

# **Using GIS to evaluate the impact of the built environment on health in “Brown’s Farm” Philippi**

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## DECLARATION

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## ABSTRACT

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This thesis uses a spatial epidemiology approach to investigate clusters of diseases across formal and informal built environments in “Brown’s Farm” Philippi.

Health data were analysed using cluster detection methods in geographic information systems to identify diseases hotspots. The identified clusters were then examined against environmental, spatial, and socio-economic variables. Data from the Desmond Tutu HIV/AIDS Foundation database, census and questionnaires were used.

Even though most of the disease clusters were found in the informal part of the study area, the data showed very limited variation in the distribution of diseases clusters across the study area.

**Keywords:** spatial; disease distributions; spatial epidemiology; built environment; geographic information systems

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# CHAPTER 1 – INTRODUCTION

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This chapter outlines the motivation that necessitated this research.

## 1.1 Background and Motivation

Diseases are often caused by bacteria, viruses and toxic substances, whereas the contracting and transmission of these disease-inducing agents is mostly due to people's built environments and social norms. Therefore, built environment and public health have been inextricably linked for centuries (Rao *et al.* 2007).

Built environment has been broadly defined as man-made or at least man-modified physical structures and spaces that provide the setting and backdrop by which human beings live (Srinivasan *et al.* 2003). These structures include; transportation systems, open spaces and buildings e.g. schools, houses, roads and parks. Other scholars have defined the built environment in terms of the infrastructure, stating that the built environment also constitutes basic services that are needed to keep societies functional (Jackson & Kochtitzky 2010). These services include provision of drinking water mains, sewage systems, streets lighting, communications facilities, etc.

The significant impact that built environment has on public health became apparent in Europe and North America in the 19<sup>th</sup> century, during the industrial revolution (Smith 2002; Barrett 2000; Brody *et al.* 2000; Brown & Moon 2004). During this time infectious diseases were the primary public health threat due to overcrowded urban environments and unsanitary conditions (Northridge *et al.* 2003b).

By the mid-20<sup>th</sup> century comprehensive city built environment planning had come into effect in most of the global north cities (Rao *et al.* 2007). Adequate sanitation systems that safely transported sewage outside city boundaries were implemented. Also, zoning policies that separated neighbourhoods for residential, industrial and business spaces were put in place. These efforts effectively brought infectious disease epidemics under control (Wendy *et al.* 2003). In the 21<sup>st</sup> century there remains an important connection between public health and the built environment in

global northern cities. However, the current diseases of concern are lifestyle diseases or chronic diseases e.g. diabetes, hypertension, obesity and cancer, and injuries (Lozano *et al.* 2012; Walker 2013).

Likewise, the global south has not been immune to this epidemiological transition. However, besides the adoption of liberal economic and political models, industrialization, rapid rural-urban migration, advances in infrastructure and medical technology, the burden of disease has doubled in the developing world. This is because, in developing countries, the current epidemiological transition to chronic disease transpires alongside an ongoing battle against HIV/AIDS pandemic, malaria, Tuberculosis (TB), SARS and recent to the list, Ebola (Lozano *et al.* 2012; Campbell & Campbell 2007; Thomas *et al.* 2002; Coovadia *et al.* 2009; Chopra & Sanders 2009).

### **1.1.1 Built Environment Factors and Health in the 21st Century**

Risk factors for diabetes, hypertension and obesity are generally perceived to be the following;

- Unhealthy diet,
- Lack of physical activity,
- Alcohol and tobacco abuse (WHO 2010).

These risk factors are attributable to built environment factors such as land use choices, housing conditions and population density (Feng *et al.* 2010; Obermeyer *et al.* 2008). Empirical evidence has shown that high density, poor housing conditions and household crowding increase the risk of TB transmission (Baker *et al.* 2008; Johnstone-Robertson *et al.* 2011; Hargreaves 2011). In South Africa high HIV/AIDS prevalence has been found in over-crowded, poor housing and settlement conditions with inadequate services (Development Works 2005).

A study that examined the effects of adverse housing and neighbourhood conditions on the development of diabetes mellitus at St. Louis area, Missouri showed that poor housing conditions were an independent and major contributor to the risk of incidence of diabetes among middle-aged African Americans (Schootman *et al.* 2007). Also, literature has pointed to the fact that a cold, damp, poorly constructed

house is related to high risk of cardiovascular diseases, respiratory diseases, depression and anxiety (Matte & Jacobs 2000).

