area.

The change in activity over the years 2007, 2009 and 2011 is mostly downward with the exception of the five and 35 km range that show an increase. The most prominent absolute drop in consent numbers is at the peak of the distribution at 20 km (40% less consents). The downturn appears to have mostly affected greenfield construction at the fringes of the city. However, building activity in 2011 appears to have already recovered to almost 2007 levels at distances of 10, 15 and 25 km from the CBD. If the peak in building activity associated with large scale greenfield developments on the city fringe is slowly moving outward, it would be expected that activity 25 km from the CBD will surpass activity at 20 km in the next few years. Some of this transfer of activity might already be happening. This trend is mostly determined by the rate of land supply for residential development and the pace of supporting infrastructure development.

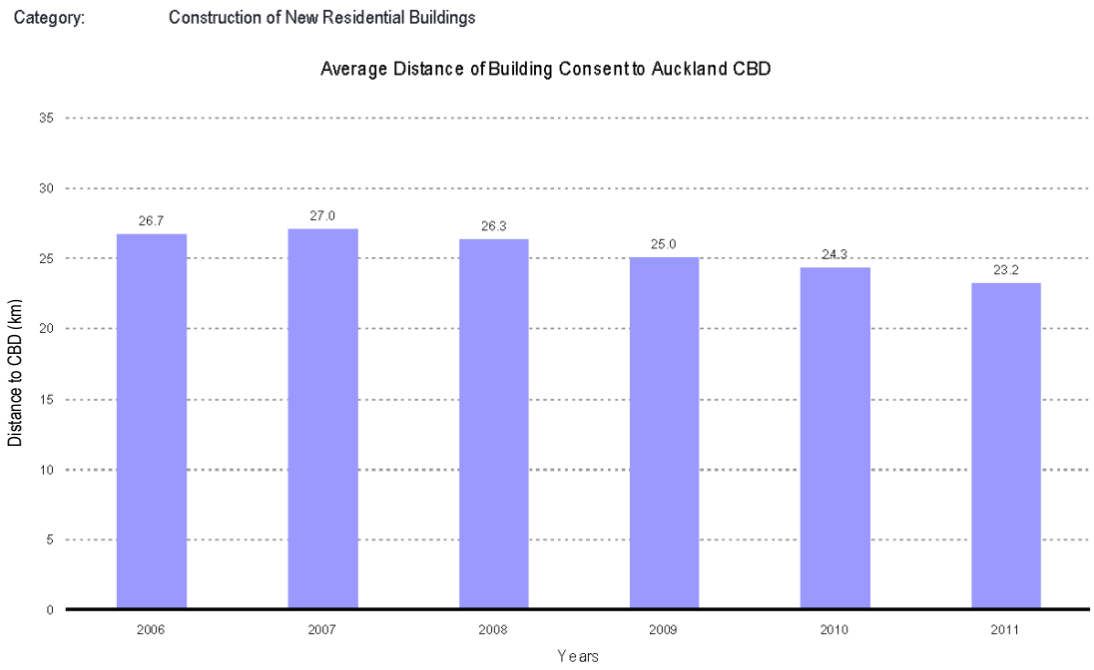


Figure 8: Trend in average distance to CBD of building activity

An interesting development is that the average distance to the CBD of building activity has decreased over the last five years. This decrease is shown in figure 8. It coincides with the downturn and the associated reduction in building activity on the outskirts of Auckland. However, it may also be interpreted as an indication for intensification in urban development.

2.2.3 Building activity in area units

Figure 9 compares maps of building cost on the left and building activity density on the right in area units for the years 2006-2007, 2008-2009 and 2010-2011. The 2006-2007 maps in the series represent just before the global economic downturn affected the market. Therefore, the series can be used to explore the spatial trends going from high to low in market conditions.

Figure 9 shows that the distribution of building activity density within the urban limits of Auckland is very dynamic. Many areas experience fluctuating levels of building activity. These urban dynamics contrast to the apparent low dynamics of building activity density in rural areas. The stark contrast between urban and rural is an inherent result of the mapping method, which limits the sensitivity of the map for variation on the lower end of the scale, especially in large rural area units.

At first glance, there does not appear to be any overall drop in building activity. Under closer scrutiny the slowdown can be pinpointed to a reduction in activity of the major greenfield developments on the outskirts of the city.

