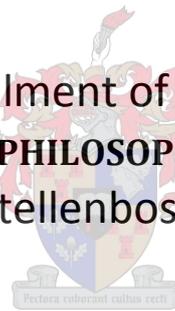


Business clustering along the N1-M1-N3 corridor in Northern Johannesburg, 2001-2012.

By

Xaven Pillay

Presented in partial fulfilment of the requirements for the degree of **MASTER OF PHILOSOPHY** at the University of Stellenbosch



Supervisor: Prof. HS Geyer

Centre for Regional and Urban Innovation and Statistical Exploration

“)

2014

Authors Declaration

By submitting this assignment electronically, I declare that the entirety of the work contained therein is my own, original work, that I am the sole author thereof (save to the extent explicitly otherwise stated), that reproduction and publication thereof by Stellenbosch University will not infringe any third party rights and that I have not previously in its entirety or in part submitted it for obtaining any qualification.

Date: 25 November 2014

Abstract

As a communication axis between Pretoria and Johannesburg the Old Pretoria Main Road always served as a linear force of attraction. This force was subsequently strengthened, first by the construction of the M1 and N1 motorways and later by the N3. Anecdotal evidence points to these sections of the motorways being some of the fastest-growing development corridors in South Africa. This paper analyses business clustering along these sections of the corridor from 2001 to 2012 using GIS technology. Of particular importance are the new economic geography forces that led to such a clustering of firms and the rationale for locating along these sections of the corridor.

Opsomming

As 'n kommunikasie as tussen Pretoria and Johannesburg, het die Ou Pretoria hoofpad altyd gedien as 'n liniere aantrekkingskrag. Hierdie aantrekkingskrag was versterk eers deur eers die konstruksie van die M1 en N1 hoofweë en later deur die N3. Dit wil voorkom asof hierdie gedeeltes van die hoofweë van die vinnigste groeiende ontwikkelingskorridors in Suid Afrika is. Hierdie studie analiseer die besigheidsgroepering langs hierde dele van die korridor van 2001 tot 2012 deur van GIS tegnologie gebruik te maak. Van spesefieke belang is die nuwe ekonomiese geografiese kragte wat tot hierdie groepering van maatskappye lei en die rasionaal vir die posisionering langs hierdie gedeeltes van die korridor.

Acknowledgements

I would like to thank Professor HS Geyer for making valuable suggestions and comments that have improved both the content and exposition of this paper. I am of course responsible for all mistakes.

For all my data needs I wish thank Dumisani from COJ (City of Johannesburg), Chris Wray from GCRO (Gauteng City Region Observatory), Nash Sankar of Evaluations, Stuart Martin of GTI (Geo Terra Image) and Helene Verhoef from the geography division of Statistics South Africa.

My most heartfelt of appreciation goes towards the 3 A's of my life, without their support, love and understanding none of this will even be possible.

Table of Contents

Centre for Regional and Urban Innovation and Statistical Exploration	1
Authors Declaration	2
Abstract.....	3
Opsomming.....	3
Acknowledgements.....	4
1. Introduction.....	7
2. Locational consideration	7
3. The composition, functioning and classification of corridors	10
4. The Research method.....	11
5. Survey	14
a. Survey results on the N3.....	15
b. Survey results on the M1.....	19
c. Survey results on the N1.....	25
6. GIS Analysis Results for the N1-M1-N3	31
7. Conclusions.....	47
8. Bibliography.....	49

List of Figures

Figure 1 Area of Study in the City of Johannesburg	12
Figure 2 Demarcation of N1-M1-N3 business clusters using 2012 imagery.....	13
Figure 3 A sample of a business clusters showing the land use descriptions	14
Figure 4 Business cluster Area 4 (2012 Imagery).....	16
Figure 5 Longmeadow Business Estate (http://www.longmeadowoa.co.za/about/home) ...	17
Figure 6 Business cluster Area 5 (2012 Imagery).....	18
Figure 7 Business cluster Area 1 (2012 Imagery).....	19
Figure 8 Business cluster Area 3 (2012 Imagery).....	20
Figure 9 Business cluster Area 6 (2012 Imagery).....	22
Figure 10 Business cluster Area 2 (2012 Imagery).....	22
Figure 11 Business cluster Area 7 (2012 Imagery).....	23

Figure 12 Business cluster Area 8 (2012 Imagery).....	24
Figure 13 Business cluster Area 9 (2012 Imagery).....	25
Figure 14 Business cluster Area 10 (2012 Imagery).....	26
Figure 15 Business cluster Area 11 (2012 Imagery).....	27
Figure 16 Business cluster Area 13 (2012 Imagery).....	28
Figure 17 Business cluster Area 12 (2012 Imagery).....	29
Figure 18 Business cluster Area 14 (2012 Imagery).....	30
Figure 19 Business cluster Area 15 (2012 Imagery).....	31
Figure 20 A sample of Foot Print Extraction for 2001 and 2012	32
Figure 21 Business Cluster area 1 in 2003 and 2012	34
Figure 22 Business Cluster area 2 in 2003 and 2012	34
Figure 23 Business Cluster area 3 in 2003 and 2012	35
Figure 24 Business Cluster area 4 in 2003 and 2012	35
Figure 25 Business Cluster area 5 in 2003 and 2012	36
Figure 26 Business Cluster area 6 in 2003 and 2012	36
Figure 27 Business Cluster area 7 in 2003 and 2012	37
Figure 28 Business Cluster area 8 in 2003 and 2012	37
Figure 29 Business Cluster area 9 in 2003 and 2012	38
Figure 30 Business Cluster area 10 in 2003 and 2012	38
Figure 31 Business Cluster area 11 in 2003 and 2012	39
Figure 32 Business Cluster area 12 in 2003 and 2012	39
Figure 33 Business Cluster area 13 in 2003 and 2012	40
Figure 34 Business Cluster area 14 in 2003 and 2012	40
Figure 35 Business Cluster area 15 in 2003 and 2012	41
Figure 36 Geographic distributions of Non Residential GTI data for 2001 & 2012	46

List of Tables

Table 1 Calculation of difference in area development -based on m ²	33
Table 2 Sample of results showing the land use differences between 2001 and 2012	45

Key Words

New Economic Geography, Geographic Information Systems, Agglomeration, Business clustering, high technology clusters, light manufacturing and warehousing, corridors, highways, N1, M1, N3

1. Introduction

The research aims and objectives in this paper attempts to indentify and understand why similar businesses cluster together along the N1-M1-N3 corridors of Northern Johannesburg, are the agglomeration of business due to economic forces, in particular those of new economic geography ,as well as the evolution of the corridors along the motorways.

A vast array of businesses lines the sides of the N1, M1 and N3 highways between Pretoria and Johannesburg. It is apparent that specific locations along the highways tend to be preferred by different kinds of businesses – high technology companies along the N1 between the Buccleuch interchange, Midrand and Centurion; white collar offices with specialized services, retail stores and light industry buildings along the M1; and fragmented development of food warehousing, automobile offices, logistic companies and light industries along the N3. It is obvious that these highways form part of rapidly growing development *corridors* between the two core cities. The economic potential of these nodes of development are indicative of the growing economies of scale along the corridors.

The formation of these corridors has led to the creation of attractive space for business location, adding to the creation of circular cumulative causation along the routes between the Johannesburg and Pretoria CBDs. Some of the former occupiers of the CBDs have moved elsewhere due to a combination of loss of clients, increasing cost-income differentials, lack of space, congestion and risk of crime.

Why have these agglomerations taken place along these sections of the highway? What has attracted businesses to these locations? Are these clusters still expanding? What are the consequential issues arising from such corridor development along these economic spines? This paper will attempt to answer the first; second; and third question outlined above as well as to measure how these corridors have evolved from 2001 to 2012.

2. Locational consideration

Much of the urban form and movement away from the CBD that can be seen along the highways between Pretoria and Johannesburg can be related to the effects of urban development explained in the filter down theories of Burgess (1925), Hoyt (1939) and Harris and Ullman (1945) and by trade off theory (Pacione, 2009).

The central place theory of Christaller (1933) and expanded by Lösch (1940) have assisted planners and geographers in their understanding of the spatial organisation of the economy through the positioning of high order and low order goods and services in relation to a market place or sphere of influence. Christaller's theory provides a good explanation of describing the honeycomb spatial pattern of urban location. Of particular importance to this study is the hierarchical positioning of urban centres along the N1-M1-N3 corridors in an effort to minimise the friction of distance for the provision of goods and services to consumers (Rodrigue, 2014).

Hotelling's (1929, p.41) law stated that there is an "undue tendency for competitors to imitate each other in quality of goods, in location, and in other essential ways." The outcome of Hotelling's model entails two firms strategically locating adjacent to each other to maximise their service areas (Henrickson, 2012). This spatial economic phenomenon may guide us in our understanding of why

firms tend to cluster in certain locations relative to their market areas. Similarly when looking at where the businesses tend to locate in this study area it could be argued that firms strategically chose to locate along the N1-M1-N3 due to accessibility to more markets and in an effort to maximize their profits. Berry's (1967) classification of nodes, commercial ribbons and specialized areas gives us a greater understanding of the retail, office and warehousing patterns we see on the N1-M1-N3 today. The clustered, sometimes fragmented rows of car dealerships, home fabrics and home furnishings and clothing districts in this paper's study areas can be linked to Berry's model. Guy (1998) and Borchert (1998) provide further analyses and explanations into the business configurations of Berry and enable us to better understand how these retail structures usually cluster together based on types of goods or services provided. Borchert (1998) provided insight into continuously changing demand and supply factors that lead to retail dynamism. The demand side focus on the rapidly changing consumer preferences and shopping behaviour while the supply side entails the retail units' response to the changing economic conditions and increasing competition. It is these forces that have influenced retail business structures, an insight that is useful to this study and assists in the better understanding of why retail has developed in the areas along the N1-M1-N3 (Borchert, 1998). Guy (1998, p.258) on the other hand enhances our understanding of the retail configuration along the N1-M1-N3 by putting forward that retail areas in suburban areas "have grown through the conversions of residential and other property in order to serve neighbouring areas with convenience or occasionally comparison goods" (Guy, 1998)

Renner (1974), Weber (1928) and Hoover (1945) all provided good empirical arguments surrounding the locational dynamics of industries. Classical Weberian location theory enforces that profit seeking firms will be attracted to those locations where they will benefit from a minimizing of their transport costs. Hoover explained why firms tend to locate at resource sites and break-of-bulk sites, as well at points where other firms are already in existence (Scott, 1982), all aspects of location economics that are relevant to this study.

The push and pull factors for industry attraction to sub-urban areas, as Scott (1982) explains, lie in the developments of truck transport and newly designed highways, the invention of horizontal plant layouts, cheap land in the suburbs, the decentralization on the working population, proximity of the suburbs to airports and accessibility of the periphery to the residences of managers and staff. Recent trends have shown the inner-city location continues to remain attractive to certain kinds of labour intensive industries while the capital intensive firms tend to locate towards the periphery (Scott, 1982).

Vast improvements in communication technology have led to many offices (Insurance; banking; finance; head offices and business services) and capital intensive firms moving away from the confinement of the city centre. In Gauteng, office developments are moving out of the city centres and are generally locating in higher-income and predominantly white suburban areas such as Sandton. The reasons behind these locational decisions lie in the fact that these areas are characteristic of lower congestion, higher availability of amenities, greater ease of vehicle usage and the locations are in close proximity to middle and high income employees (Harrison et al., 2008). The movement of offices to these areas entails the servicing of a higher income local community in better surroundings.

The offices along the N1-M1-N3 also benefit from the exposure created from the surplus of commuters travelling by, giving these companies an added marketing advantage over competitors. The locational positioning also offers excellent infrastructural advantages to many of the local and multinational freight forwarding, warehousing and distribution companies along the routes – in essence increasing the efficiency of service to the clientele in their sphere of influence. It was Oum and Park's (2004) research on distribution centres in Northeast Asian countries that revealed that multinational enterprises follow the following locational considerations: market size, transport conditions, labour considerations and input costs before the positioning of their firms (Hong, 2007).

A specific area of interest in this study is the clustering of high technology enterprises along the N1 corridor in Midrand. The formation of these kinds of clusters is driven by enterprises associated with non-production functions such as command and control functions and training and service activities. In the survey results of firms by Rogerson (1998), centrality between Johannesburg and Pretoria, image and corporate visibility and the importance of the highway network were the leading locational factors influencing the establishment of firms in that area. Just as location factors play a vital role in attracting firms to settle along the N1-M1-N3, one cannot dismiss the economic contemplation of these firms when they cluster together.

New economic geography (NEG) has been described as an explanation for the formation of a large variety of economic agglomerations in geographic space due to imperfect competition (Fujita & Krugman, 2004). The goal of NEG as Krugman (1991a) sees it is to explain how the geographical structure of an economy is shaped. Firstly, centripetal (concentration) forces which involve circular causation involving a variety of pull factors attract labour and industry to an area. This may include better access to amenities, knowledge spillovers, high wages, bigger space, lower rental and bigger markets. Secondly he relates the tension to centrifugal forces involving push factors such as those experienced by companies in the CBD. These include: high rents; insufficient space; lack of infrastructure; crime in the city; congestion and commuting struggles. Together these factors lead to diseconomies of scale. (Fujita & Krugman, 2004).

Rogerson (2010) refers to many studies that have shown the importance of location and agglomeration economics in the choice of location of firms and enterprises. Avandi (1997) argued that clusters offer crucial technological support systems in an information rich environment. This enables enterprises that are located within an agglomeration to benefit from technological externalities and collective technical support (Rogerson, 2010).

Research has shown how the clustering of low-order firms can steal revenues from the non-clustered low order rivals and that clusters only arise at those locations that appear to be optimally positioned for low level and same level consumer purchases (Mulligan et al., 2012). Aside from low order clustering Porter (1990) made reference to clusters of innovation (COI) in Silicon Valley referring to them as frequently observed concentrations of interconnected organizations where proximity leads to shared advantages through the aggregation of expertise, intellectual property patents and specialized resources (Engel & del-Palacio, 2009). In central place theory retail trade and service activities often tend to cluster, forming urban centres at one geographic scale and shopping centres at another (Mulligan et al., 2012).

“Where firms cluster together, there are efficiency gains from outsourcing, labour pooling and knowledge spillovers” (Krugell & Rankin, 2012, p.299). Levy's (1996) World Bank study of the small

medium and micro-enterprise (SMME) economy revealed that the most successful SMME manufacturing companies are generally run by educated and experienced entrepreneurs. This highlights the importance of information and the ability to correctly interpret the information when decisions regarding the locations relative to the types of enterprise are made.