Literature shows that the following built environment factors can prevent high prevalence of obesity and overweight by encouraging physical activity:

- Neighbourhoods with cycling tracks, sidewalks, streetlights, no crime, easy access to recreational facilities, easy access to healthy food facilities, parks
- Schools with playgrounds
- Well-connected street network that reduce travel time from place to place
- No sprawling (Lopez & Hynes 2006; Ziraba *et al.* 2009; Feng *et al.* 2010; Booth *et al.* 2005).

Also, people are said to be more likely to consume goods that are easily accessible to them in terms of proximity and affordability. For instance a study that evaluated the association between proximity to and coverage of traditional fast-food restaurants and fast-food consumption among rural adults showed that increased age, poverty, increased distance to the nearest fast-food restaurant were associated with less frequent weekly consumption of fast-food meals (Sharkey *et al.* 2011). Also increased number of restaurants within a five-minute walk of a person's house is associated with an increased Body Mass Index (BMI), *ceteris paribus*, and that women who reside within relative proximity to supermarkets and grocery stores unlike to convenience stores and fast food outlets tend to have lower BMIs (Raja *et al.* 2010).

### **1.1.2 Motivation of the study**

An appropriate, well-structured built environment cannot be seen as a luxury, but rather an important determinant of healthy and thriving communities. Therefore, it is of fundamental importance to understand the local dynamics of the correlation between health and the built environment. More so in the global south where urban planning and policies are still at infant stage.

The complex dynamics of cities in developing countries, with their concentration of the poorest and most vulnerable housed within informal settlements pose a critical

challenge not only to the land managers but to public health community as well. Informal Settlements (internationally referred to as Slums or Shack towns) are highly densely populated communities housed in self-constructed shelters made from diverse materials, sometimes under conditions of informal land tenure (Barry 1999; Barry & Rütther 2005). These settlements usually lack proper outdoor and indoor infrastructures such as roads, streets, and sanitation.

Informal settlements constitute large and continuously growing percentage of the cities' population in low and middle income countries (Abbott 2000; Abbott 2001). During 2005, it was estimated that of the 43 million South African population, 8.5 million were still living in informal settlements (Rodrigues *et al.* 2006). From 1993 to 2005, informal settlements and informal settlements dwellings (shacks) increased from approximately 50 to 200 and 28 300 to 98 031 respectively in Cape Town (Rodrigues *et al.* 2006). The biggest share of the burden of diseases in South Africa has been found in these communities (Bradshaw *et al.* 2003). Characterised by poverty, poor housing conditions, high population density and inadequate services, the built environment within the informal settlements is one of the primary factors escalating the residents' vulnerability and susceptibility to contracting and transmitting diseases (McMichael 2000).

Upgrading of the infrastructure within informal communities is an inevitable response to epidemiological and socio-economic challenges brought about by rapid urbanization. However, the impact of these interventions on community health is not well understood. Therefore it is against this background that the African Centre for Cities (ACC) through the Healthy City Lab (of which this study is part) has undertaken a multidisciplinary research programme whose objectives are;

- To contribute towards a better and more holistic understanding of the relationship between the urban environment and health in Cape Town and other cities of the global South,
- And to contribute towards urban planning policy and practice that facilitates the creation of healthy urban environments (ACC 2009).

## **1.2 Research question**

Positioned as a response to the call for more interdisciplinary research by the ACC's Healthy City Lab, this dissertation seeks to answer the question: is there a link between the spatial distribution of diseases and the built environment within Philippi "Brown's Farm" settlement? Empirical evidence, as reviewed above, cumulatively provides significant insight into these relationships. However, as already alluded to, so far, there exists only limited literature on spatial epidemiology in Southern Africa, with a focus on the impact of the built environment.

## **1.3 Objective**

- To use GIS to establish and map the spatial distribution of diabetes, hypertension, obesity, TB and HIV/AIDS in "Brown's Farm" Philippi, Cape Town.

## **1.4 Research Hypothesis**

At the outset of this investigation, the initial hypothesis is that the disease profiles of "Brown's Farm" Philippi is influenced by the built environment factors of where people reside.