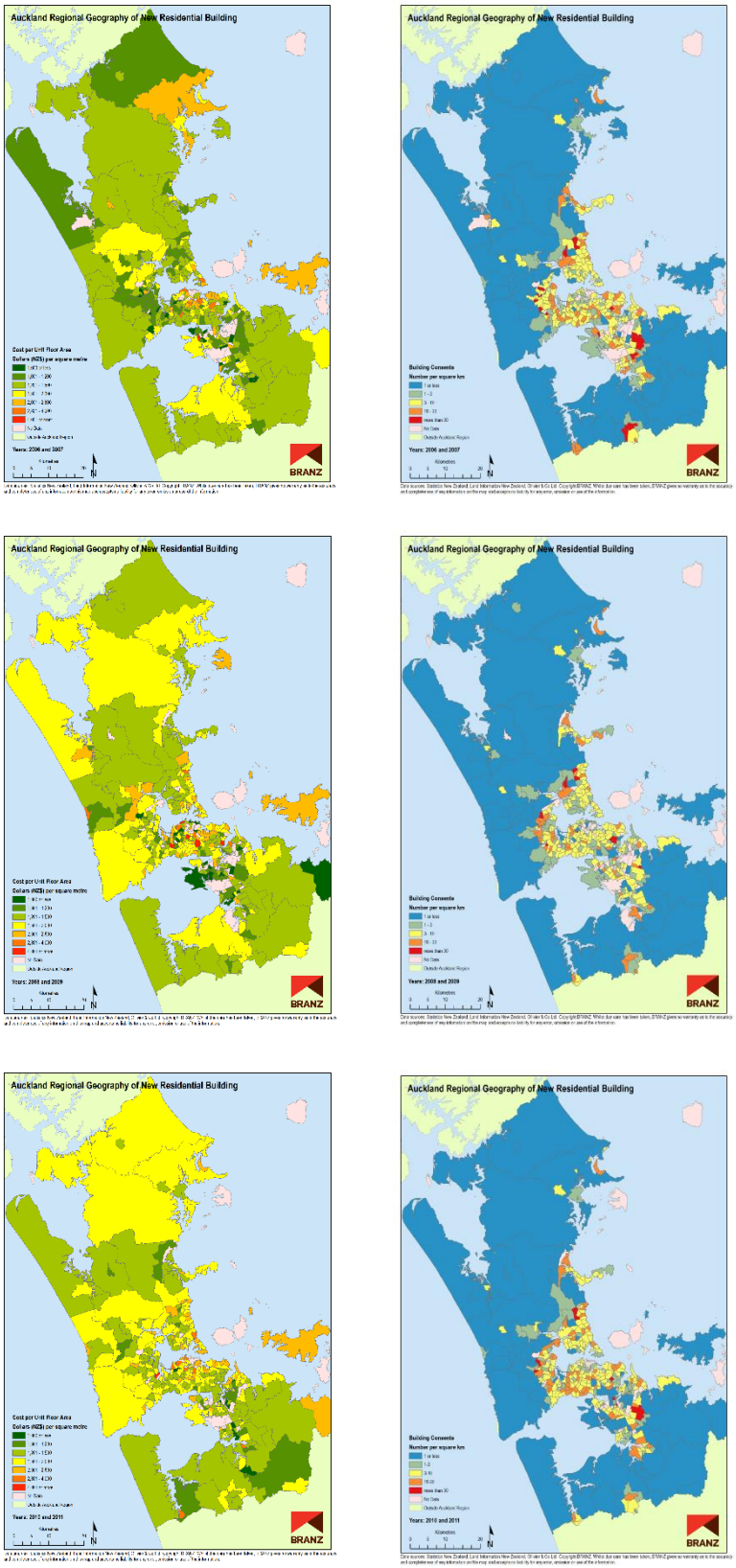


Figure 9: Atlas map time series for construction cost (left) and building consent density (right) for the years 2006-2007, 2008-2009 and 2010-2011

An overall trend of rising construction cost is visible with many areas going from green (below $\$1500/m^2$) towards yellow ($\$1500/m^2$ to $\$2000/m^2$). Areas with a cost above

yellow (greater than $2000/m^2) largely coincide with Auckland's more sort-after neighbourhoods found along the east coast of Auckland. Evaluation of the construction cost distribution with the spatial trends in building activity density confirms a commonly known construction market phenomenon, that downturns mostly affect the low-cost end of the market where the margins are tight and clients more vulnerable. For example, the greenfield development in Auckland south (see C and F in Figure 6) are at the lower end of the building cost scale and they feature a reduction in consent density in 2008-2009.

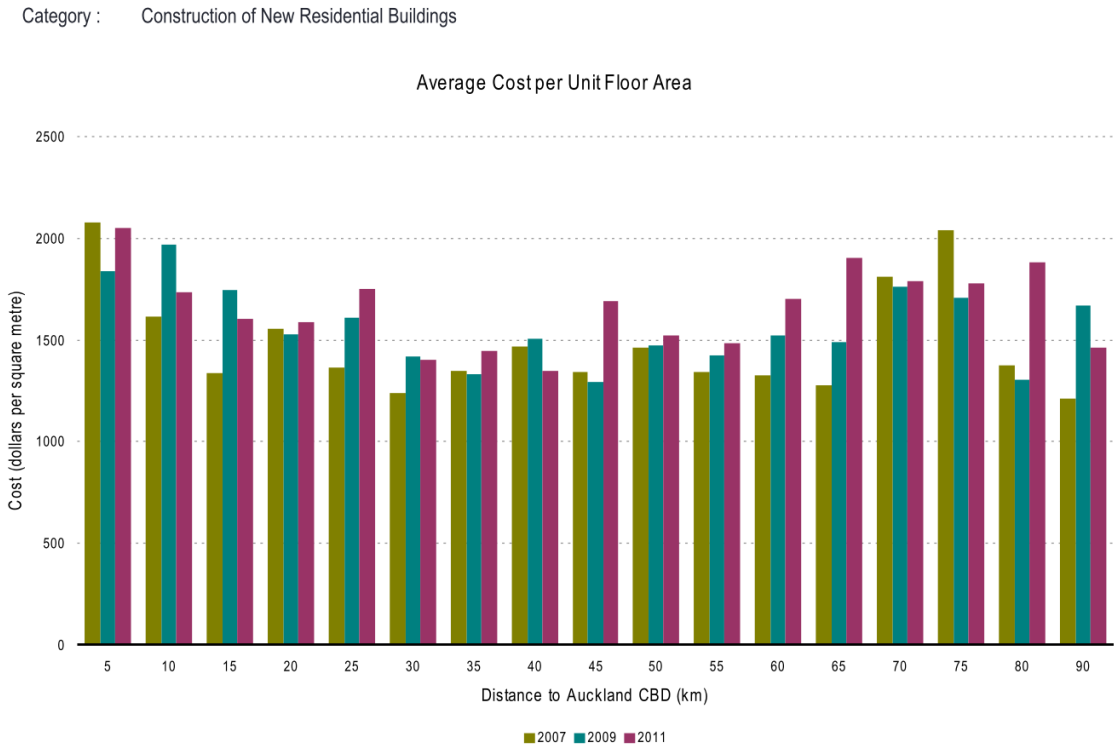


Figure 10: Average cost per unit area in relation to road distance to CBD

Figure 10 shows how the construction cost in Auckland varies according to road distance to the CBD. Construction cost is lowest in the rural areas of the region. Inner-city construction is 30% more expensive than construction at the urban fringes at the 20 km range. This difference could be a strong indication of the presence of a cost premium for inner-city construction, if the building typology and clients over Auckland's urban area are similar. However, from the maps in Figure 9 it could be observed that there are significant differences between adjacent neighbourhoods at equal distance from the CBD. Therefore, a more rigorous analysis is required to separate the contribution and influence of the different socio-economic factors on building costs.

A cost premium also appears to affect construction in the range from 60 km and beyond. This could be the result of the development of high-end lifestyle properties.

2.2.4 Distribution of growth

A more effective presentation of trends in maps is to capture the rate of change instead of the absolute values of the parameters. The Atlas provides annual growth maps for investment, consent count and added floor area for the period from 2006 to 2011. These maps present the rate and direction of change for these parameters in neighbourhoods based on area units. The ranges in the scaling for these maps is based on the standard

deviation of the distribution of actual growth values of the different areas in the maps. The ranges are symmetrically distributed around the average value of the distribution.

Figure 11 shows the average annual change in residential building investment from 2006 to 2011 per unit area. Analysis of the trends shows that the average change in invested dollars per neighbourhood (area unit) was -$32,000 with a standard deviation of $1 million. Some 30 (8%) of all 380 neighbourhoods with building activity experienced an annual growth of more than $510,000 per year and another 40 (11%) of neighbourhoods experienced negative growth in excess of -$560,000 per year. The investment growth in the remaining 81% of neighbourhoods falls in the range in between these numbers.

There are 18 neighbourhoods with more extreme investment changes in excess of $1.7 million per year, either positive or negative. These areas represent 24% of building activity in Auckland. This volume of building activity is equally distributed between the growing and the declining areas for residential building investment over the monitored period.

Amongst the most active areas visible in are well known development hot spots. Key figures for the top 50 neighbourhoods by annual building investment are listed according to their ranking in Table 1 in Appendix A.