Aside from the above economic considerations in trying to understand the business clustering on the N1-M1-N3, Castell (1996) pointed to another type of economy that drives urbanization, termed the 'spatial economies of synergy.' He explained that by sharing a space with a valuable partner in a particular network increases the possibility of adding value as a result of the innovation generated by this interaction. He sees metropolitan areas as likely nodes for various networks. These nodes act as attractors for capital, talent or other valued things (Blanco, 2014).

In light of the above mentioned theories and empirical research the evolution and composition of corridors is the next issue to be dealt with.

3. The composition, functioning and classification of corridors

There are many examples of attempts to define *urban corridors* or *development axes*. Although many different terms are found in planning, economics and geography literature to describe the development axis concept, it can best be defined as a phenomenon that comes into existence when interaction between two development centres leads to the creation of conducive conditions for further economic development along the communication axis connecting the two nodes (Geyer, 1988). Put another way, development corridors are said to connect major nodes to create a purposeful interaction that would require high-density development of both residential and commercial activity along a transport route (Donaldson, 2006). The South African authorities (1984) in the Draft National Development Plan defined the development axis as a system of development centres situated on a communication axis near each other or as a linear manifestation of arteries emerging from the developing centres. This linear manifestation of the development axis can also be called a 'development finger' (Mayer 1969). Gruber (1976) suggests that there is a merging of regions somewhere between the two centres from which the corridor originates while Geyer (1988) focuses on the communication axis between two or more development centres as a linear force of attraction due to socio-economic interaction along the nodal line.

Geyer (1988) suggested that a development axis must have the following attributes to be regarded as a corridor: *It must at least have a dominant development centre at either end with a communication axis linking the two centres; Interaction on the axis must create potential for further development; the development centres on the axis must be mutually dependant in order to support communication on the axis; and the axis must be physically and economically growing.* This paper focuses on the areas situated towards the North of the Johannesburg CBD and the areas south of the Pretoria CBD, forming the economic activity spines along the dominant communication axes formed by the N1, N3 and M1. Both the M1 from Johannesburg CBD as well as the N3 from Ekurhuleni join the N1 at the Buccleuch off ramp and continue towards Pretoria.

Although much of the literature on corridor development is old, they are however still relevant in many respects. Today we see examples where governments use them as an instrument to promote spatial, economic and social restructuring and integration (Donaldson, 2006).

4. The Research method

The search for a suitable technique of measuring business clusters along the N1-M1-N3 corridors has led down a meandering road of papers on urban sprawl, agglomeration and clustering. In most of the research, density and distance have come up in the research methodologies as methods to measure clustering. For this study preference is given to those studies that have used geographical information systems (GIS) in the determination of their results.

A review of many research papers that utilized GIS in their analysis has provided much needed guidance on the successful methods that were utilised to determine results. The research also highlighted certain shortfalls that were most prevalent in studies when using GIS. These include shortcomings of sources due to highly aggregated data that the studies require, as the data is supplied by a multitude of sources which implies that the data may not always be consistent with the study areas (Ewing et al., 2002). Heavy reliance on descriptive and multivariate statistics can cause unreliable results due to spatial autocorrelation. So is the agreement on the geographic scale of observation that should be used. Both Torrens (2008) and Wallsten (2000) agree that using the wrong geographic scale may cause modifiable areal units due to data skewing. It is for this reason that 'patches' calculated from land parcel footprints were used in the Torrens (2008) study while Wallsten (2000) calculated the entire distance of each firm to another.

The first step in this study was to find suitable data for an ESRI GIS mapping application. Several sources were collected based on the historical review of other case studies mentioned earlier. A majority of the data and imagery was obtained from the City of Johannesburg (COJ) municipality. These included aerial photography dating back to 2003 as well as the latest imagery for 2012. The building footprints, cadastral land parcels and zoning data were also obtained from the COJ. Demographic data from Census 2011 as well as the latest geographical hierarchy of spatial layers was obtained from Statistics South Africa (StatsSA). A private company involved in the evaluation of property provided useful information on the characteristics of the different building footprints. Valuable information on the different characteristics of buildings in the study area was also obtained from a private GIS company for the years 2001 and 2012. The data had to be spatially analysed, projected and geo-corrected as they had come from many different sources.

A rectangular polygon was digitized and serves as the area of interest (AOI) for this paper. Within this AOI the latest aerial photography was interpreted using a desktop method and a centre line following the N1-M1-N3. A spatial proximity buffer of 500 metres was then created on either side of this centre line. The 500 metre buffer enabled a more focused area of interest along the motorways. All the building footprints within this buffer were selected for analysis. Apart from the locational selection processes, spatial joins were also carried out that updated the attributes of the building footprints with the information from the zoning, cadastral and point layers. This gave the footprints more detailed information with which to analyse.

A further demarcation of all business, industrial and commercial areas along the N1-M1-N3 was done using the 2012 imagery. The demarcation was done keeping in mind the 500 metre centreline buffer. This enabled a more detailed analysis of the areas along the routes characterized by clusters of commercial, business and industry. Fifteen different areas along the routes were identified and

labelled as Area 1 to Area 15, starting from the Grayston off-ramp on the M1 and the Modderfontein off-ramp on the N3 to the Samrand off-ramp on the N1 in the City of Tshwane. The idea was to begin the analysis of the areas of interest starting from 2012 and visually comparing that to the available data along the highways till 2001.

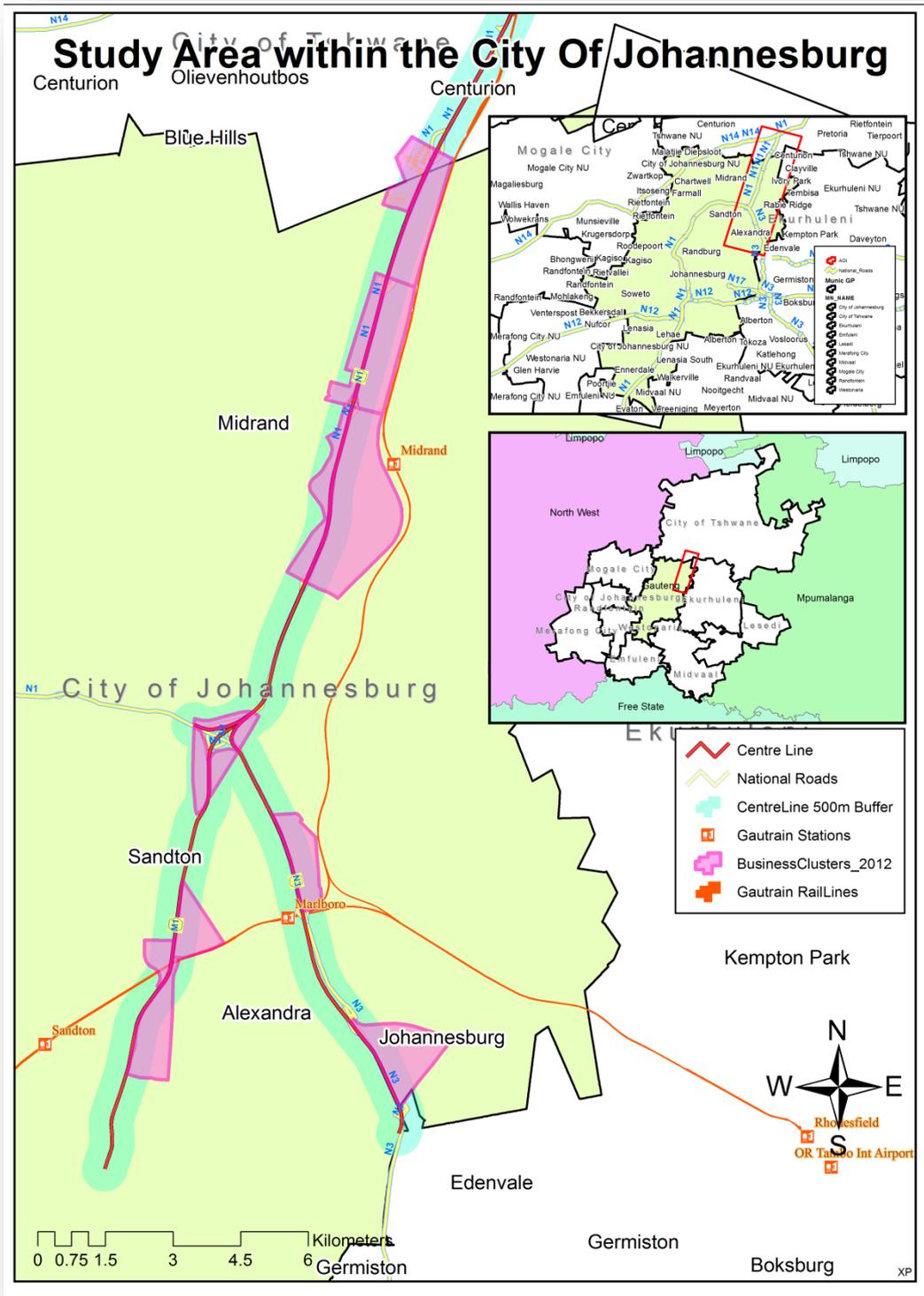


Figure 1 Area of Study in the City of Johannesburg

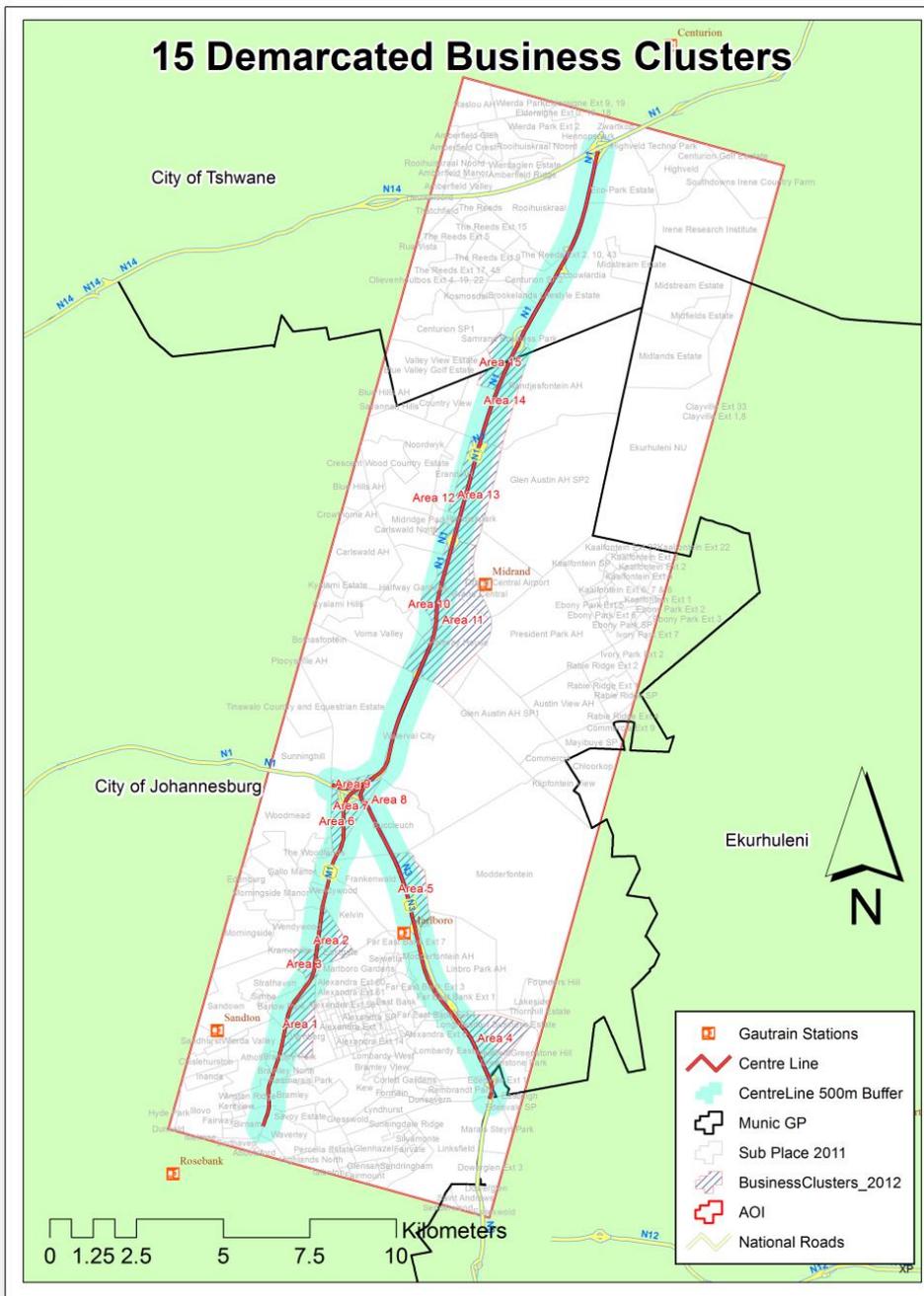


Figure 2 Demarcation of N1-M1-N3 business clusters using 2012 imagery

The latest zoning data from the city of Johannesburg (COJ) was viewed to gain a better understating of the study area. Clearly evident within the majority of the different business clusters is that most of the areas along the highways are zoned *Special*.

type or names of certain businesses due to the resolution of the video image being distorted or blocked from view by an object (truck, wall, road construction, etc). The GPS capture of areas proved very useful especially when compared to collected data from the different data sources. It allowed judgement calls on which sources of data would prove more useful and which were inaccurate. It should be noted though that all data sources used were very useful in achieving the objectives of this project.

The point data for years 2001 were used in conjunction with the imagery for 2003 and the point's dataset for 2012 were used with imagery for 2012. These datasets were used to extract the building footprints from the COJ footprint layer that was attained for 2012. This provided sets of layers for the buildings that existed in 2001 and 2012; this was then verified with the 2003 imagery and the 2012 imagery. Although this did not give a precise account it provided a more than adequate account of what occurred on the ground within these business clusters over the years 2001 and 2012.

a. Survey results on the N3

Results based on 2014 Survey and 2012 imagery

The N3 consisted of two main business clusters demarcated as areas 4 and 5; both areas are situated on the eastern side of the N3. Area 4 located near the Modderfontein off-ramp consisted primarily of the Longmeadow Business Estates. The area on the western side opposite the business clusters are flanked by residential properties.