## **1.5 Scope of the study**

This study uses spatial statistics in a Geographical Information Systems (GIS) to investigate the spatial distribution of HIV/AIDS, TB, Diabetes, Obesity and Hypertension and to evaluate how these distributions vary across formal and informal built environments in "Brown's Farm" Philippi.

## **1.6 Study Limitations**

Efforts made to get access to clinic data indicating individuals disease status proofed unsuccessful. Hence the study relied on incident data of 162 study participants who agreed to get tested for HIV/AIDS, TB, Diabetes, Hypertension and obesity and have their results used for the purposes of this study (see chapter 4, section 4.2.2 for details). For reasons explained in chapters 4 and 5 the sample data acquired for the

health data was insufficient to effectively represent the diseases distribution with the study area but rather focussed on validating the analytical methodology than providing substantive conclusions to the initial study objectives.

## **1.7 Thesis Outline**

The second chapter of this dissertation provides a scoping review of the literature on disease spatial distribution analysis techniques. Chapter three outlines an overview of the study areas' ("Brown's Farm" Philippi) built environment status quo. This outline incorporates an evaluation of the study site layout and infrastructural design. The forth chapter encompasses a presentation on data acquisition and preparation, and the methods followed in data analysis. A presentation of the study results are found in chapter five. The sixth chapter comprises of the study results discussions and interpretation. References and appendices are found at the end of the dissertation.

## CHAPTER 2 – LITERATURE REVIEW

---

### 2.1 Introduction

Post the apartheid regime, South Africa has transitioned into one of the most urbanised countries in sub-Saharan Africa, the largest and most industrialised economy in Africa, and the 28th-largest economy in the world (Collinson *et al.* 2007). Nearly two-thirds (62 per cent) of its total population of 48 million people live in urban areas (Binns & Nel 1999). By 2033, South Africa is expected to have nearly three-quarters of its population living in urban areas (Collinson *et al.* 2007). The rapid urbanisation has put an alarming pressure on the natural and physical environments of South African cities. Calling upon comprehensive urban planning and policies to ensure that South African cities sustainably expand into health driven physical structures that comfortably house the rapidly growing population.

Historically, urban environmental planning and policies have always been driven by public health concerns (Williams & Wright 2007; Wendy *et al.* 2003; Northridge *et al.* 2003a; Rao *et al.* 2007). However, despite the overwhelming evidence (even though mostly from the global north) on the link between the built environment and health (outlined in chapter one) the orchestration of the joint urban planning and public health frameworks in developing countries is still limited to addressing issues of toxic exposure, traffic engineering, sanitation, zoning etc (Smit *et al.* 2011; Northridge & Sclar 2003). Urban planning and design policies are still at infant stage in South Africa and Africa as a whole (Frank & Kavage 2008). Hence it is an opportune time for an improved research on the link between the built environment and health for policy guidance.

### 2.2 The global burden of diseases

Two decades ago, the global health concern was mostly centred on starvation, malnutrition and the shortening life expectancy. Since then, the human health story has drastically evolved; now people have too much to eat that they are getting obese and sick (Mathers & Loncar, 2006). Even in developing countries where child malnourishment has remained a serious concern, there has been an improvement

as global child malnutrition decreased from 24% to 16% by 2010 (Lozano *et al.* 2012).

In 2010, there were 52.8 million deaths globally (Campbell & Campbell 2007). The pre-transitional causes (infectious, maternal, neonatal, and nutritional diseases) accounted for 24.9% of the deaths in 2010, down from 34.1% of 1990 (Groenewald *et al.* 2008; Lozano *et al.* 2012). The life expectancy has increased by 12 years for women and 11 years for men (Lozano *et al.*, 2012). However, people are unable to enjoy living longer as a result of an increase in the Years Lived with Disability (YLDs) due to chronic diseases.

Deaths due to chronic diseases increased by 8 million between 1990 and 2010 (Mathers & Loncar 2006). Chronic diseases were responsible for 2/3 of deaths globally in 2010 (Lozano *et al.*, 2012). Almost 80 per cent of global deaths due to chronic diseases occurred in low and middle income countries (WHO, 2010a). Despite this global health transition, South Africa continues to experience a "quadruple burden of disease" due to HIV/AIDS, poverty, the emerging chronic diseases and injury and the ever resilient pre-transitional diseases (Bradshaw *et al.* 2003).