In addition, the most prominent growing areas are ranked here in order of their annual growth:

- Stonefields (see F in Figure 11, see rank 4 in Table 1).
- Hingaia (see H in Figure 11, see rank 5 in Table 1).
- Ormiston (see G in Figure 11, see rank 1 in Table 1).
- Silverdale Central (see A in Figure 11, see rank 13 in Table 1).
- Hobsonville East (see C in Figure 11, see rank 37 in Table 1).
- Sturges North (see D in Figure 11, see rank 16 in Table 1).
- Waiheke Island (see E in Figure 11, see rank 9 in Table 1).
- Westgate (see C in Figure 11, not ranked in top 50).
- Birdwood East (see D in Figure 11, see rank 41 in Table 1).

The areas where construction is rapidly winding down are:

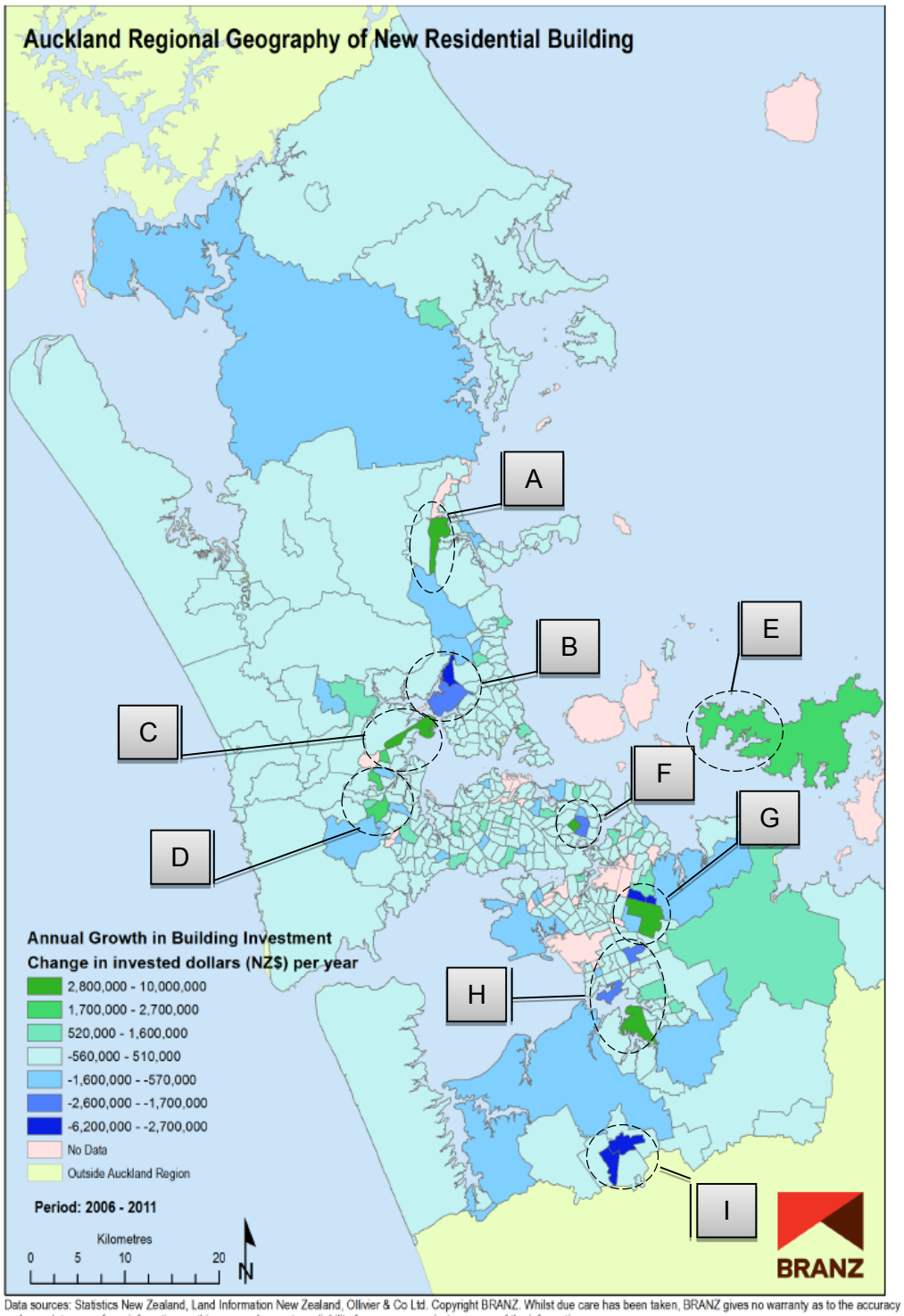
- Pukekohe West (see I in Figure 11, see rank 11 in Table 1).
- North Harbour West (see B in Figure 11, see rank 6 in Table 1).
- Mission Heights (see G in Figure 11, see rank 2 in Table 1).
- Baverstock Oaks (see G in Figure 11, see rank 17 in Table 1).
- Pukekohe North (see I in Figure 11, see rank 8 in Table 1).
- Greenhithe (see B in Figure 11, see rank 7 in Table 1).
- Mt Wellington Domain (see F in Figure 11, see rank 26 in Table 1).
- Totara Heights (see H in Figure 11, see rank 30 in Table 1).
- Wattle Farm (see H in Figure 11, not ranked in top 50).

The incrementally shifting nature of building activity on the city fringes is illustrated at the northern boundary of Auckland (see B and C in Figure 11). Hobsonville East is increasing in activity, whereas in neighbouring Greenhithe and West Harbour most space is used and a reduction in activity is visible. Similar shifts between adjacent areas are visible in the central and southern neighbourhoods of Mount Wellington and Flat Bush (see F and G in Figure 11).

Most attention so far has been on identifying and discussing major features in the maps, particularly the larger greenfield developments. However, the majority of areas show a lower rate of building activity. The combined contribution of these areas to the total activity in the region is significant – 53% of all investment happens in 335 areas that individually receive annual investments below $5 million and on average receive $1.7 million per year. This corresponds to typically five to six new consents per year per area unit for these areas. Considering their relevance to the total picture, what is striking is that the map shows there are in fact only very few area units with no new residential building activity at all. Therefore, building activity is finely distributed over the whole city and over the accessible parts of the rural areas.

In the discussion around Auckland's urban development there is substantial interest in striking a balance between outward growth (sprawl) and intensification of land use in existing urban areas. The widespread distributed building activity in the existing urban areas apart from the major greenfield developments indicates that intensification is happening through infill and redevelopment at a significant scale.

Does scale of greenfield development, lifestyle sprawl, infill and redevelopments happen in line with council plans for Auckland? While strictly seen this question might not qualify directly as a construction sector issue, indirectly it does. This is because the tension between plans and reality provides useful markers for interested stakeholders in the sector to better understand the direction of market developments.