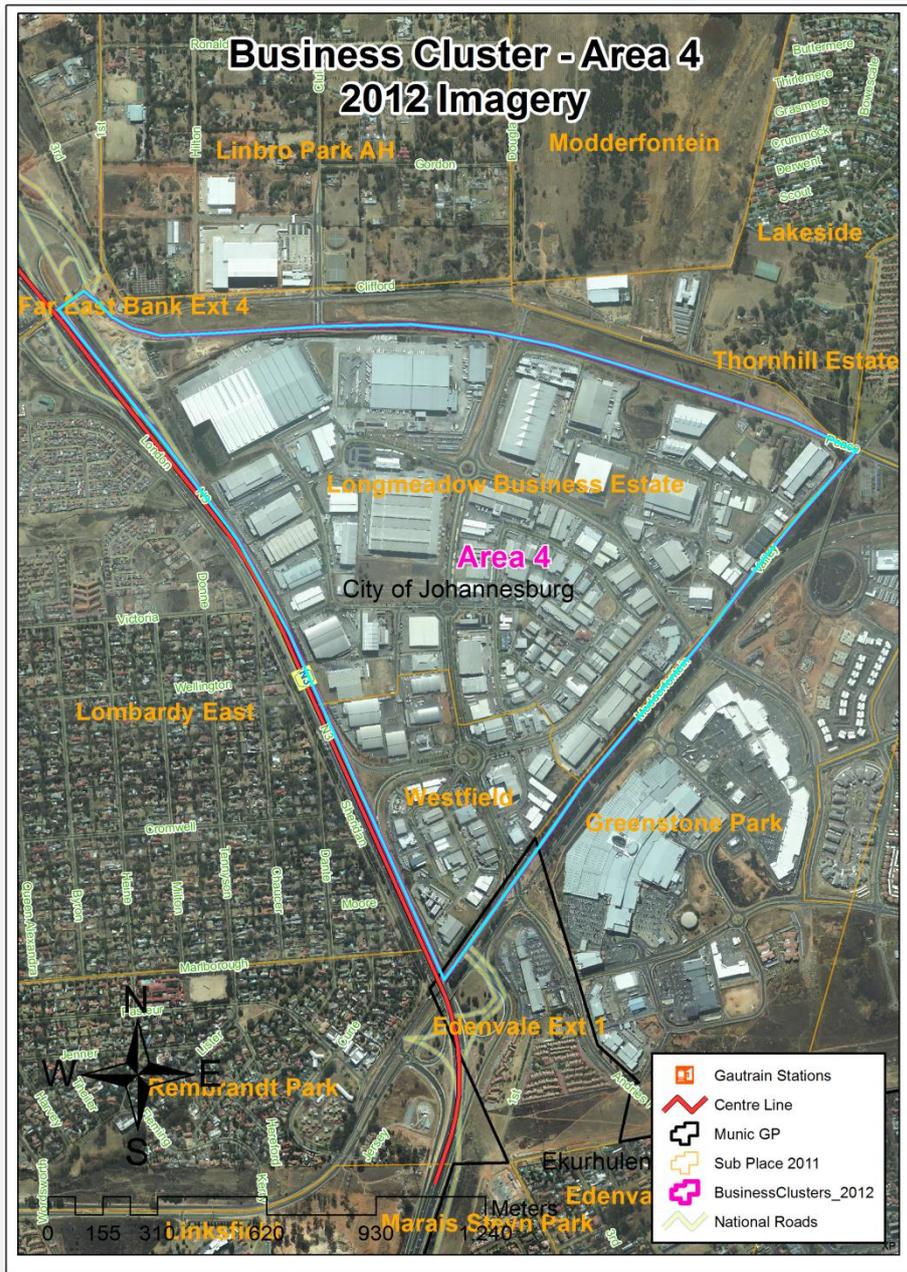


Figure 4 Business cluster Area 4 (2012 Imagery)

The area is a bustling hub of huge warehouses, logistic companies, distribution depots, wholesalers, light manufacturers and servicing companies, most of which require spacious premises to carry out their business activities (Refer to Table 1). The central location of the business estate offers ease of access to Sandton, Midrand, OR Tambo Airport and the industrial basin on the East Rand along the transportation highway routes. Evident from the results aside from the many clustered logistic companies are the close proximity and agglomeration of the food distribution warehouses belonging to Pick n Pay, Bidvest Foods and Nestlé. Although a detailed survey of individual businesses falls outside the scope of this study, there is scope for a follow-up study in which the focus could fall on strategic (agglomeration-driven) reasons why these companies strategically located in this fashion.

An observation witnessed is the added proximity advantage that the wholesalers, manufacturing and production line companies have in situating so close to the numerous logistic companies. This most probably assists in their product distribution.



Figure 5 Longmeadow Business Estate (<http://www.longmeadowoa.co.za/about/home>)

The business cluster demarcated as Area 5 is located along the eastern side of the N3 between the Marlboro off-ramp and Buccleuch interchange. Vacant land dominates the western side of the highway opposite the business cluster.

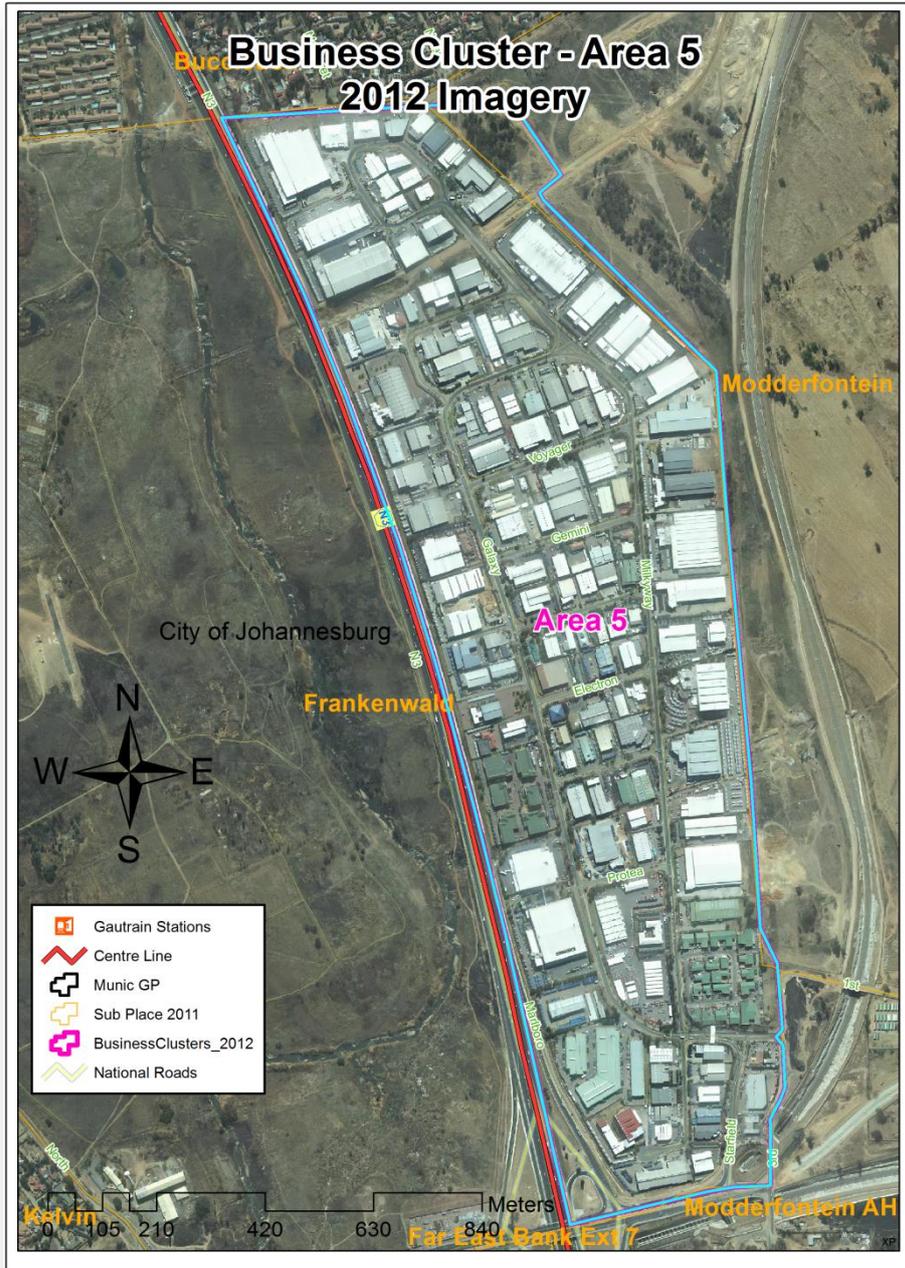


Figure 6 Business cluster Area 5 (2012 Imagery)

Most of the businesses are located within the Linbro business park. The business park is home to a wide variety of corporate head offices, ICT companies, car dealerships and engineering solutions companies manufacturing motors, motor parts, specialist instrumentation or equipment. There are not as many large warehouses as are evident in Area 4. The analysis of the survey results provided the detail of the many ICT related companies as well as the many companies involved in the engineering of industrial motors, parts, equipment and instruments within the business park. A few car dealership head offices are also situated in the area.

b. Survey results on the M1

Results based on 2014 Survey and 2012 imagery

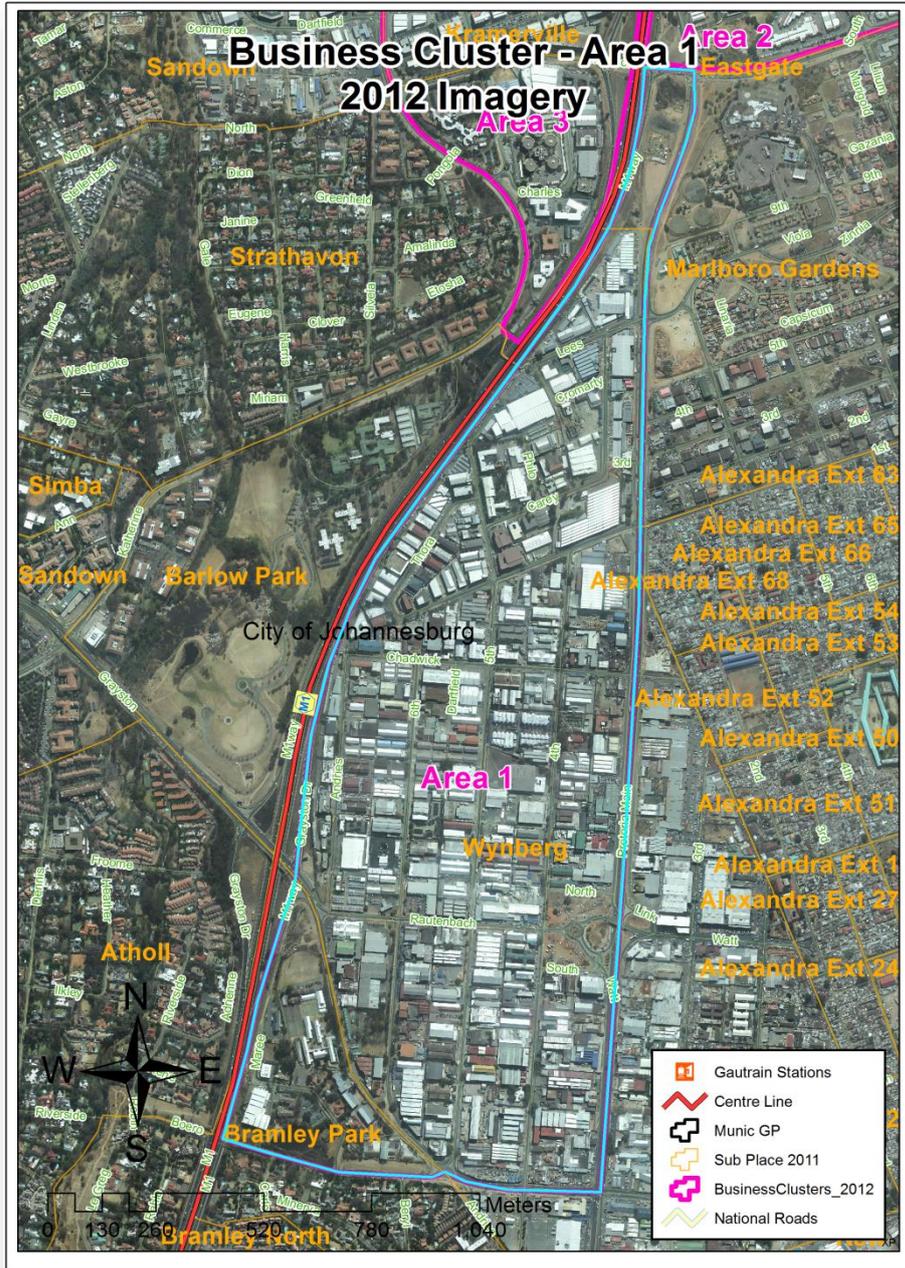


Figure 7 Business cluster Area 1 (2012 Imagery)

The survey of the area 1 situated on the eastern side of the Grayston off-ramp revealed a cluster of home industry related companies, motor vehicle, motor vehicle spares and parts, and panel shops.

The area was also abundantly laden with furniture stores and factory shops selling business and home furniture. The survey also revealed a clustering of electrical and electricity related products and services clustered together in the area. This provides a perfect example of how businesses agglomerate based on the principles of NEG. There were bigger warehouses located towards the northern end of the business cluster, these often consisting of company showrooms, manufacturing and administration all located on one business property.