### **2.3 Foundations and current developments of Spatial Epidemiology**

The use of mapping and spatial analysis techniques to describe and analyse geographic variations on geographically indexed health data relative to demographic, environmental, behavioural, socioeconomic and genetic risk factors has been defined as spatial epidemiology (Elliott & Wartenberg 2004). The documented history of spatial epidemiology dates as early as the writing of the Hippocrates in the 15th century BC (Brown & Moon 2004). Re-emerging in the 18th century when in 1792 the German Physician Leonhard Ludwig Finke produced a world map of diseases to geographically classify indigenous diseases relative to the prevailing physical, social, and cultural features of the surrounding environments (Barrett 2000). In 1796, the Physician Valentine Seaman used a spot map together with climatic and topographic characteristic of the lower East Side of New York to observe the diffusion patterns of yellow fever (Berke 2005). At Central London, in 1854, Dr John Snow identified a

water pump as the source of a cholera outbreak by plotting the location of cholera deaths on a dot-map (see figure.2.1 below). The map demonstrates the relative distribution of cholera deaths (indicated by the small black bars) arranged around a locationally fixed point being the water pump.

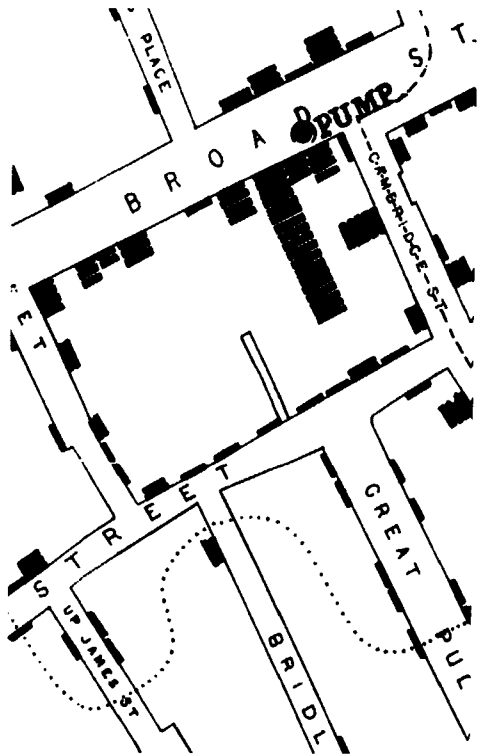


Figure 2.1: Snow's map of cholera deaths in the Broad Street area (Brody et al. 2000)

Dr John Snow's work has been praised as heroic on account of achieving four critical things in research;

- He made and proofed a hypothesis with evidence that changed scientific opinion to fact.
- He innovatively used spatial-analysis devices to improve the then body of knowledge on the cause of cholera by proofing that the pump was the source of the local epidemic.
- His work was able to guide public health policy and decision making.
- He made the foundational discovery of cholera transmission as being waterborne instead of airborne as many had thought (Mcleod 2000).

It is hence popularly believed that this particular work by Dr John Snow was the foundation of spatial epidemiological analysis techniques (Smith 2002).

Evaluating techniques implemented by Dr Snow on his work on cholera, one learns that Snow did not achieve this breakthrough by exclusively using the dot-map in figure 1 above. Instead, it was through a combination of literature, laboratory skills, medical acumen, deductive reasoning and acquired knowledge of the built environment within the study area. Also, through the qualitative data collected through door-to-door surveys and of course the dot-map that he was able to combine spatial information regarding the water supplier and cholera incidence to identify an association. The identified association led to the closing of the Broad Street pump and consequential decline of cholera in London (Brody *et al.* 2000). The combination of both qualitative and quantitative methods is increasingly valued by many in the field as a robust alternative approach to spatial epidemiology (Walker 2013).

The approach taken in this thesis also pursues a broader viewpoint to spatial epidemiology. This thesis makes use of GIS computational power and algorithmic ability to conduct spatial analysis as well as its visualisation abilities to explore the spatial data. Also used are some qualitative modes of knowledge (surveys, expert knowledge captured from the existing literature and prior knowledge of the study area's built environment).