Area units: Silverdale Central (A); Greenhithe and North Harbour West (B); Westgate and Hobsonville East (C); Sturges North and Birdwood East (D); Waiheke Island (E); Mt Wellington Domain and Stonefields (F); Baverstock Oaks, Mission Heights and Ormiston (G); Hingaia, Totara Heights and Wattle Farm (H); Pukekohe North and Pukekohe West (I)

Figure 11: Investment growth for new residential construction in Auckland's area units

3. DISCUSSION

This section sets out which issues and trends identified in the observations of the case study baseline review in Section 2 are directly relevant to Auckland's construction industry performance. Structural socio-economic drivers outside the direct control sphere of the industry that evoke spatial change on the layout of sector will be assessed on their impact on identified issues and the stress it puts on businesses. Potential opportunities for sector improvement surrounding the identified issues will be discussed at the end.

3.1 Rising construction costs

Section 2 illustrated trends in building activity in Auckland using information in the Atlas. A significant issue found is the rapid rise of construction cost above inflation. This trend is not specific to Auckland, rather it is a national issue and is being addressed by Government through the work of the Productivity Commission.

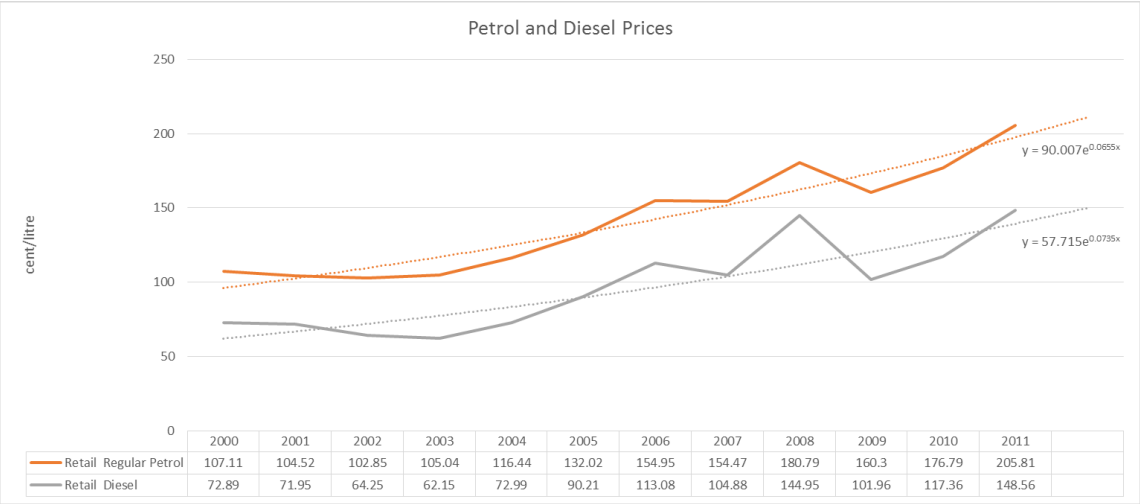
Affordability issues are particularly pertinent to Auckland (and also Christchurch since the Canterbury earthquakes in 2010 and 2011) where property prices are still rapidly increasing despite Government intervention with loan-to-value ratio restrictions on lending. For a growing group of Aucklanders, buying a property is out of their financial reach. This problem is further amplified by a supply of new residential dwellings that does not keep pace with population growth. Supply has also been further tightened by the global financial crisis. Moreover, the apparent rising construction cost and increasing size of Auckland houses further undermines housing affordability. Construction of larger numbers of smaller houses could provide some respite, but the sector can only respond to effective demand, which is apparently absent. In addition, profit margins at the low end of the market are generally smaller and therefore less attractive when involving construction in small numbers.

The review of the distribution in building activity by region does not point directly to any regional spatial productivity issue that is specific to Auckland. The analysis in Section 2 indicates that a significant part of new residential construction is thinly distributed over the region. Development at the urban fringes is dominated by larger scale construction. Larger developments provide more opportunities for economies of scale. A possible link between larger developments being served by larger firms cannot be confirmed at this stage. However, the distinct balance between distributed activity and confined larger scale developments is an indicator of the degree of fragmentation and bespoke nature of the market. Evidence in the maps of Figure 9 and the graph in Figure 10 within Section 2 show that construction costs vary significantly as a function of location. Unsurprisingly, less desirable areas tend to have lower cost construction. However, even construction costs in these areas have been rising rapidly.

Given the pressures in the Auckland market it will be essential for the sector to prove that its cost development is not out of control. Understanding this will not be easy and requires knowledge of procurement methods and work processes. The present business model in the construction sector appears to change slowly as discussed in the general problem definition in Section 1.2.1. In the following sections, we look at some external cost drivers potentially affecting the sector.

3.1.1 Exposure to rising fuel costs

Figure 12 shows petrol and diesel prices over the period 2000-2011 (Ministry of Economic Development, 2012). It illustrates that petrol prices have increased on average 6.5% per year and diesel 7.3% per year. Corrected for inflation, this equates to a net annual cost increase of 3.9% to 4.7% for fuel.



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Retail Regular Petrol	107.11	104.52	102.85	105.04	116.44	132.02	154.95	154.47	180.79	160.3	176.79	205.81
Retail Diesel	72.89	71.95	64.25	62.15	72.99	90.21	113.08	104.88	144.95	101.96	117.36	148.56

Figure 12: Trend in fuel prices (source: Ministry of Economic Development)

Estimates in literature indicate that between 29-58% of the cost of construction materials is in transportation. Materials can be between 30-50% of a project's total cost. Therefore 9-29% of total project cost can be related to moving material. In addition, earth-moving equipment uses fossil fuels. Labour, crafts and other service personnel move to site individually by fossil-fuelled transport, such as cars or vans.

The construction sector is vulnerable to rising transport costs because it is a labour-intensive and an inherently mobile production system. The system depends on a complex network of supporting supply chains. A significant part of freight is large volumes of low value bulk materials. Almost all transport of material, equipment and labour will go by road to building sites. Given this signature of construction-related transport, the sector is very depended on fossil fuels.

Therefore, even though the evidence is circumstantial, it seems appropriate to attribute a fraction of the observed cost increase in new residential construction to a rise in transport costs.

However, does the sector recognise its sensitivity to rising fuel costs? The current procurement system does not make fuel-related costs transparent so general awareness amongst builders is low (Ying, 2014). The sector appears to be in need of a long term plan to reduce its fuel vulnerability. In the Auckland region, this transport issue can be exacerbated by vulnerability to local congestion problems.

3.1.2 Exposure to rising urban land costs

Grimes & Liang (2007) have analysed the determinants of land cost in the Auckland region. They found that the cost of land in Auckland is higher than in other cities in the North Island and that the gap has been increasing over time. The spatial pattern of land prices in the Auckland region is consistent with economic models for a mono-centric city (Glaeser et al, 2008). Prices decrease with distance from the CBD and distance from the coast. Land use restrictions by means of zoning are expected to disturb the most economic allocation of land in a city. Planners in Auckland want to curtail sprawl into the rural areas, so have introduced a formal growth boundary. The impact of this formal growth boundary, the metropolitan urban limit (MUL), has had a binding effect on Auckland, driving up land prices in the city more rapidly than under unbound conditions (Glaeser and Gyourko, 2006). Sprawling beyond the boundary into rural areas has become a more exclusive lifestyle choice. Zoning in Auckland has also promoted spatial segregation of industrial, commercial and residential land utilisation. The resulting

separation has created asymmetries in land prices between adjacent land areas of different use.