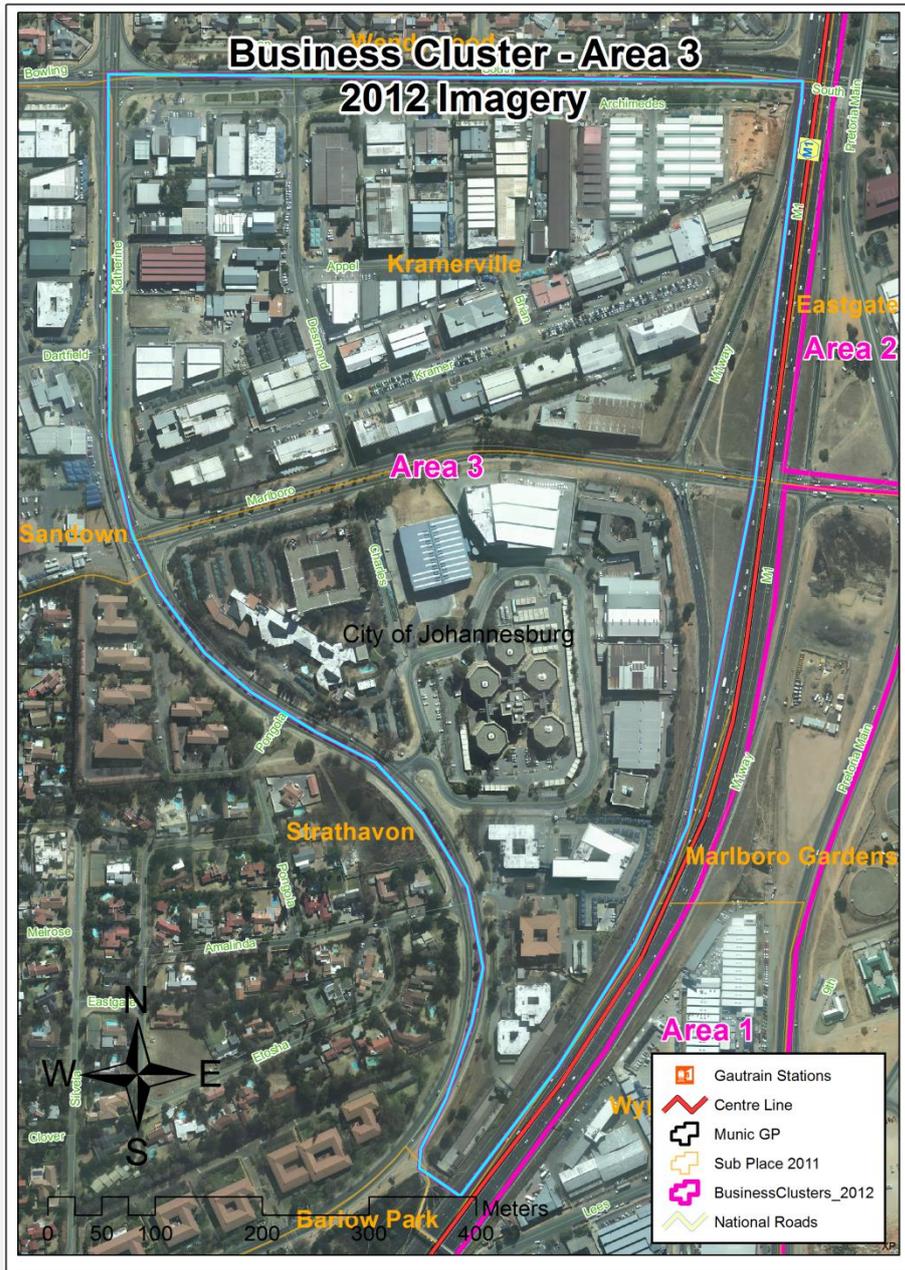


Figure 8 Business cluster Area 3 (2012 Imagery)

The western side of the M1 is strewn with huge businesses and warehouses located towards the Southern side of the cluster. There are many offices and business parks located in this area with companies requiring huge space to conduct their business. There are clothing companies and medical supply companies that have their offices and manufacturing situated next to each other, the same can be said about the furniture holding company Ellerines which has made the area their head office. Security company ADT and media giant Sterkinekor and Primedia are also located in the area together with other related media firms of Primemedia. North of the cluster, in Kramerville, were found a cluster of high end designer studios featuring a multitude of home industry accessory companies from luxury designer furniture to designer kitchens and bathroom accessories. The area along the highway tapers off into a mix of residential space with houses that have been converted into business together with huge corporate offices of companies like SAGE making its way toward the Woodmead Retail Park complex and the Buccleuch interchange.



Figure 9 Business cluster Area 6 (2012 Imagery)

On the eastern side opposite of Kramer Street you see companies like Unitrans, Toyota, Lexus, adorning the sides of the highway. The area also has huge fashion and furniture retails outlets and head offices. The bigger companies like Cummins who manufacture diesel engines have their offices directly next to the manufacturing side of their business. This company who manufactures diesel engines is clustered with Toyota, Lexus. Also evident in the cluster is Tripark business park which houses many media and film companies, this is similar to what has been witnessed diagonally across the highway in area 3 with the Sterkinekor and Primedia cluster.



Figure 10 Business cluster Area 2 (2012 Imagery)

Areas 7, 8 and 9 situated at the Buccleuch off ramp have become thriving areas of development with huge industries giants such as Group 5, Oracle, BYTES Technology, Nashua, Cell C, Vodacom and British Telecom establishing their business offices in the area. The mega project of Waterfall City located on the western side of the highway also has some of its office and warehousing locations of its shareholding and property developers (Atterbury and Attacq) located in Area 7 on the eastern side of the highway.



Figure 11 Business cluster Area 7 (2012 Imagery)



Figure 12 Business cluster Area 8 (2012 Imagery)

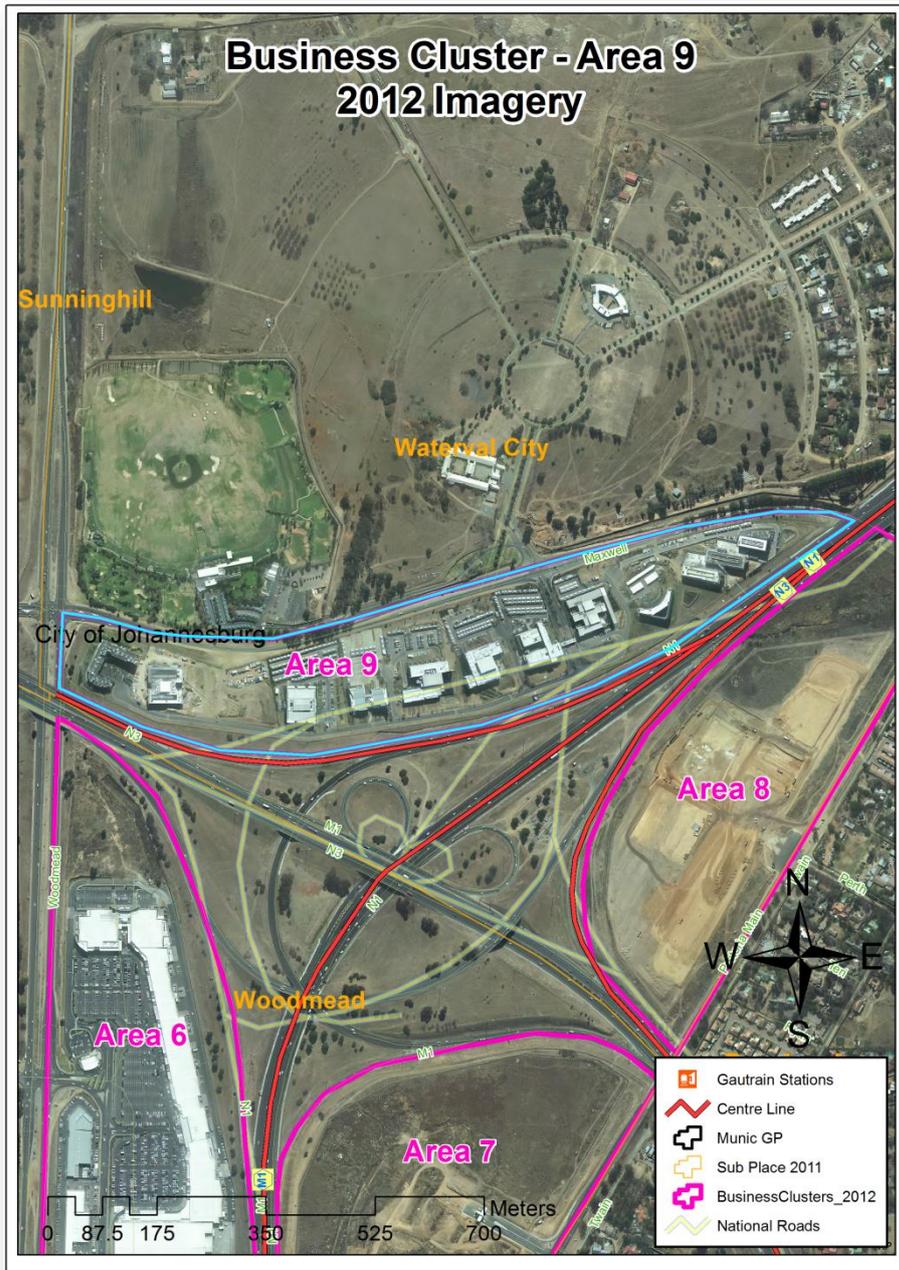


Figure 13 Business cluster Area 9 (2012 Imagery)

c. Survey results on the N1

Results based on 2014 Survey and 2012 imagery

An interesting observation made during the survey was that as soon as you enter the N1 headed towards Pretoria at the Buccleugh interchange you become aware of the presence of the big technology (Oracle, Bytes, Altech, Nashua, etc) and medical firms (Bristol Myers Squibb and Medtronic,) as you drive by. Approaching Allandale your view scans over cleared ground with major construction and numerous hoisted cranes on the eastern side of the highway, the infamous

Waterfall City and the mega structure the Mall of Africa are set to be built here. The landscape already holds the Waterfall hospital, some residential property and offices. The eastern side of the highway witnesses the development of more corporate offices for the property developers and Shareholdings Company Atterbury and Attacq adorned with a view overlooking the development on the western side.

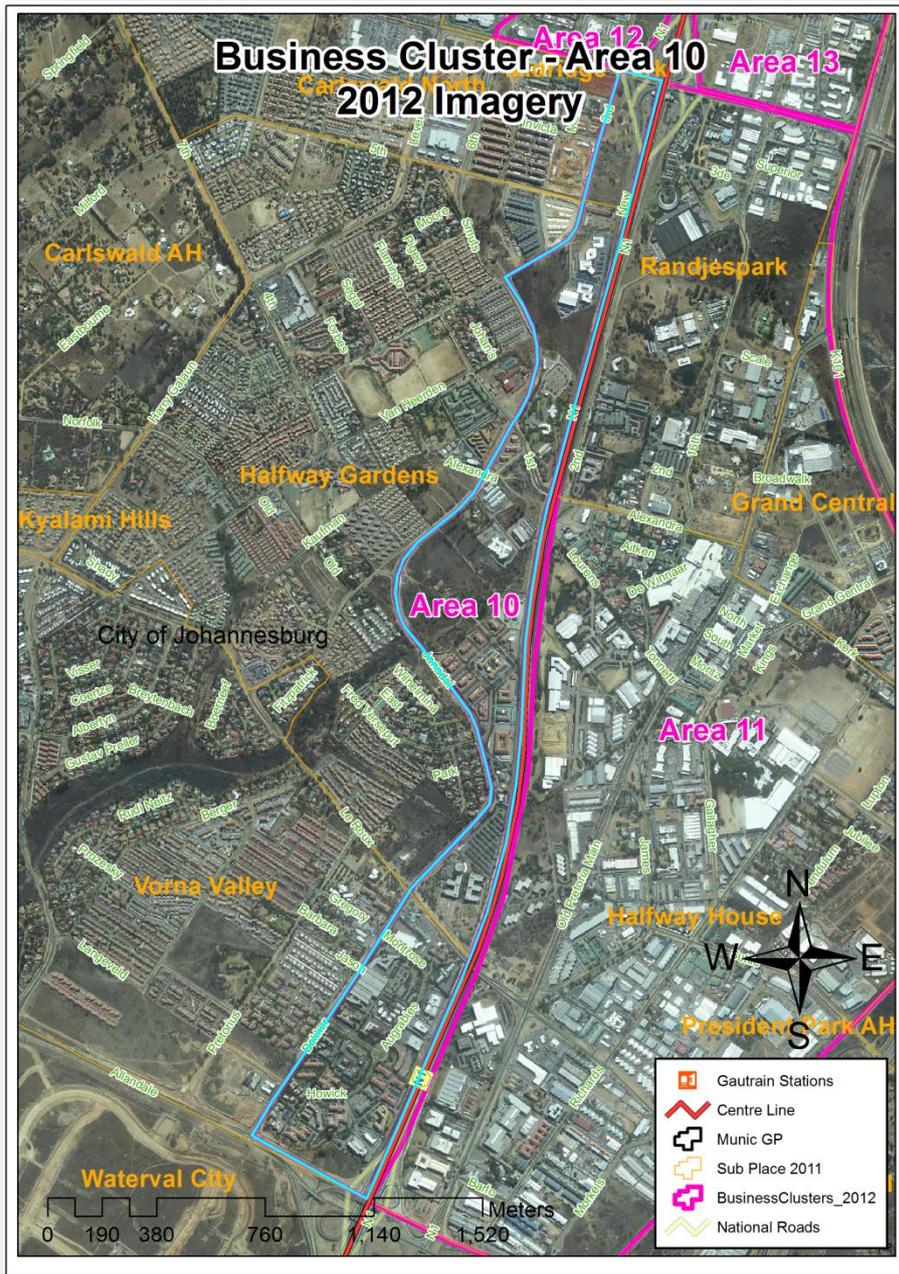


Figure 14 Business cluster Area 10 (2012 Imagery)

There is a complexity of office parks, corporate head offices and residential addresses situated along the western side of the N1 in business cluster area 10. Waterfall Office Park, Siemens, Altech, Inveco,

Varsity College, Riverview Park and Thornhill Park form some of the clusters of offices in the area. An interesting observation in the area was the number of educational facilities located so close to each other: Varsity College, Unisa, Post Office learning institute, Netcare Training Academia and the Midrand Library situated within close proximity of each other. A few electronic companies were also noticed in the area from Scheider Electric, PFK electronics and SVA electronic.