## **2.4 GIS and spatial epidemiology**

Over a century since John Snow's discovery, spatial epidemiology tools have greatly advanced due to improved access to health data and advancement in technology. Collaboration between public health, spatial epidemiology, spatial statistics and Geographical Information Science has also greatly contributed towards advancing spatial epidemiology analysis tools, creating an emphasis on interdisciplinary collaboration and knowledge translation (Elliott & Wartenberg 2004). A number of tools and methods have been conceived, while some just improved as a result of this collaboration (Gatrell *et al.* 1996; Beale *et al.* 2008). Software tools that integrate specialist statistical methodologies and spatial analysis have been developed for use in spatial epidemiology (Bailey 1996; Rushton 2003; Elliott & Wartenberg 2004; Lentz 2009). Spatial methods commonly employed in epidemiology include proximity analysis, spatial regression methods, interpolation and extrapolation, cluster

detection and analysis (employed in this dissertation) and aggregation methods (Auchincloss *et al.* 2012).

Geographic Information Science (GIS) remains a new frontier and indispensable tool in spatial epidemiologic research. GIS provides powerful quantitative and qualitative spatial analysis techniques and tools to examine geographically indexed health data, identify trends, and create predictive models (Rushton 2003). Spatial statistics or geo-statistics tools in GIS can provide insight into spatial correlation and dependency of diseases with built environment factors.

The spatial statistics tool employed in this thesis (spatial cluster analysis tools), is a commonly used methodology in spatial epidemiology and one that has been greatly enhanced by the collaboration between epidemiology and spatial statistics (Fritz *et al.* 2012; Gatrell *et al.* 1996; Auchincloss *et al.* 2012). Spatial cluster analysis has been defined as the examination or identification of locations with unusually excessive concentrations of events in space and or time (Bailey 1996). There exists numerous spatial cluster analysis methods and tools for every data type, providing researchers with more robust statistical and analytical capabilities (Wheeler 2007). This study makes use of hotspot analysis, cluster and outlier analysis tools in the ArcGIS software to identify, analyse and map diseases hotspots/clusters within the study area. These tools are built on the principle of the nearest neighbour analysis.

## **2.5 Spatial cluster analysis case studies**

As already alluded to, GIS and the associated spatial statistics software tools have immensely contributed to the advancement and efficiency of spatial cluster analysis tools in spatial epidemiology research.

A study whose aim was to determine and map the spatial nature of infant mortality at a sub district level in South Africa in order to identify high risk areas used the Bayesian convolution conditional autoregressive, Moran's I spatial autocorrelation and Kulldorff spatial scan statistic, to indicate that districts in Kwazulu Natal were at high risk of infant mortality (Sartorius *et al.* 2011). Cramb and Mengersen in their study used Bayesian disease mapping to produce a cancer atlas for Queensland Australia. This study concluded that chronic disease atlases are a useful tool for

assessing and quantifying geographical inequalities (Cramb *et al.* 2011). A study that mapped AIDS incidences in Uganda discovered the following spatial distribution of AIDS incidences;

- that the infection was from the urban areas to the rural areas by people working in the cities when they returned home,
- HIV/AIDS was also spread on major transport routes and lastly;
- that the military played a major role in the spread of the virus.

This discovery ultimately led to relevant prevention and impact mitigation programmes (Obbo 1993).

Also, a study that used geo-additive models to assess non-linear spatial variation of HIV infections among women in local communities in Durban, South Africa revealed significant HIV infection distribution patterns that could not be explained by either sexual behaviour or demographics (Wand *et al.* 2011). Spatial density maps created through web-based client application in GIS have been used to detected risk areas with high concentration of TB in Barcelona Spain (Dominkovics *et al.* 2011).

## **2.6 Summary**

The exploratory spatial epidemiology techniques leveraging on the quantitative capabilities of GIS has been an important addition to disease surveillance studies.

## CHAPTER 3 – STUDY AREA DESCRIPTION

---

### 3.1 Introduction

The central quest of this chapter is to provide a contextual description and background of the study area, 'Brown's Farm', Philippi.