The distribution of rising land prices in Auckland is likely to create outward pressure on businesses that cannot increase their turnover or income at an equal rate. For instance, bulky materials require a lot of space when stored. Therefore, if the value of these type of materials is low such as is typical in construction, it will become very expensive to store them for longer periods in Auckland. This means two possible business responses to land price increases for a situation where the sold volume of materials per year is fixed. One response is to move the distribution storage facility to the fringe of the city, where land prices are lower. The other is to keep the business in the same location and minimise the holding time for materials on the shelf and maximise the flow. The choice or balance between the two options will depend on the nature of demand and upstream supply chain characteristics.

Most builders, subcontractors and trades in Auckland rely on building merchants for material supply. Only the larger operators will place a part of their orders with the manufacturer due to their scale of operation. Material prices offered to builders include the cost of transport to the building site. Therefore, builders will select their material supplier purely based on the lowest offer (Vidalakis, 2011). It is assumed that the best offer will come from the material supplier with most efficient distribution and procurement systems or the lowest overheads due to locations and staff costs.

Material suppliers, such as building merchants and manufacturers, will be aware of the impact of rising land values on the bottom line of their businesses, because they have either significant capital investments in property or increasing property-related operational costs. Given this supply chain structure, construction cost will be affected by land prices, if material distributors are restricted in their location choices and if they cannot improve the flow through their businesses. If all building merchants were to move outward, the supply routes to inner-city building sites would increase in length. For Auckland, spatial trends of the local businesses in the construction supply chain need to be investigated to verify if land prices are affecting the spatial structure of the sector's distribution system resulting in longer supply routes.

Given the current inner-city congestion problems it is very likely that there is a cost premium for inner-city construction projects in Auckland. Residential construction on the fringe of the city, which is a dominant feature of urban growth in Auckland, should be less affected, but verification is needed. The cost of construction per square metre as depicted in the Atlas (see Figures 9 and 10) shows a difference in cost between inner-city and fringe construction. However, it is currently impossible to discriminate distribution costs from variation due to construction type and quality so additional information is needed.

Another urban effect of higher land prices is an intensification of land use. The impact of intensification will be that building sites will become smaller, especially in the inner-city. Builders will have to adapt to working in more confined sites with less space for storage of materials, equipment and waste. Also, construction projects will have to work in a built environment that will be less tolerant to construction. Construction will have to work within an ever-increasing amount of requirements for site operations to minimise the inconvenience to surrounding areas. In addition, the to-site logistics may be hindered by city traffic problems and it might be more difficulty to ensure the security of building sites.

All of these factors combined make it very likely that the construction cost in urban Auckland will rise faster than in other places in New Zealand, unless the supply structure of the local construction sector is improved.

3.2 Opportunities in construction logistics

Traditional construction logistics is characterised by experts as being uncontrolled, inconsiderate, disruptive and wasteful (Sullivan et al, 2009). The nature of a New Zealand construction project is traditional (Ying et al, 2014). Therefore, there are opportunities for the New Zealand construction sector to improve. Given the challenges the sector is facing, there is a good rationale for the sector to do so.

The first step would be for builders and main contractors to take a more active co-ordinating approach to site logistics. In the current approach, building projects are broken down into work packages by the builder, which can be subcontracted out in a form that makes trade subcontractors responsible for their material procurement, material delivery and waste removal. This practice can be regarded as an extreme form of spreading risk and responsibility. Under these conditions logistics issues can arise unexpectedly at any time during the project, because there is no planned integration. Most issues will occur when the pressure is highest. It is left to the trade subcontractors to sort out any issues when they occur. This lack of co-ordination and the limited responsibility of trade subcontractors can be detrimental to projects when relations and communication are suboptimal. This system is also incapable of reaping the benefits of potential synergies between supply streams.

A more co-ordinated approach for construction logistics is required for small, complex urban construction sites. However, even for less demanding sites, benefits can come from better considered material and storage management, better traffic management, better vehicle utilisation, safer site conditions, better site security through co-ordinated oversight, and better utilisation of trade specialists when not wasting time on unloading and carrying materials.

Developing and implementing better construction logistics will require a culture change, which is never easy, but it has the potential to build a significant competitive advantage for those business that make an early start addressing it.

3.3 Taking the spatial approach to sector performance further

This case study was limited to one topic of one theme in the Atlas, residential building activity. This particular topic allowed us to explore the scale and distribution of growth of Auckland's residential built environment and to develop a sector perspective on the implications of this growth on industry structure and performance. For the previous part of the discussion the Atlas was instrumental first in providing the essential data to identify a sector specific issue on the base of sound evidence and then second to bring this issue in the spatial context of New Zealand's largest growing city and build the case around the vulnerabilities of the sector's traditional industrial organisation as integral part of it.

The followed approach demonstrates the value of the Atlas for addressing industry issues but also has limits of which its users that want to build their own cases using its material should be aware. Many questions and observations on which were touched when working through the evidence in the Atlas required additional information from other sources to better understand them. Such information could be included in the Atlas for sharing with other stakeholders. Many of the findings based on the Atlas confirmed notions of what we thought we knew, but were missing the essential evidence. The Atlas has delivered some of the evidence.

Due to the chosen limited scope of this case study the second theme in the Atlas, which is "Trends in Industry Structure" has not been used. It contains information on the locations and scale of businesses in the industry. The discussion we indicates that rising land prices put outward pressure on businesses in the supply chains of construction, therefore the Atlas can be used to expand on the case by identifying which parts of the

value chain are really sensitive to the urban pressures of a growing city. This will have to be done in a separate case.

Further useful research into Auckland industry structure would be to identify the spatial and temporal structure of the business networks involved in particular project types in range of representative urban settings in the city. Individual business performance and stressors in these projects need to be explained considering their particular role and service to the project, their general service portfolio, and their spatial and non-spatial business structure, their network of business relations, their bargaining power and their experience. Ultimately understanding is needed to clarify and balance how both spatial and non-spatial considerations in supply chain management of construction projects influences both the cost to clients and the lifecycle performance of the delivered buildings in their functionality and local context.

A monitoring strategy for tracking developments in the industrial organisation of construction in New Zealand in the context of urban development is essential for informed industry productivity enhancement. The Atlas provides a glimpse of the type of spatial information that we are already collecting which could be integrated in such an sector focussed information strategy, however now the thinking needs to start of what evidence is missing to truly help individual businesses and the sector as whole, which is a complex task requiring collaboration.