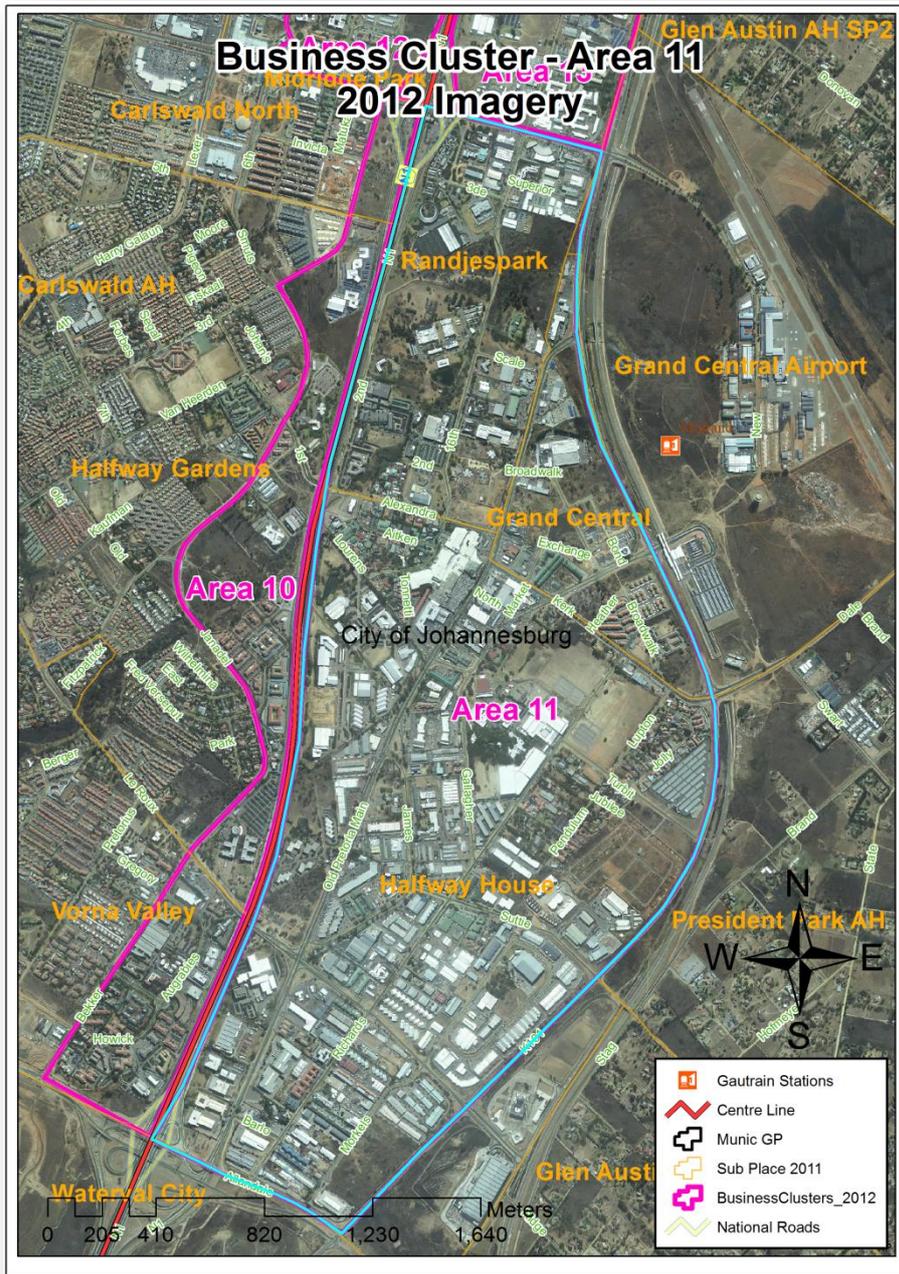


Figure 15 Business cluster Area 11 (2012 Imagery)

Area 11 on the eastern side of the N1 witnesses a display of mostly light manufacturing, warehousing and head offices (the likes of BMW and Neotell). Huge business parks such as Growth Point adorn the eastern side of the N1 opposite the Riverview and Thornhill office parks, the survey of areas located on the eastern side of the New road off ramp reveals a high agglomeration of

related medical company offices, medical laboratories', cosmetic giant L'O real and pharmaceutical companies. The medical giant Johnson and Johnson have also located in business cluster area 13 and their building is clearly visible from the highway. The area includes a mix of commercial and industrial business parks with huge warehousing displaying bays for receiving and dispatching. High technology companies have also agglomerated in the area with giants such as Pinnacle Africa, Mustek, MTN, Acer, HTC and TomTom all within a close proximity of each other.

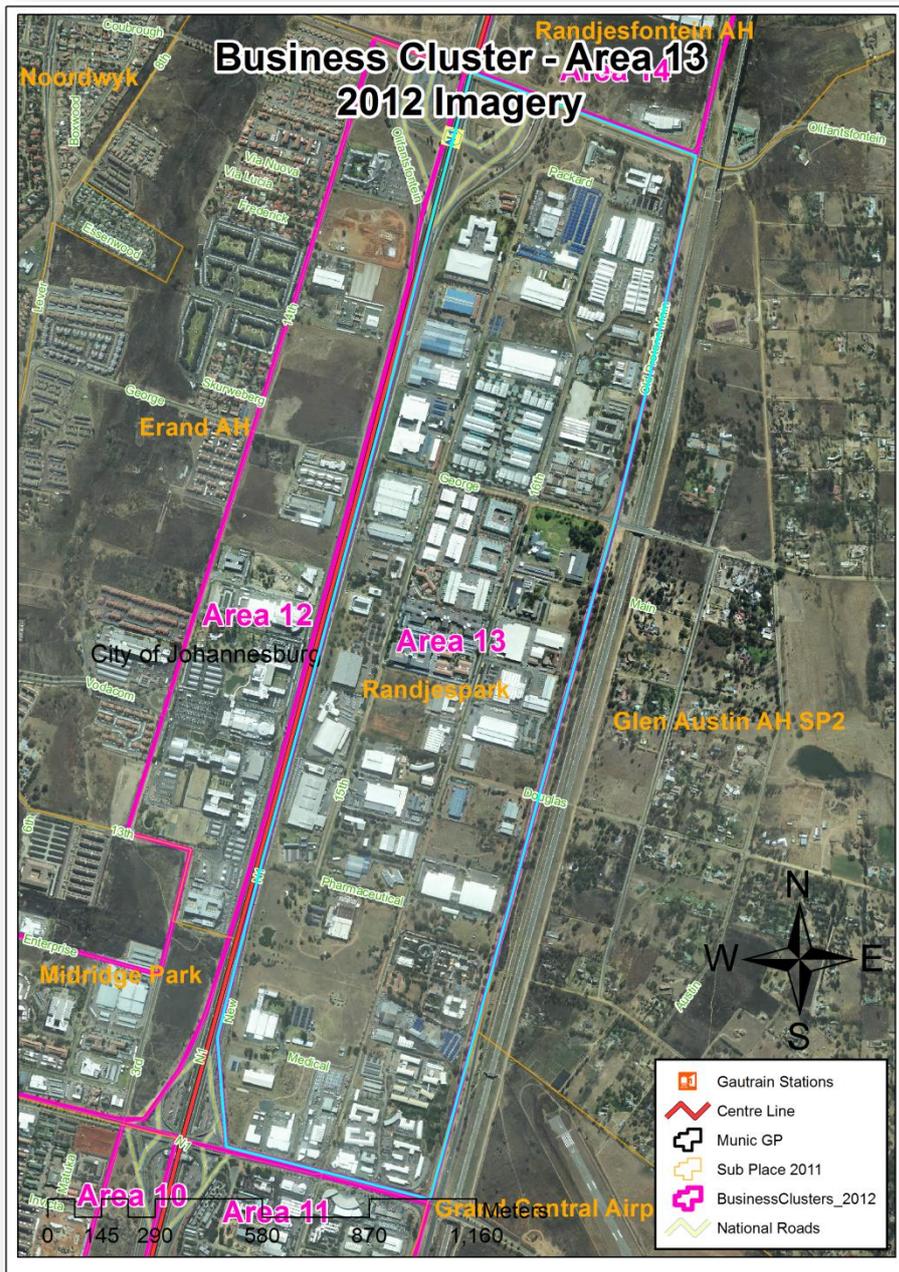


Figure 16 Business cluster Area 13 (2012 Imagery)

Across the highway on the western side immediately opposite Johnson and Johnson is the home of cellular giant Vodacom. The business cluster area 12 has many related technology companies with high clusters of offices and highly clustered sectional title residential buildings. Vodaworld itself

contains sections for business as well as retail shops that are related to their cellular service and bandwidth; these extend to most technology products including vehicle tracking devices.

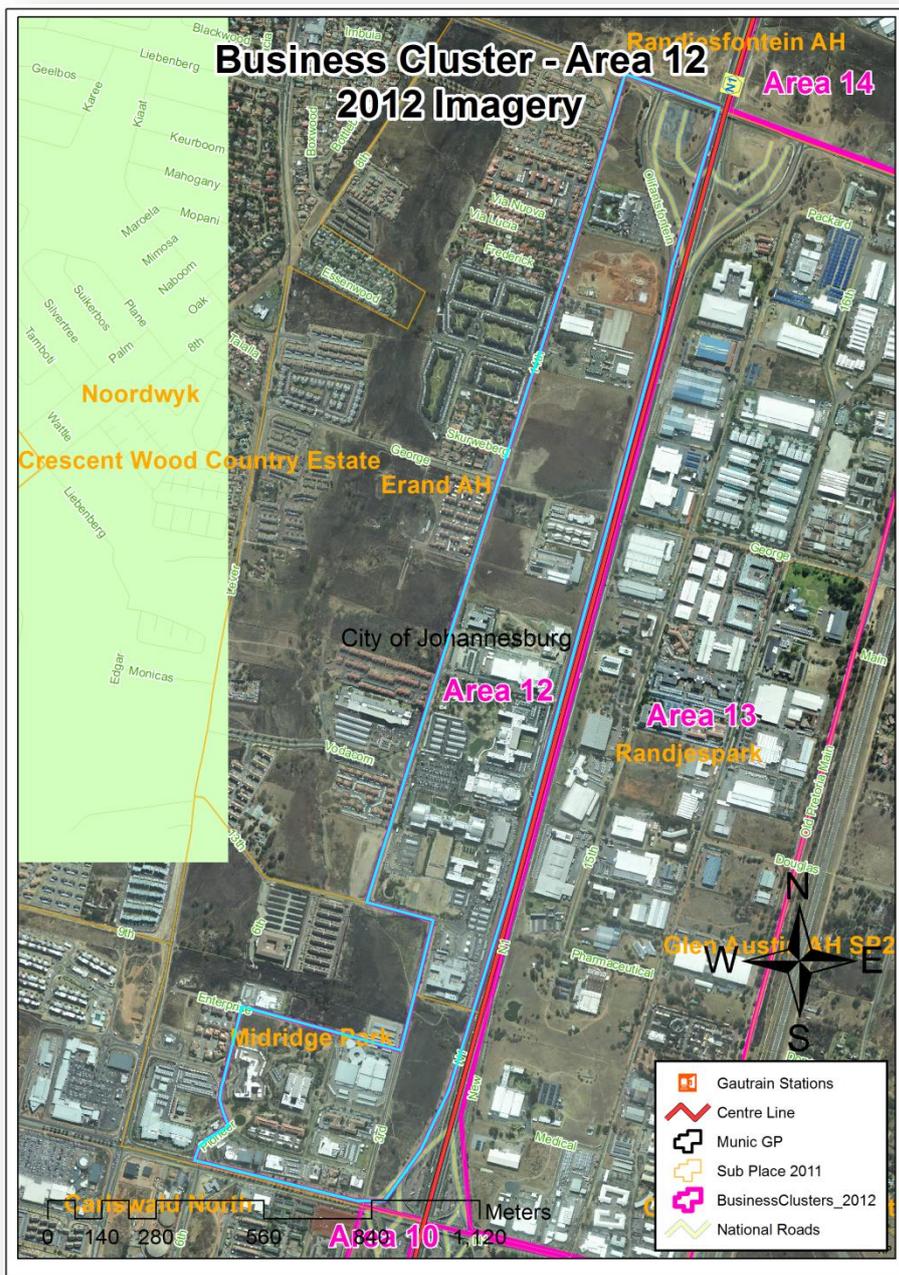


Figure 17 Business cluster Area 12 (2012 Imagery)

Moving North towards the N14 sees the eastern side of the N1 (Area 14) flanked with Midrand North and South Corporate Park and the N1 Business Park within which again is a complete mix of commercial and industrial businesses and offices with mini units, warehousing and light manufacturing being the order of the day.



Figure 18 Business cluster Area 14 (2012 Imagery)

Area 15 near the Samrand off ramp at Yen road sees the up and coming layout of ICT, technology and telecommunication companies filling up and developing the area. Signposts for available Industrial and commercial property stands are up for sale. Names such as Esquire, Datacentrix and Sizwe IT group are settled in and between the developing construction sites for new companies in the business cluster. The area is also home to the N1 Industrial Park located towards the north of the business cluster. An interesting observation that falls out of the scope of this study area are the business clusters near the Samrand off ramp towards N14, there are many different dealers of truck and bus vehicles (MAN, Mercedes, Inveco, etc) that have clustered together on both sides of the N1.