### 3.2 The background of 'Brown's Farm' Philippi

The study area for this research, Brown's Farm is a settlement located within one of the largest yet recent townships in Cape Town called Philippi (Statssa 2005). Philippi is situated approximately 20 Kilometres East from the city centre, (see figure 2 below) and has an area of 45 square kilometres (STATSSA 2012). In 2011, Philippi's population was 191 025 people, had a dwelling count of 61 797 households with an average household size of 3.09 (Statssa 2013). Philippi falls under the administration of the municipality of the City of Cape Town.

*Table 3.1 Proportions of dwelling types in Philippi (Statssa 2013).*

Philippi's dwelling type	Number	Percentage
Formal Dwelling	27 002	43.7%
Informal dwelling/shack in backyard	13 841	22.4%
Informal dwelling/shack Not in backyard	20 545	33.2%
Other	412	0.7%
Total	61 800	100.0%

- The population is predominantly Black African (94%).
- 32% of those aged 20 years and older have completed Grade 12 or higher.
- 62% of the labour force (aged 15 to 64) is employed.
- 78% of households have a monthly income of R3 200 or less.
- 44% of households live in formal dwellings.
- 67% of households have access to piped water in their dwelling or inside their yard.



- 77% of households have access to a flush toilet connected to the public sewer system.
- 84% of households have their refuse removed at least once a week.
- 86% of households use electricity for lighting in their dwelling (Statssa 2013).

### Brown's Farm Locality Map

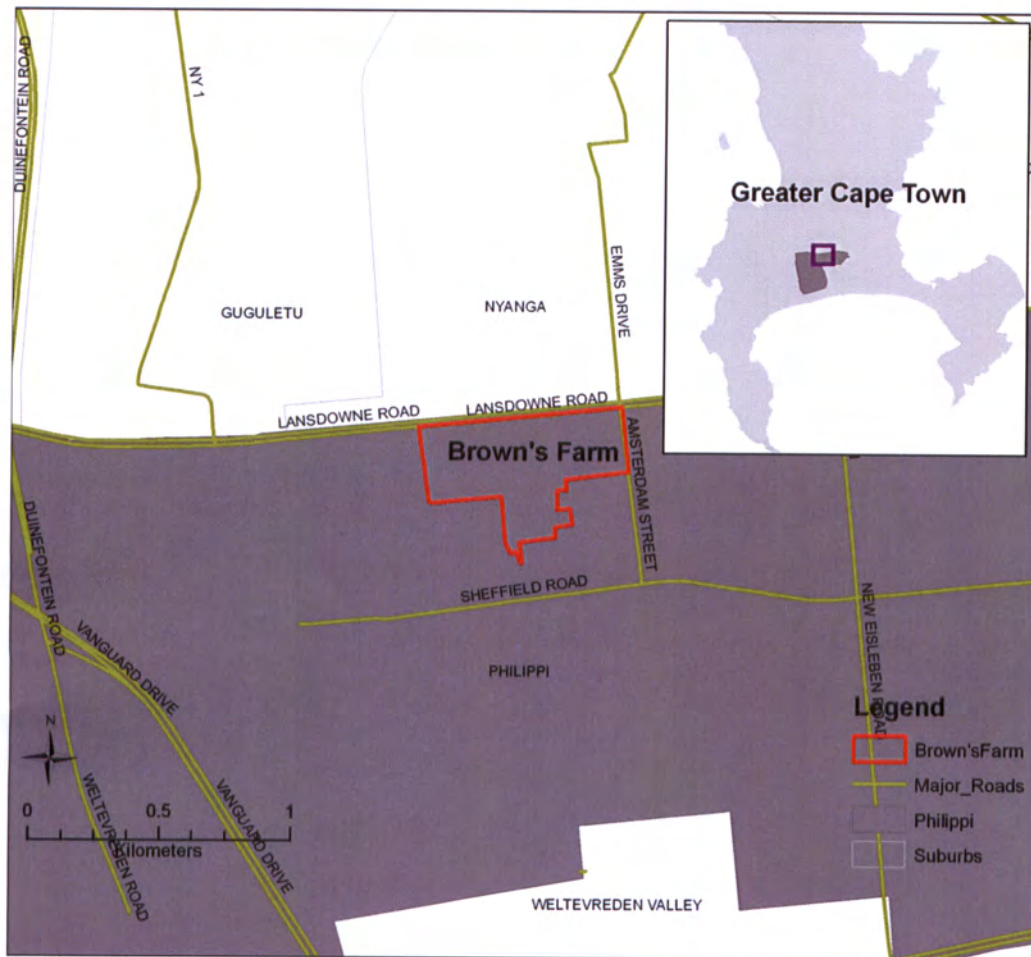


Figure 3.1: Location of Brown's Farm (Source: City of Cape Town, 2009)