Further development of the Atlas is possible and needed both in spatial coverage, breadth and depth to get better understanding on New Zealand's construction industry performance, however such expansion of a shared information source has to be driven by demand and consensus in the industry.

4. CONCLUSION AND RECOMMENDATIONS

In this report trends in residential building activity in the Auckland region were explored in a case study based on ready-to-use information from a new sector resource, the "Auckland Atlas of Construction". The Atlas provides information on Auckland regional trends for the period from 2000 to 2012 and spatial trends for the Auckland region for the period from 2006 to 2011.

In the case study a current perspective on the structure and trends of new residential construction in Auckland was developed by systemic exploration and assessment of selected material from the Atlas. Regional and spatial trends were assessed on their impact and meaning in relation to sector performance.

The key findings of the analysis of regional trends are:

- The Auckland region's new residential construction market follows distinctly different patterns from the rest of New Zealand. The market is far more volatile. The supply of new dwellings had already started to decline in 2005, two years before the onset of the global downturn. At the bottom of the low in 2009, only one-quarter of consents were issued as compared to the number at the peak in 2002.
- In 2000 Auckland's new dwellings were smaller than those in the rest of New Zealand, while in 2012 they were larger. The average dwelling size has increased 30% over the examined period to 210 m^2 in 2012.
- New residential construction costs in the Auckland region are rising rapidly at twice the speed of inflation. Costs in the rest of New Zealand follow a trend similar to Auckland but are lower. The drivers behind cost increases are unclear, but have attracted attention from the Government's Productivity Commission.
- The affordability and undersupply issues in Auckland makes the identified rise in construction cost a sector issue, especially as the sector is locked in a traditional work and production model in which it has proven to be hard to improve productivity.

The key findings of the review of distributional trends of building activity are:

- Auckland is growing outward through large scale greenfield developments at the city boundary and in urban satellites. In addition, there is significant large scale redevelopment happening of underutilised and former industrial land. However, more than half of the production of new residential dwellings is thinly distributed infill in existing urban areas and lifestyle development in rural areas.
- Inner-city construction is 30% more expensive than construction at the fringes of the city. Construction cost is lowest in the rural areas, except for those areas that are dominated by construction of rural and coastal lifestyle development. Construction near the shoreline is also more expensive, especially on the east coast.
- The analysis confirmed that more sort-after neighbourhoods also have higher construction costs. Most greenfield developments operate at the lower end of the market. However, the breakdown of the contribution of market preferences and sector performance issues cannot be done on the base of current data in the Atlas.
- The case study shows that the distribution of growth in Auckland's built environment follows familiar patterns found in other large cities flanked by extensive rural areas such as in countries like the United States and Australia. It follows the growth patterns of a mono-centric city.

The discussion focused on spatial drivers that influence the issue of rapidly rising construction costs:

- The argument indicates that external drivers such as fuel cost increases exceeding inflation and rapidly rising land prices are likely to contribute significantly to the continued rise in construction cost. Both drivers have an impact on the cost of the supply chains of building projects. Rising land cost will create pressure on the sector's supply businesses to move their operational distribution centres away from urban Auckland to cheaper land. Therefore, haulage routes to inner-city projects will get longer over more congested roads. Rising fuel costs add to this trend, as they are a key vulnerability of the sector due to its mobile and fossil fuel-intensive nature.
- The current traditional approach towards construction management, procurement and logistics in building projects implies that the sector will not take counter measures to compensate for rising operational costs. Fuel cost rises combined with urban pressures such as congestion, smaller building sites and longer haul routes on its supply chains and production processes impact on Auckland's inner-city construction resulting in an ever-increasing cost premium. In addition, the traditional construction logistics are characterised by experts as uncontrolled, inconsiderate, disruptive and wasteful.
- This current status and international experience with alternative approaches indicate that there are good opportunities in construction logistics to improve on current practice.

Recommendations

Given the current pressure on new residential housing supply and long term trends that put pressure on the supply chains in Auckland it is recommended the sector seriously considers the possibilities of reaping the benefits of a more planned approach to construction logistics and supply chain management. Early adaptors might be able to build a competitive advantage. As a whole, the sector might be able to mitigate some of the impact of the indicated externalities on the cost of construction by dedicating more attention to smarter logistics.

Finally, the case study demonstrated the value of the Atlas' spatial information through analysis of trends in residential building activity. It was shown how the baseline can be used to build a shared understanding of the structure, nature and opportunities of the residential market in Auckland.

Only a small part of the Atlas has been used for this case study. There are plenty of lessons and cases that can be built using its wider content in combination with other resources. However, to better understand building activity it is recommended that the scope of the Atlas is broadened to include baseline information on socio-economic data in neighbourhoods and a detailed building topology of Auckland, such that the analysis primary drivers of construction costs and sector performance can be significantly improved.

In addition, the Atlas is currently focused on Auckland. Other regional construction markets in New Zealand, such as Christchurch, also experience stress. The need for shared information on construction supply and demand will be felt in these regions, therefore the Atlas could also be expanded to cover trends in other regional markets.

5. LITERATURE AND LINKS

5.1 Publications

The literature list has separate listings for:

- Peer-reviewed articles.
- Books.
- Reports, plans and policy publications.

This serves to emphasise the difference in character, function and independence between these types of publications.

5.1.1 Peer-reviewed articles

Allen, S. G. (1985), 'Why construction industry productivity is declining', *Review of Economics and Statistics* **LXVII** (4), 661-669.

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Vrijhoef, R. & Koskela, L. (2000), 'The four roles of supply chain management in construction', *European Journal of Purchasing and Supply Management* **6**(3-4), 169-178.

Ying, F., Tookey, J. E. & Roberti, J. R. (2014), 'Addressing effective construction logistics through the lens of vehicle movements', accepted for publication in *Engineering, Construction and Architectural Management*.

5.1.2 Books

Wilkinson, S. & Scofield, R. (2010), *Management for the New Zealand Construction Industry*, *2nd edition*, paperback, Pearson, New Zealand.

Sullivan, G., Barthorpe, S. & Robbins, S. (2010), *Managing Construction Logistics*, Wiley-Blackwell, Chichester, West Sussex, U.K.

Glaeser, E. L. (2008), *Cities, agglomeration, and spatial equilibrium*, Oxford University Press.

5.1.3 Reports, plans and policy publications

Auckland Council (2011), *Auckland Plan*, Policy Document.

Auckland Council (2013), *The Proposed Auckland Unitary Plan*, Policy Document.

Auckland Council (2012), *Housing Action Plan Stage 1*, December 2012, Policy Document.

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PWC (2011), *Valuing the Role of Construction in the New Zealand Economy*, A Report Prepared for the Construction Strategy Group.

The New Zealand Productivity Commission (2012), *Housing Affordability Inquiry, Final Report*, Policy Document.