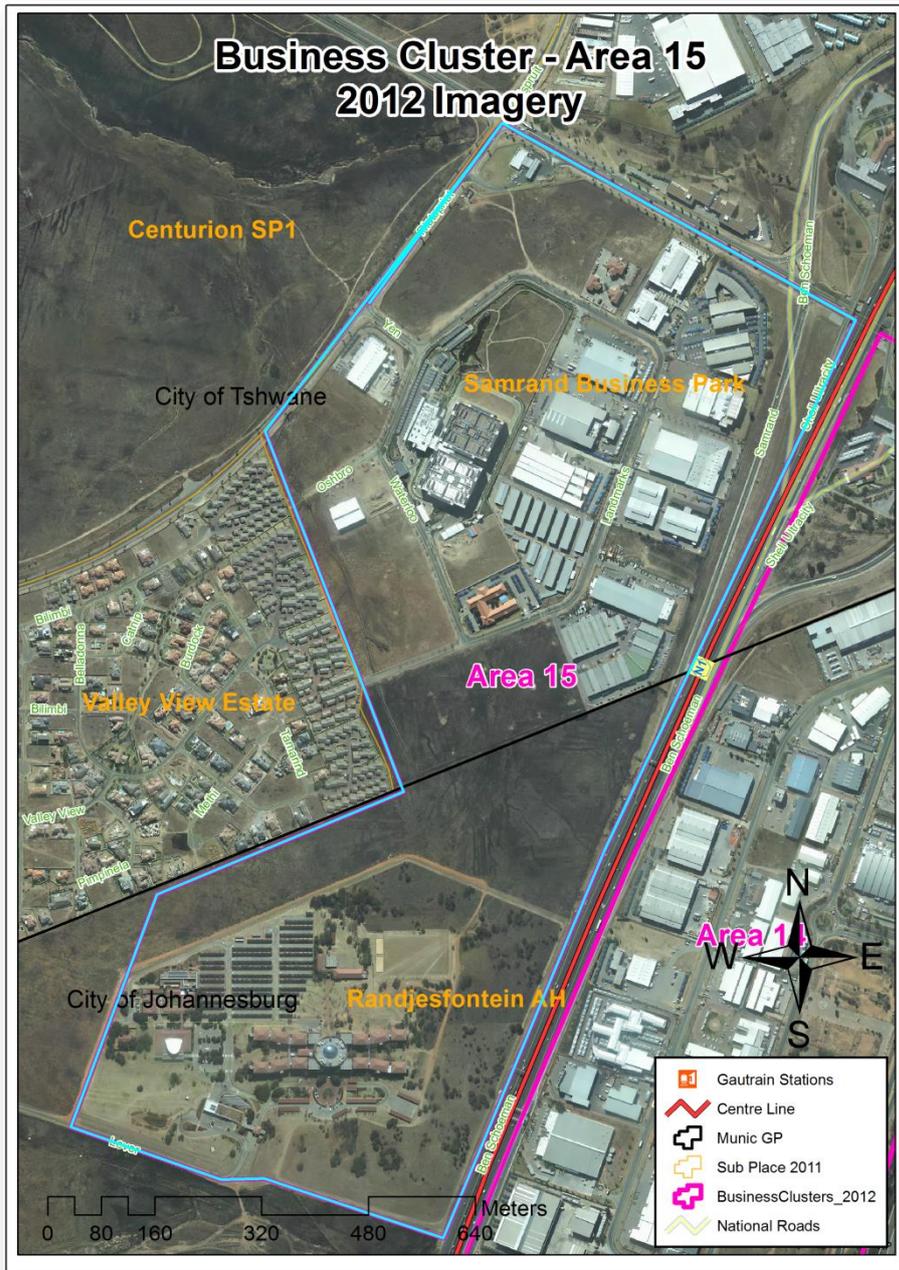


Figure 19 Business cluster Area 15 (2012 Imagery)

6. GIS Analysis Results for the N1-M1-N3

As mentioned earlier the GIS analysis was conducted using different sets of data and different sets of imagery to attain the most accurate account of reality as per the development of the business clusters over 11 years. Extracting the footprints for the years 2001 and 2012 enabled the calculation of the sum of square metres that were utilized by development within each business cluster for the year 2001 and the year 2012. There were some inaccuracies with regards to the building foot prints,

these however were corrected for by comparing the 2 datasets (COJ and Private company), merging them and digitizing new building foot prints using the 2012 imagery.

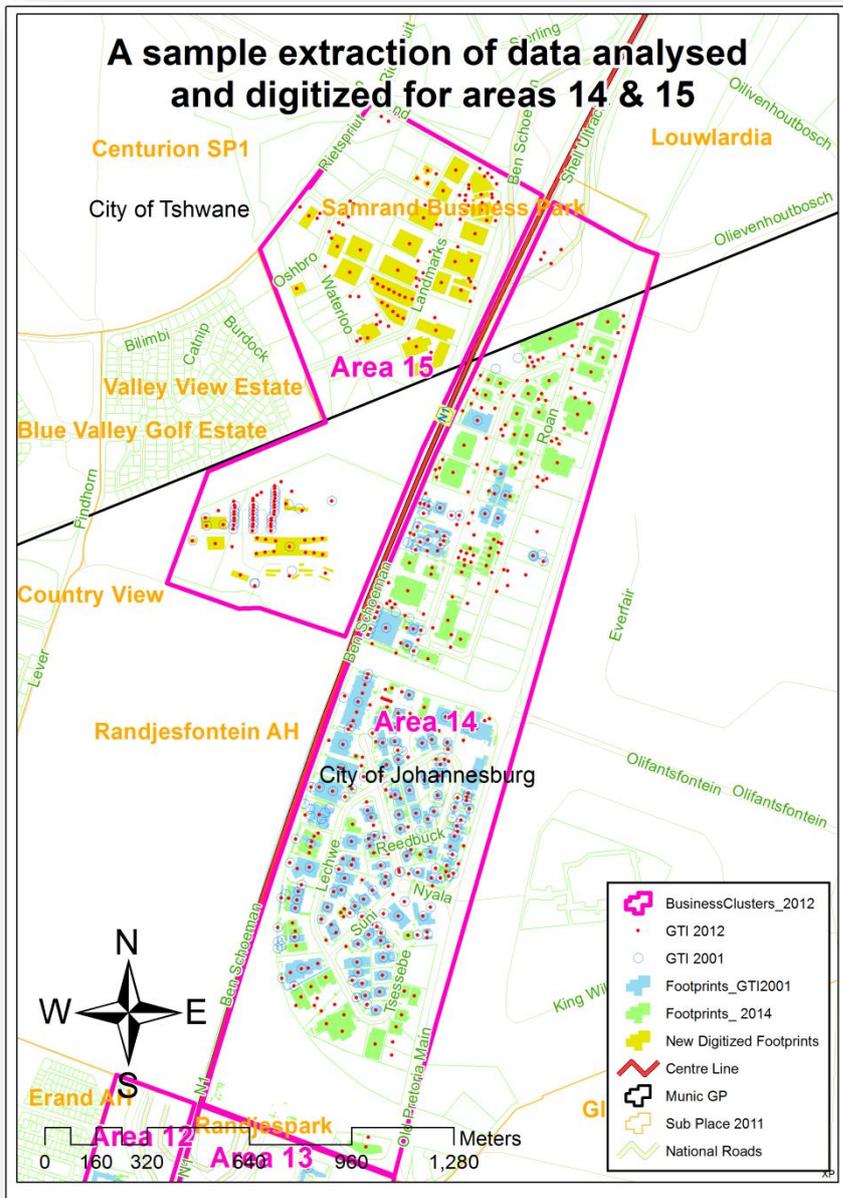


Figure 20 A sample of Foot Print Extraction for 2001 and 2012

Cluster	Count 2001_Ftpts	Count 2012_Ftpts	Total (M ²)-2001	Total (M ²)-2012	ClusterArea_Total (M ²)	2001_Area%	2012_Area%	%_Difference	Dominant_LandUse
1	439	1173	468822.46	581187.23	1544035.3	30.363455	37.640799	7.27734463	Light Industries & Warehousing/Distribution
2	119	365	162711.26	193723.59	1000382.78	16.2649	19.364946	3.10004637	Light Industries & Warehousing/Distribution
3	77	279	91477.63	126846.22	428561.1011	21.345295	29.598165	8.25286987	Light Industries & Warehousing/Distribution
4	22	756	19646.22	581219.48	1960274.513	1.0022178	29.649902	28.6476846	Light Industries & Warehousing/Distribution
5	154	778	198255.94	445238.52	1229910.436	16.119543	36.20089	20.0813468	Light Industries & Warehousing/Distribution
6	16	88	59005.27	130057.26	538015.5769	10.967205	24.173512	13.2063072	Commerce
7		3		364.52	325012.8412	0	0.1121556	0.11215557	
8		5		79.18	217676.4998	0	0.0363751	0.03637508	
9		27		27839.68	224330.1451	0	12.410138	12.4101377	
10	124	556	100669.18	169003.55	1091608.949	9.2220919	15.48206	6.25996792	Commerce
11	589	2612	665007.43	1005373.17	4810493.051	13.824101	20.899587	7.07548554	Commerce
12	35	291	74404.92	136764.88	962506.2357	7.7303312	14.209246	6.47891491	Commerce
13	338	966	376330.47	506962.23	1985111.038	18.957653	25.53823	6.58057698	Light Industries & Warehousing/Distribution
14	154	750	180952.35	354840.57	1644391.679	11.004212	21.578835	10.574623	Light Industries & Warehousing/Distribution
15		43		114978.7	906356.8728	0	12.685809	12.6858088	Commerce

Table 1 Calculation of difference in area development -based on m²

The calculation of the difference in development per square metres clearly shows the degrees of spatial development that has occurred between the years 2001 to 2012. Some areas sustained more development while others remained the same with varying degrees of development. The new areas of development were noticed extending towards the Buccleuch interchange and North along the N1 towards the City of Tshwane.

Aside from the footprint analysis, the aerial photography allowed an excellent visual interpretation of how the business areas have changed from 2003 – 2012.

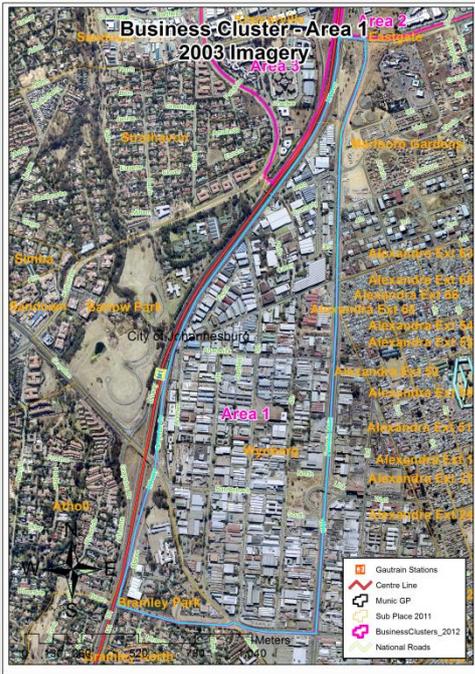


Figure 21 Business Cluster area 1 in 2003 and 2012

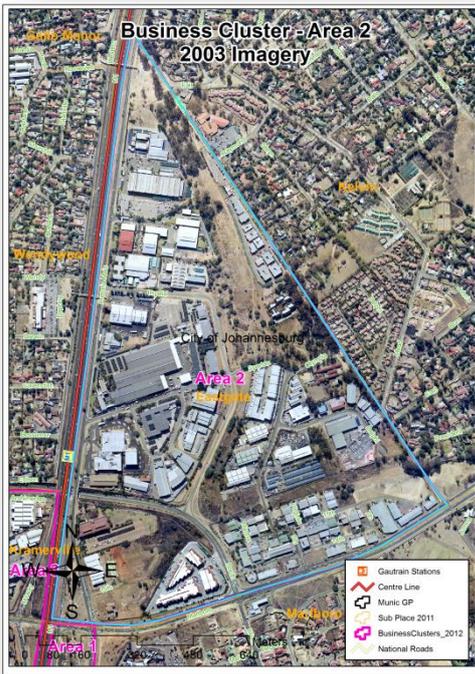


Figure 22 Business Cluster area 2 in 2003 and 2012

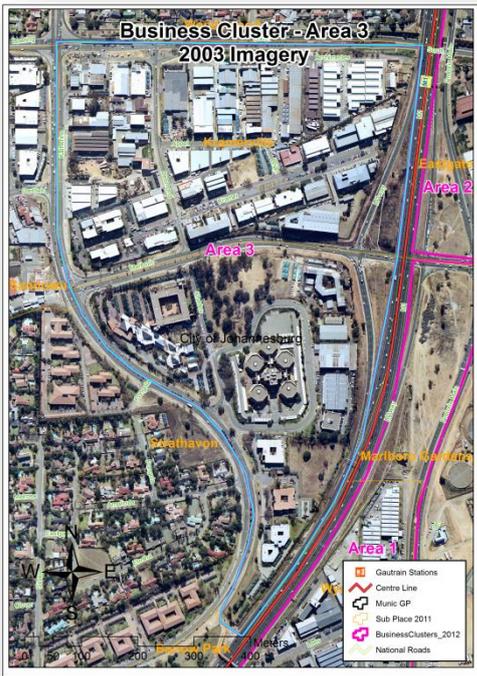


Figure 23 Business Cluster area 3 in 2003 and 2012



Figure 24 Business Cluster area 4 in 2003 and 2012

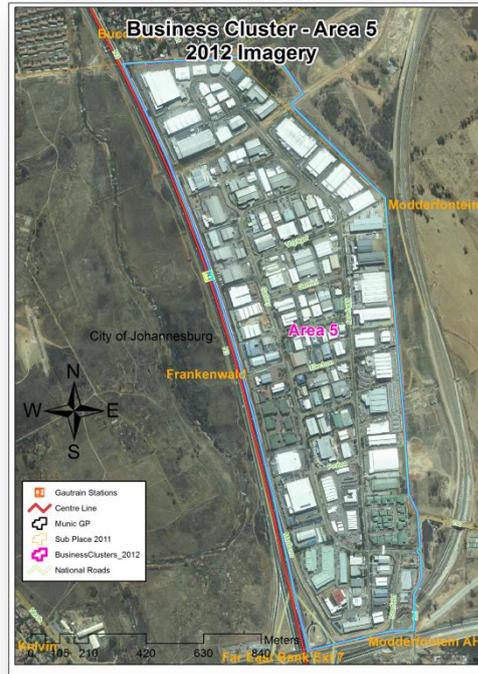
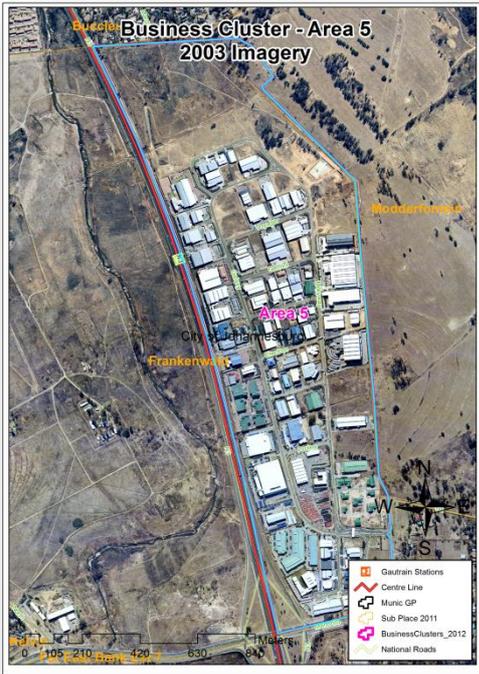