5.2 Links to the Auckland Atlas of Construction

5.2.1 Main page

- http://www.branz.co.nz/Atlas

5.2.2 Theme pages

- http://www.branz.co.nz/Atlas_activity
- http://www.branz.co.nz/Atlas_trends

5.2.3 Topic pages building activity theme

- http://www.branz.co.nz/Atlas_cnrb
- http://www.branz.co.nz/Atlas_aerb
- http://www.branz.co.nz/Atlas_cnnb
- http://www.branz.co.nz/Atlas_aenb

APPENDIX A TOP 50 OF AREAS BY BUILDING INVESTMENT

Table 1: Top 50 Auckland neighbourhoods by annual building investment for 2006-2011

Building Activity in Auckland Neighbourhoods 2006 - 2011		*annual building activity*		*cost of work per dwellings*		*floorarea per dwelling*		*cost per unit area*	
		million NZ$		*NZ$*		*m^2*		*NZ$ per m^2*	
rank	*area*	*Avg Value*	*Annual Change*	*Avg Value*	*Annual Change*	*Avg Value*	*Annual Change*	*Avg Value*	*Annual Change*
1	Ormiston	31.6	4.2	255,822	24,197	214	9	1,193	62
2	Mission Heights	23.5	-5.4	294,540	17,815	258	9	1,141	27
3	Fairview	22.3	0.3	345,223	15,381	261	-5	1,322	83
4	Stonefields	22.0	10.5	277,193	1,847	212	3	1,306	-8
5	Hingaia	21.0	8.0	310,502	-2,993	231	-2	1,346	-2
6	North Harbour West	20.3	-5.6	332,163	27,529	260	-1	1,277	112
7	Greenhithe	18.6	-2.1	327,187	26,698	238	-4	1,374	135
8	Pukekohe North	18.2	-3.6	247,248	6,699	193	9	1,284	-27
9	Waiheke Island	16.2	2.4	423,251	49,280	189	9	2,243	142
10	Omaha	15.1	0.2	446,369	28,191	243	-1	1,837	121
11	Pukekohe West	14.5	-6.2	208,308	5,452	160	6	1,302	-14
12	Beachlands-Maraetai	14.5	-0.4	327,261	18,004	238	-3	1,373	92
13	Silverdale Central	14.4	3.8	300,550	16,556	216	5	1,392	46
14	Pinehill	14.4	1.2	383,883	4,337	297	-5	1,294	39
15	Takanini South	10.3	1.2	254,613	19,031	165	15	1,540	-21
16	Sturges North	10.2	2.4	334,709	12,694	234	3	1,428	37
17	Baverstock Oaks	10.1	-4.7	236,054	463	200	-3	1,182	19
18	Dairy Flat-Redvale	9.5	-0.8	498,809	15,728	343	4	1,456	30
19	Tauhoa-Puhoi	9.4	-0.7	351,689	12,958	231	4	1,520	30
20	Orewa	9.1	-0.0	298,104	11,372	221	-5	1,347	86
21	Orakei North	9.0	-1.5	467,675	-23,466	205	8	2,281	-192
22	Cape Rodney South	8.8	-0.3	407,805	25,903	218	12	1,867	19
23	Point View	8.7	1.0	432,936	-10,776	297	-26	1,456	103
24	Northcross	8.6	-0.9	233,847	7,466	206	4	1,135	14
25	Warkworth	8.5	0.6	270,499	7,086	198	-1	1,368	44
26	Mt Wellington Domain	8.5	-2.0	267,748	825	210	3	1,274	-11
27	Riverhead	7.4	0.2	593,711	12,288	367	9	1,619	-4
28	St Heliers	7.4	0.3	582,429	22,469	296	-6	1,970	121
29	Gulf Harbour	7.3	0.2	407,606	14,114	243	1	1,678	49
30	Totara Heights	7.2	-1.7	232,895	37,317	185	24	1,261	35
31	Kingseat	7.1	-0.8	427,930	10,873	285	12	1,499	-23
32	Mcleod	6.4	-0.2	170,434	4,941	148	-1	1,153	45
33	Turanga	6.4	-1.1	515,610	45,819	392	19	1,316	52
34	Waitaramoa	6.3	-1.6	1,042,044	-177,936	405	-21	2,572	-324
35	Tahekeroa	6.2	0.3	330,828	8,124	238	-1	1,392	40
36	Drury	6.0	-0.9	337,840	2,394	256	-5	1,322	36
37	Hobsonville East	5.7	3.1	268,602	-1,416	174	-1	1,540	-2
38	Glenavon	5.7	-0.3	212,002	10,985	67	12	3,166	-348
39	Albany	5.6	-0.6	321,856	79,154	210	5	1,530	328
40	Wade Heads	5.6	-0.2	318,981	7,320	242	-4	1,317	54
41	Birdwood East	5.5	1.7	248,566	10,958	177	1	1,402	52
42	Hillsborough West	5.5	0.3	327,606	41,622	230	21	1,424	50
43	Mission Bay	5.5	-0.2	717,957	19,115	318	24	2,254	-104
44	Rothesay Bay	5.5	0.4	395,631	20,964	247	-1	1,604	94
45	Army Bay	5.0	-0.2	295,890	24,155	203	-1	1,458	129
46	Kumeu East	5.0	0.8	489,396	19,029	280	5	1,746	34
47	Hunua	4.8	-0.5	312,903	-3,747	230	6	1,360	-50
48	Waiuku West	4.8	-1.1	227,267	8,981	177	1	1,281	43
49	Kohimarama East	4.8	-0.1	691,252	-83,370	352	-18	1,961	-143
50	Clevedon	4.6	0.7	369,804	36,792	273	15	1,353	56

APPENDIX B BUILDING ACTIVITY THEME IN THE ATLAS

The building activity theme in the Atlas provides ready-to-use information on the scale and distribution of building activity in the Auckland region. The construction sector produces and changes buildings and infrastructure, and the trends and distribution of building activity are key to capturing and understanding sector dynamics. This section of the Atlas therefore answers questions such as:

- Where are the main centres of building activity in Auckland?
- What is the scale of production?

B.1 Information generation

B.1.1 Data sourcing and integration

A variety of data sources have been utilised to create the Atlas content under this theme. Building activity in the Atlas is defined by consented building work in the Auckland region. Building consents provide information on the number of projects, the type, the value and the associated floor area. The primary source of data used for building consents in the Atlas has come from Whats On Ltd. This data source did not include administration of non-building construction activity. Therefore, the Atlas is limited to activity related to construction and alteration of buildings.

In its raw form Whats On data was unsuitable for development of the maps and graphs for Atlas content because it is not geo-referenced, i.e. the dataset does not include a unique identifier that places each consent to a specific location on the Earth's surface. As a result, each building consent record was pinpointed to a physical location based on specific address information using a properly geo-referenced address database that was generated from a Land Information New Zealand base address list by the firm, Oliver & Co Ltd. This process is called geo-coding.