Figure 25 Business Cluster area 5 in 2003 and 2012

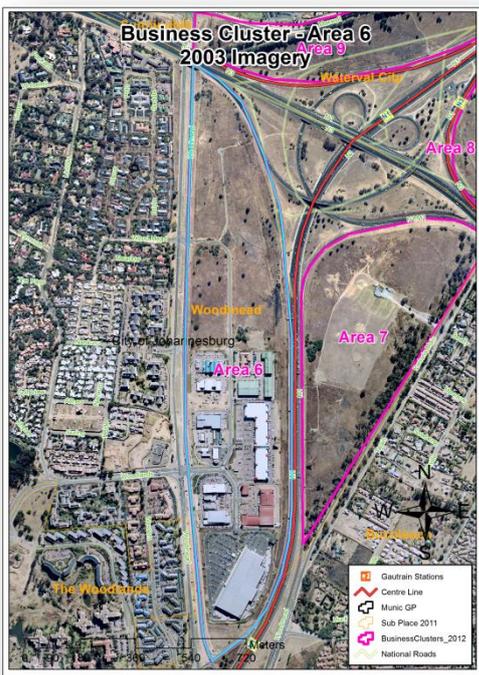


Figure 26 Business Cluster area 6 in 2003 and 2012



Figure 27 Business Cluster area 7 in 2003 and 2012

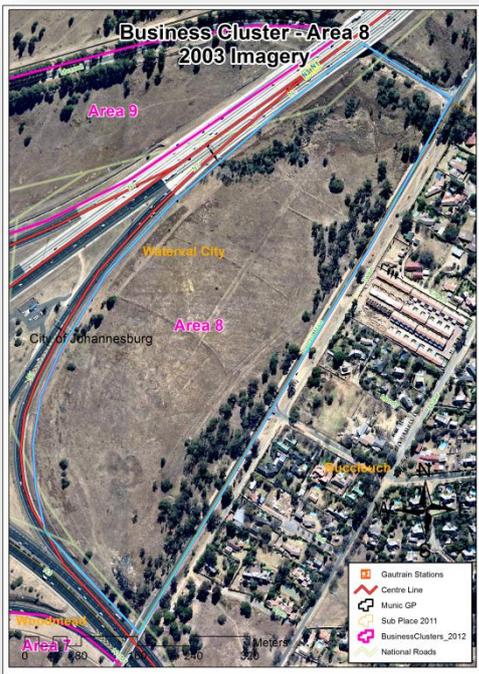


Figure 28 Business Cluster area 8 in 2003 and 2012

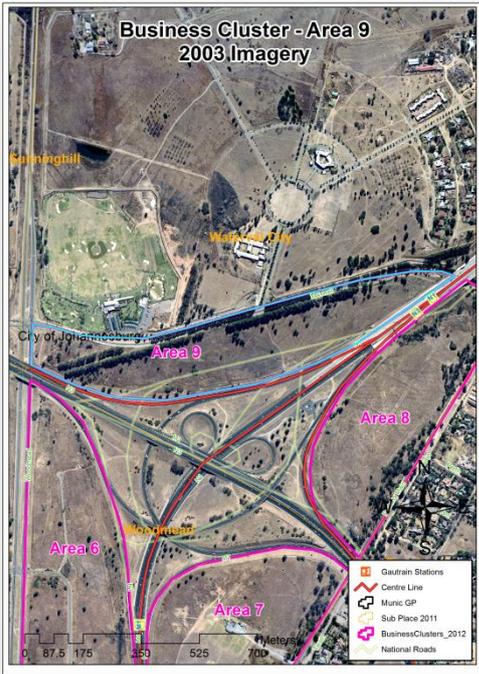


Figure 29 Business Cluster area 9 in 2003 and 2012

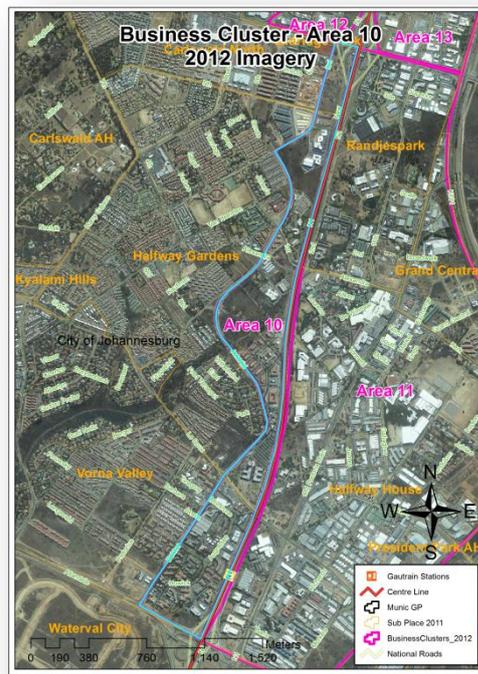
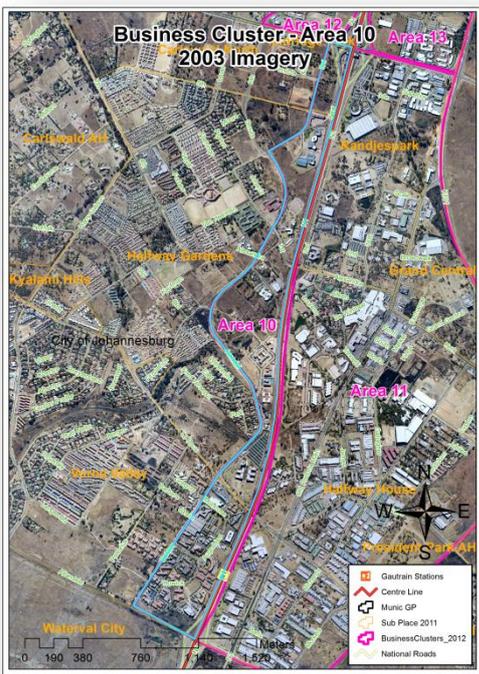


Figure 30 Business Cluster area 10 in 2003 and 2012

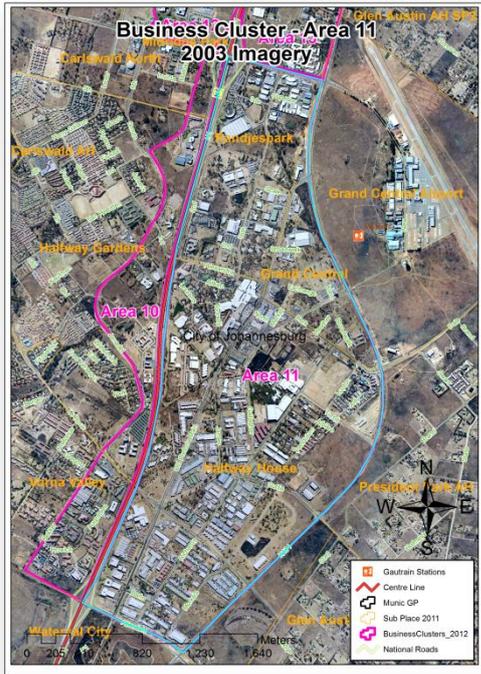


Figure 31 Business Cluster area 11 in 2003 and 2012



Figure 32 Business Cluster area 12 in 2003 and 2012

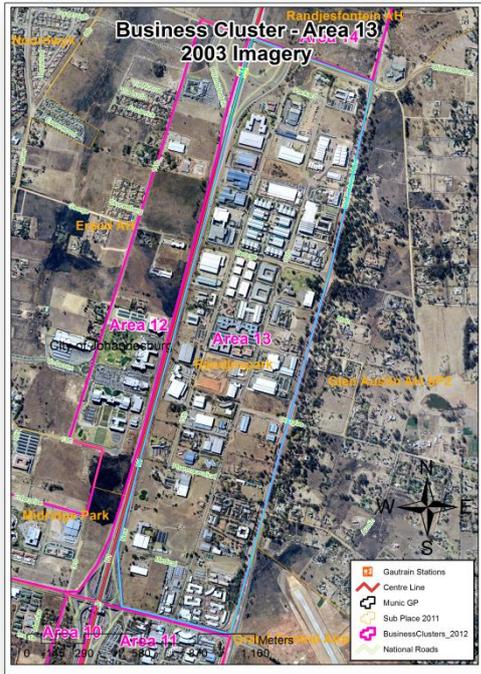


Figure 33 Business Cluster area 13 in 2003 and 2012



Figure 34 Business Cluster area 14 in 2003 and 2012

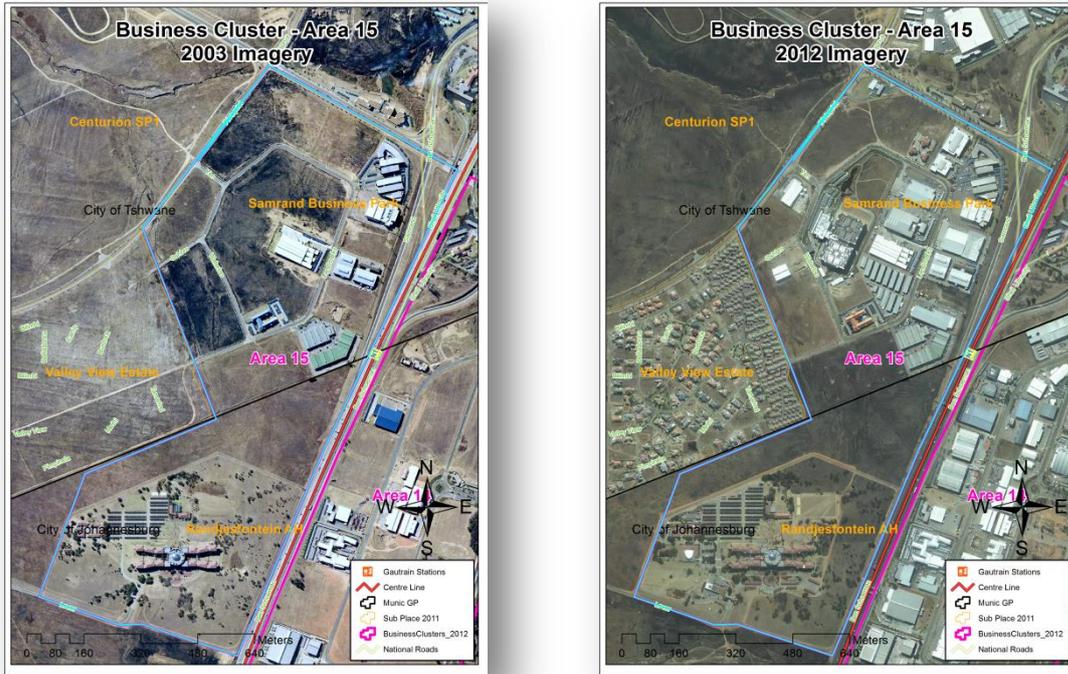


Figure 35 Business Cluster area 15 in 2003 and 2012

GIS analysis was also conducted on the 2001 and 2012 data from Geo Terra Image by spatially joining the data to the fifteen business clusters and calculating which land use increased the most over the 11 years. The results show that in almost every business cluster light manufacturing and commerce developed the most. The data also points to the substantial increase in carports which points to the large numbers of people that work in the area travelling by car.

Business Cluster Area	Land Use Description	GTI 2001	GTI 2012	Highway
1	Accommodation	1	2	M1
1	Car Ports	35	47	M1
1	Commerce	10	12	M1
1	Government	1	1	M1
1	Light Industries & Warehousing/Distribution	430	456	M1
1	Open Parking	14	23	M1
1	Other Schoos	9	10	M1
1	Parks	1	1	M1

Business Cluster Area	Land Use Description	GTI 2001	GTI 2012	Highway
1	Petrol Station, Service Station	4	4	M1
1	Sports Facilities	3	3	M1
1	Terminals	1	2	M1
1 Total		509	561	
2	Access Control	3	3	M1
2	Car Ports	49	64	M1
2	Commerce	24	28	M1
2	Light Industries & Warehousing/Distribution	101	119	M1
2	Office Parks	3	3	M1
2	Open Parking	9	11	M1
2	Petrol Station, Service Station	1	1	M1
2	Police	4	4	M1
2 Total		194	233	
3	Access Control	2	3	M1
3	Car Ports	22	32	M1
3	Commerce	13	11	M1
3	Light Industries & Warehousing/Distribution	58	68	M1
3	Office Parks	3	3	M1
3	Open Parking	4	4	M1
3	Petrol Station, Service Station	1	1	M1
3 Total		103	122	
4	Car Ports	8	132	N3
4	Commerce	2	1	N3
4	Light Industries & Warehousing/Distribution	9	175	N3
4	Primary School	8	8	N3
4	Sports Facilities	3	4	N3
4 Total		30	320	

Business Cluster Area	Land Use Description	GTI 2001	GTI 2012	Highway
5	Access Control	1	1	N3
5	Car Ports	103	196	N3
5	Light Industries & Warehousing/Distribution	97	212	N3
5	Office Parks	1	1	N3
5	Open Parking	14	25	N3
5	Petrol Station, Service Station	1	1	N3
5 Total		217	436	
6	Car Ports	4	2	M1
6	Commerce	13	20	M1
6	Open Parking	9	16	M1
6	Petrol Station, Service Station	1	1	M1
6	Shopping Centre	1	4	M1
6 Total		28	43	
7	Post & Telecommunications	1	1	N1
7 Total		1	1	
10	Access Control	4	5	N1
10	Accommodation	2	3	N1
10	Car Ports	81	189	N1
10	Commerce	51	72	N1
10	Office Parks	4	6	N1
10	Open Parking	8	15	N1
10	Petrol Station, Service Station	1	1	N1
10	Tertiary Education Institutions	2	4	N1
10 Total		153	295	
11	Access Control	33	57	N1
11	Accommodation	1	2	N1
11	Car Ports	243	341	N1

Business Cluster Area	Land Use Description	GTI 2001	GTI 2012	Highway
11	Commerce	385	501	N1
11	Community Facilities	2	1	N1
11	Energy Production & Distribution	1	1	N1
11	Health Care - Other Facilities	2	1	N1
11	Hospitals & Clinics	1	1	N1
11	Light Industries & Warehousing/Distribution	23	85	N1
11	Office Parks	37	37	N1
11	Open Parking	53	32	N1
11	Other Education Institutions	4	4	N1
11	Petrol Station, Service Station	10	11	N1
11	Places of Worship	8	4	N1
11	Shopping Centre	5	2	N1
11	Terminals	1	1	N1
11 Total		809	1081	
12	Access Control	3	7	N1
12	Accommodation	1	1	N1
12	Car Ports	40	134	N1
12	Commerce	19	49	N1
12	Office Parks	2	4	N1
12	Open Parking	3	13	N1
12	Sports Facilities	5	2	N1
12 Total		73	210	
13	Access Control	6	17	N1
13	Accommodation	1	1	N1
13	Car Ports	198	253	N1
13	Commerce	89	85	N1
13	Government	2	2	N1

Business Cluster Area	Land Use Description	GTI 2001	GTI 2012	Highway
13	Light Industries & Warehousing/Distribution	91	106	N1
13	Office Parks	10	8	N1
13	Open Parking	9	9	N1
13 Total		406	481	
14	Access Control	1	22	N1
14	Car Ports	74	141	N1
14	Commerce	10	15	N1
14	Light Industries & Warehousing/Distribution	91	181	N1
14	Office Parks	2	1	N1
14	Open Parking	7	29	N1
14	Water Storage & Sewerage Treatment plants	3	2	N1
14 Total		188	391	
15	Access Control	1	2	N1
15	Car Ports	29	84	N1
15	Commerce	7	43	N1
15	Open Parking	1	9	N1
15	Sports Facilities	1	1	N1
15 Total		39	139	
Grand Total		2750	4313	

Table 2 Sample of results showing the land use differences between 2001 and 2012

The results also show significant increases in development on the N1 and N3. Spatial Statistical Analysis was conducted using Geo Terra Image data for the years 2001 and 2012. A distributional directional analysis tool was used to measure the geographic distribution of the data. The tool also known as the standard deviational ellipse creates an ellipse around the distribution of the data. The results show how development according to the 2012 GTI non residential data has moved northwards on the N1 towards The City of Tshwane and eastward along the N3 compared to how the GTI data was distributed in 2001. This reaffirms what was established in the aerial photography and the foot print development analysis that is that business development has intensified greatly on the N1 and N3 corridor.

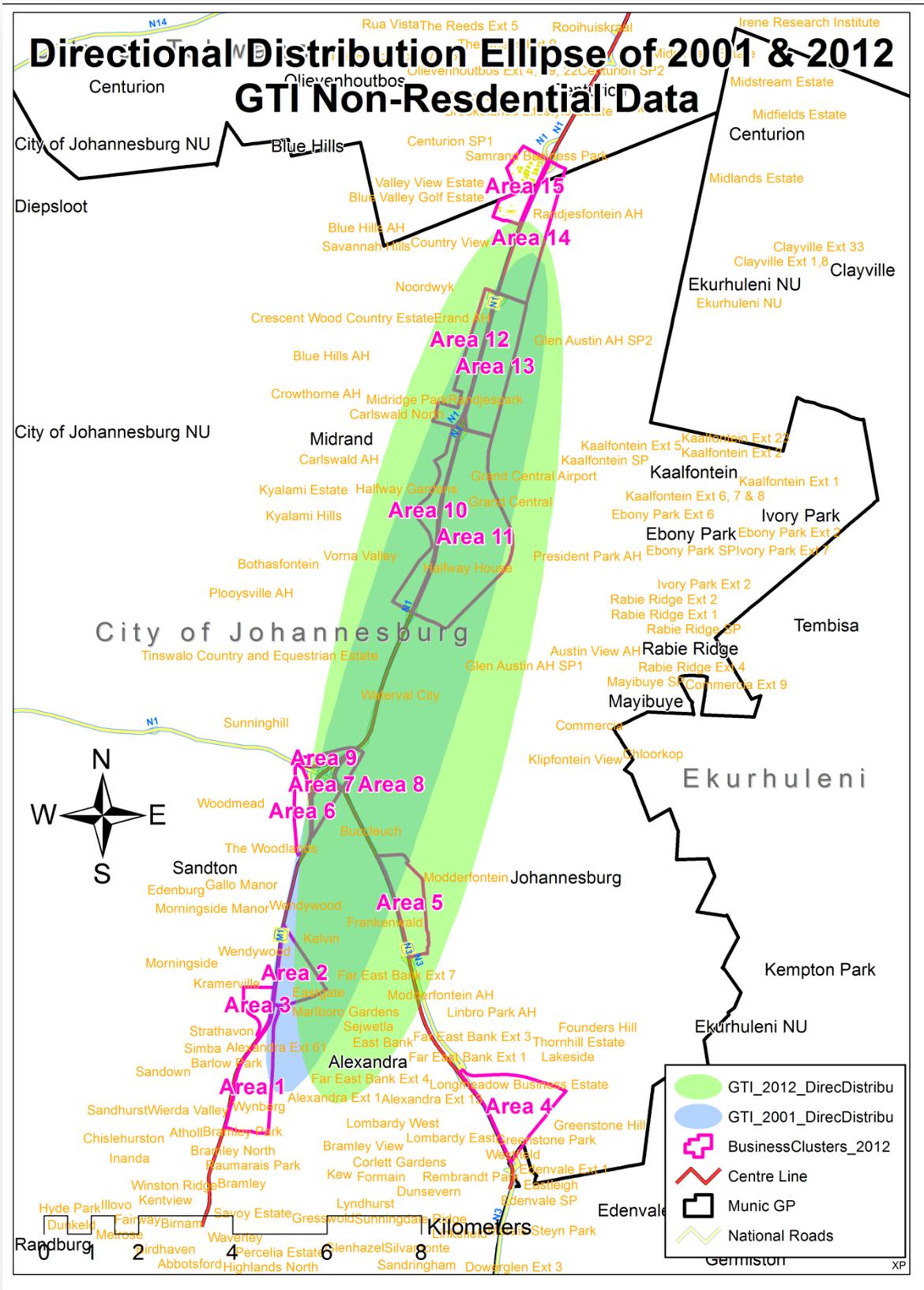


Figure 36 Geographic distributions of Non Residential GTI data for 2001 & 2012

7. Conclusions

In this paper an attempt has been made to identify kinds of businesses that tend to cluster along the N1-M1-N3 corridors of northern Johannesburg. The study is based on 15 business clusters along the three sections of the motorways. The GIS analysis shows that substantial new development has occurred in Northern Johannesburg along the corridors between the city cores of City of Johannesburg and City of Tshwane over the study period. Existing and older business parks have been pushed to capacity which has led to the establishment of new developments along the N1-M1-N3. Greater development can be witnessed along the N1 and N3, probably due to vast tracks of available land so close to the highways. The nodes or business clusters along the highway are in fact thriving areas of economic potential growing daily. This is due the great significance that the highways play in their existence, either via greater accessibility, highway visibility or brand exposure.

The analysis has proven that the M1-N1 is a mature corridor that is in some parts fully developed and the route from Grayston off-ramp on the M1 towards Samrand Avenue on the N1 could be regarded as a continuation of the same corridor. The N3, although growing, has not developed as much along the entire length of the corridor. This is evident in the large tracks of vacant land along its sides. The business parks however have developed substantially. It will of course be a mistake to underestimate the importance of the N3, because as an extension of the N1 and M1, it plays a highly significant role in the development of both in northern Johannesburg.

With reference to the literature on corridors covered in this paper, it is clear that the parts of the M1, N1 and N3 that were studied in this paper are in fact a maturing corridor linking different nodes of economic activity. Nodes on the corridors include the financial hub of Sandton City, the industrial hub of Ekurhuleni, the airport, as well as the legislative capital of Pretoria and, in the heart of Gauteng, Johannesburg city. Perhaps referring to it as a forked corridor fragmented by clusters of residential activity, commercial and industrial development, vacant land and mining activity may be a better way to describe the development corridors of northern Johannesburg.

Of course an important aspect of business clustering could also be due to the policy implications of the City of Johannesburg in directing certain types of industry away from the city centre and towards different areas along the highways. Not only does this promote movement away from the city centre, it also enables the multidirectional flow of traffic making better use of the highways. An analysis of the latest zoning data proved that aside from a few business clusters, the majority of the business clusters along the highways were settled on land zoned as "Special." The establishment of the commercial and industrial business parks along the highways have also provided a greater attraction to the areas with business and corporate parks offering fully catered mini units and offices for small business, as well as light manufacturing and warehousing for distribution and logistics of bigger business enterprises. The business and corporate parks also offer substantial security access and control, an attribute welcomed by any sensible business owner.

The GIS analysis shows that Pretoria Main Road served as the initial corridor of development with many businesses locating along it. It also has many good examples of how business have established due to the principles of new economic geography. The development of the N1 has seen the movement of new business and business parks settling along the sides of the highways. Location, centrality and accessibility are great contributors to offices, light manufacturing, warehousing and distribution activities being located along these routes.

This project has succeeded in fulfilling the aims and objectives that were set in the beginning. Business clusters were identified along the N1-M1-N3. The literature on economic theory has also provided an applicable explanation as to why similar businesses tend to cluster together along the highways. Many businesses have agglomerated together in line with the principles of New Economic Geography.

The N1-M1-N3 seems to be a maturing corridor fragmented by clusters of residential activity, commercial and industrial development, vacant land and mining activity. The three highways form a forked or connected corridor of growing economic activity linking bustling nodes of development. The M1 from Grayston headed along Samrand on the N1 may be considered as part of the same mature corridor, fragmented in areas due to vacant land, residential property and mining activity.

The limitations to this study stem from the limited supply of datasets available on the businesses in Johannesburg. As mentioned earlier there were some inaccuracies with regards to the building foot prints, these however were corrected for by comparing the two datasets, merging them and digitizing new building foot prints. The time frame of this project did not allow for a detailed or holistic study of business clustering and a further detailed study is encouraged and should provide interesting economic and corridor results for Gauteng. These results may also be used in conjunction with outlier and cluster analysis to provide additional findings along the routes.

A further corridor study at higher levels of spatial inclusion of Gauteng could also be used to link the phenomenon with network theory and provide greater insight into how the different nodes of economic activity function. This would definitely lead to better planning for infrastructure and economic development of different communities and economic hubs within the province.

8. Bibliography

- Ascani, A., Crescenzi, R. & Lammarino, S., 2012. *New Economic Geography and Economic Integration: A Review*. [Online] Department of Geography and Environment Available at: <http://www.ub.edu/searchproject/wp-content/uploads/2012/02/WP-1.2.pdf> [Accessed 18 July 2014].
- Blanco, H., 2014. Range of Contemporary Urban Patterns and Processes. *Strungmann Forum Reports*, 14.
- Borchert, J., 1998. Spatial dynamics of spatial structure and the venerable retail hierarchy. *GeoJournal*, 45.
- Brown, S., 1989. Retailing: Critical Concepts. *Journal of Retailing*, 65(4), pp.450-70.
- Dixon, P.M., 2002. Ripley's K function. *Encyclopedia of Environmetrics*, 3, pp.1796–803.
- Donaldson, R., 2006. Mass rapid rail development in South Africa's metropolitan core: Towards a new urban form? *Land Use Policy*, (23), pp.344-52.
- Engel, J.S. & del-Palacio, I., 2009. Global networks of clusters of innovation: Accelerating the innovation process. *Business Horizons*, pp.493-503.
- Ewing, R., Pendall, R. & Chen, D., 2002. Measuring Sprawl and Its Transportation Impacts. *Transportation Research Record 1831: Rutgers University*.
- Fujita, M. & Krugman, P., 2004. The new economic geography: Past, present and the future. *Regional Science*, 83, pp.139-64.
- Geyer, H.S., 1988. The terminology, definition and classification of development axes. *The South African Geographer*, 16(1/2), pp.113-29.
- Giuliani, D., Dickson, M.M. & Espa, G., 2009. *Measuring micro-level spatial clustering of firms while controlling for latent spatial heterogeneity*. [Online] [Accessed 20 July 2014].
- Guy, C., 1998. Classifications of retail stores and shopping centres: Some methodological issues. *GeoJournal*, 45.
- Harrison, P., Todes, A. & Watson, V., 2008. Transforming South Africa's cities: Prospects for the economic development of urban townships. *Development Southern Africa*, 14(1), pp.43-60.
- Henrickson, K.E., 2012. Spatial Competition and Strategic Firm Relocation. *Economic Enquiry*, 50(2), pp.364-79.
- Hong, J., 2007. Location Determinants and Patterns of Foreign Logistics Services in Shanghai, China. *The Service Industries Journal*, 27(4), pp.339-54.

- Krugell, W. & Rankin, N., 2012. Agglomeration and Firm-Level Efficiency in South Africa. *Urban Forum*, 23, pp.299-318.
- Monseny, J.J., Lopez, R.M. & Marsal, E.V., 2010. *What underlies localization and urbanization economies? Evidence from the location of new firms*. [Online] University of Barcelona Available at: <http://ssrn.com/abstract=2062229> [Accessed 18 July 2014].
- Mubiwa, B. & Annegarn, H., 2013. *Historical Spatial Change in the Gauteng City-Region*. Occasional Paper. Johannesburg: Gauteng City Region Observatory University of Johannesburg.
- Mulligan, G.F., Partridge, M.D. & Carruthers, J.I., 2012. Central place theory and its reemergence in regional science. *Annual Regional Science*, 48, pp.405-31.
- Pacione, M., 2009. *Urban Geography, A Global Perspective*. 3rd ed. Routledge.
- Parr, J.B., 2002. Agglomeration economies: ambiguities and confusions. *Environment and Planning*, 34, pp.717-31.
- Philbrick, A.K., 1957. Principles of areal functional organization in regional human geography. *Economic Geography*, 34(4), pp.299-336.
- Ridley, D.B., n.d. *faculty.fuqua.duke.edu*. [Online] Available at: <https://faculty.fuqua.duke.edu/~dbr1/research/Hotellings-Law.pdf> [Accessed 13/07/14 July 2014].
- Rodrigue, J.-P., 2014. *Transport and Spatial Organisation*. [Online] Dept. of Global Studies & Geography, Hofstra University, New York, USA Available at: <https://people.hofstra.edu/geotrans/eng/ch2en/conc2en/ch2c3en.html> [Accessed 14 July 2014].
- Rogerson, C.M., 1998. High Technology clusters and infrastructure development: international and South African experiences. *Development of Southern Africa*, 15(5), pp.875-905.
- Rogerson, C.M., 2010. Growing the SMME Manufacturing Economy of South Africa: Evidence from Gauteng Province. *Journal of Contemporary African Studies*, 19(2), pp.267-91.
- Scott, A.J., 1982. Locational Patterns and Dynamics of Industrial Activity in the Modern Metropolis. *Urban Studies*, 19(111).
- Torrens, P.M., 2008. A Toolkit for Measuring Sprawl. *Applied Spatial Analysis*, 1, pp.5-36.
- Verbeek, T., Boussauw, K. & Pisman, A., 2014. Presence and trends of linear sprawl: Explaining ribbon development in the North of Belgium. *Landscape and Urban Planning*, 128, pp.48-59.

Wallsten, S.J., 2000. An empirical test of geographic knowledge spillovers using geographic information systems and firm level data. *Regional Science and Urban Economics*, 31, pp.571-99.

|