In order to conduct construction transport trend analysis related to changes in building activity, realistic travel distance calculations were required between specified locations. These distance calculations were performed using road network analysis tools in ARCMAP. For the whole Auckland region an origin-destination matrix was developed that linked all area units in the region to each other using the shortest road route. Each map and graph in the Atlas is the result of specific combination of spatial and temporal analysis using tools and functionality of ARCMAP and MS-Access.

B.1.2 Limitation

For interpretation of building activity it is important to note that the issuing of building consents by the Building Consent Authorities always predates actual construction work. However, most information in the maps and graphs in the Atlas is aggregated over time on an annual or biannual basis Therefore, presented data in the Atlas will be a reliable indicator for building activity in a given time interval.

B.2 Information topics and structuring

B.2.1 Topics

Figure 13 shows a screenshot of the building activity theme's overview page. The theme has four topics:

- Construction of new residential buildings.
- Alteration of existing residential buildings.
- Construction of new non-residential buildings.
- Alteration of existing non-residential buildings.

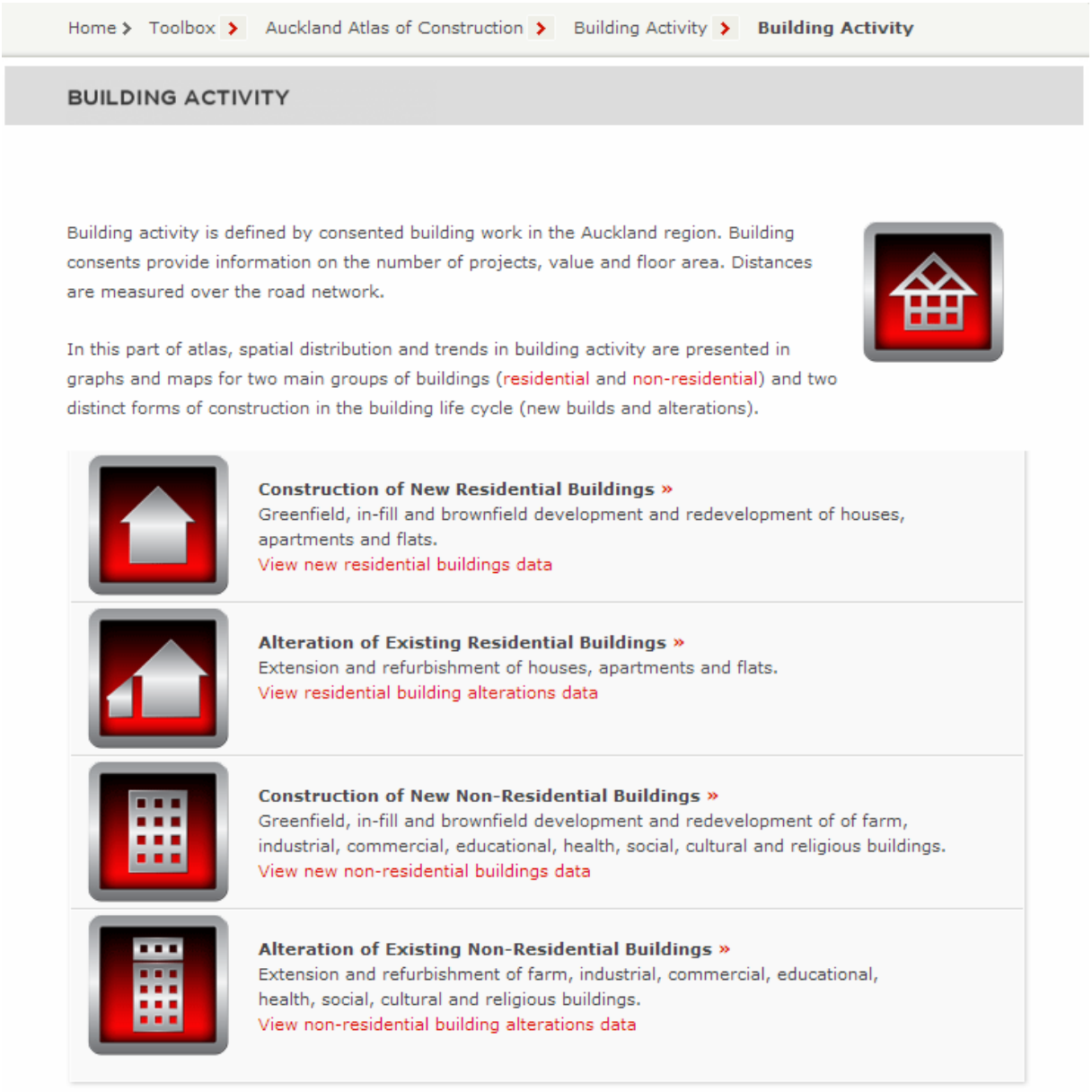

Figure 13: Screen shot of the Atlas main page for the building activity theme

B.2.2 Structure

Each of these topics is covered by a single webpage. This was a deliberate choice in the Atlas design to ensure simple, easy and fast navigation with standard web browsers. Each page is subdivided into a section containing graphs and a further section containing maps.

The first part of the webpage content provides the user with an overview of aggregated regional data such as buildings activity in terms of consent numbers, value of consents and associated floor area. In addition, it provides information on the regional trends in building activity locations in terms of distance to the Auckland's central business district (CBD).

The second part of the page reflects these trends as maps, providing a spatial distribution of building activity. Comparison of maps provides information on the change in the distribution of activity as a function of time. Therefore, the user can source the information in the Atlas to locate hot spots in activity and compare them to the activity in the surrounding areas. Table 2 provides a listing of the structure of information items that can be found on a topic page under this theme.

Table 2: Overview of typical information contents and structure of an Atlas category page under the building activity theme

Structure and Content of Individual Atlas Topic Pages under Building Activity Theme	
Part 1: Regional Building Activity in Graphs	
Regional Trends	• Number of consents 2000-2012 • Average value per consent 2000-2012 • Total annual value of consents 2000-2012 • Average floor area per consent 2000-2012 • Total annual floor area of consents 2000-2012 • Average cost per unit floor area 2000-2012
Urban/Rural Profiles	• Number of consents 2007, 2009, 2011 • Average value per consent 2007, 2009, 2011 • Average floor area per consent 2007, 2009, 2011 • Average cost per unit floor area 2007, 2009, 2011
Travel Trends	• Travel trends by number of consents 2006-2011 • Travel trends by value of consents 2006-2011
Part 2: Regional Building Activity in Maps	
Building Consent Locations	• Building consent locations • Building consent locations on topographic map
Interpolated	• Consent count density • Investment density • Typical value of consented work • Growth in building floor area • Typical floor area of consented work
Area Units	• Consent count (Map Series) • Consent count density (Map Series) • Average value (Map Series) • Total value (Map Series) • Average floor area (Map Series) • Total floor area (Map Series) • Average cost per unit floor area (Map Series) • Annual growth in investment • Annual growth in consent count • Annual growth in added floor area