Brown's Farm, previously known as Philippi West is about 0.3 square kilometres (based on area measurements made using the city of Cape Town's 2011 aerial imagery) and is predominantly residential with a population of 28 045 people (The City of Cape Town 2010). It lays between Lansdowne and Sheffield roads, (see figure 3.1 above). The dwellings in the area constitutes two main types, informal (73.90%) and the formal (Government subsidised houses popularly known as RDP

houses) (17.10%) (The City of Cape Town 2010). Like any high density, poor settlement in South Africa, Brown's Farm is also highly burdened by disease (Department of Health 2012). The settlement houses predominantly black Xhosa speaking Eastern Cape migrants.

Brown's Farm area was chosen as the study site for the following reason; a number of University of Cape Town (UCT) based researchers have carried out methodologically (expounded in chapter 4) similar research in this area and had already created community based connections that were crucial for the presumed success of the data collection process of the study. Given the exposure that Philippi communities have had to researchers, the author presumed that they would be more sensitized about the community-based benefits of research. And hence would be more accommodating making the community-based data collection process more simplified. It had been previously observed that the data collection processes of similar case studies have been compromised by a lack of direct community networks, case in point, (Musungu 2012) worked in two communities for his case studies: Graveyard Pond (in Philippi) where he had direct access to the community and community leaders, and 'Europe' (near Langa) where he worked through Slum Dwellers International (NGO) and did not have direct access to the community structures. The outcome was that the questionnaire enumeration in Graveyard Pond went smoothly and the collected data made spatial analysis possible whilst the opposite was the case for 'Europe'.

The first phase of Brown's Farm's development took place in 1991 and was earmarked to house the residents of Lusaka, Nyoka and Miller Camp settlements who were fleeing internal conflicts within their settlements (Barry 1999). This development was government driven. The first phase began with the creation of three villages constituting 2314 sites. The size of the sites ranged from 150m<sup>2</sup> (10m x 15m) to 200m<sup>2</sup> (10m x 20m) (Anderson *et al.* 2009; Barry 1999). These sites were serviced with piped water and water-born sewerage, and upon occupation, residents were allocated a flush-toilet (Anderson *et al.* 2009). Individual families would typically build a shack on their sites as they await the construction of their RDP house (Rodrigues *et al.* 2006). The planned gross residential density on these villages was 25 dwelling units per hectare (Barry 1999). Originally, the allocation of sites was to be done using waiting lists submitted by community leaders of Lusaka, Nyoka and

Miller camp. However, due to complexities in the power plays amongst the leadership of these communities, random and unplanned raiding of the villages frustrated this process (Adlard 2008). Since the democratic elections of 1994 more people have continued to move into the settlement, drastically increasing the density within the area.

Figures 3 and 4 below show how the built environment within Brown's Farm changed between the year 2000, 2004, 2006 and 2011. During the year 2000 Brown's Farm's built environment was predominately informal and highly dense with no roads and streets, (see figure 3.2 below). The City of Cape Town 2004 aerial imagery shows that four years later the area was still being structured; streets and roads had been built in some parts of the area, (see figure 3.2 below). A number of shacks had been displaced and cleared in preparation for the construction of RDP houses. However, the invasion by shacks on other parts of the area had also increased exponentially since the year 2000. In 2006, some houses had been completed while some were still under construction, (see figure 3.3 below). The upgrade had expanded to other parts of the area as well. In 2011, only three areas in Brown's Farm had been upgraded as depicted by figure 4 below. However, the upgrade process is still in progress and there are still shacks in this area. The majority of people tend to keep their old shacks as backyard houses, either to rent them out or because the RDP house is too small to accommodate the entire family. Hence, the area remains a high residential density area despite the on-going upgrade process. Also the continuous growth of the number of shacks in the area has perpetuated this problem. These have resulted in the built environment of Brown's Farm being of informal and formal housing, as of 2011.

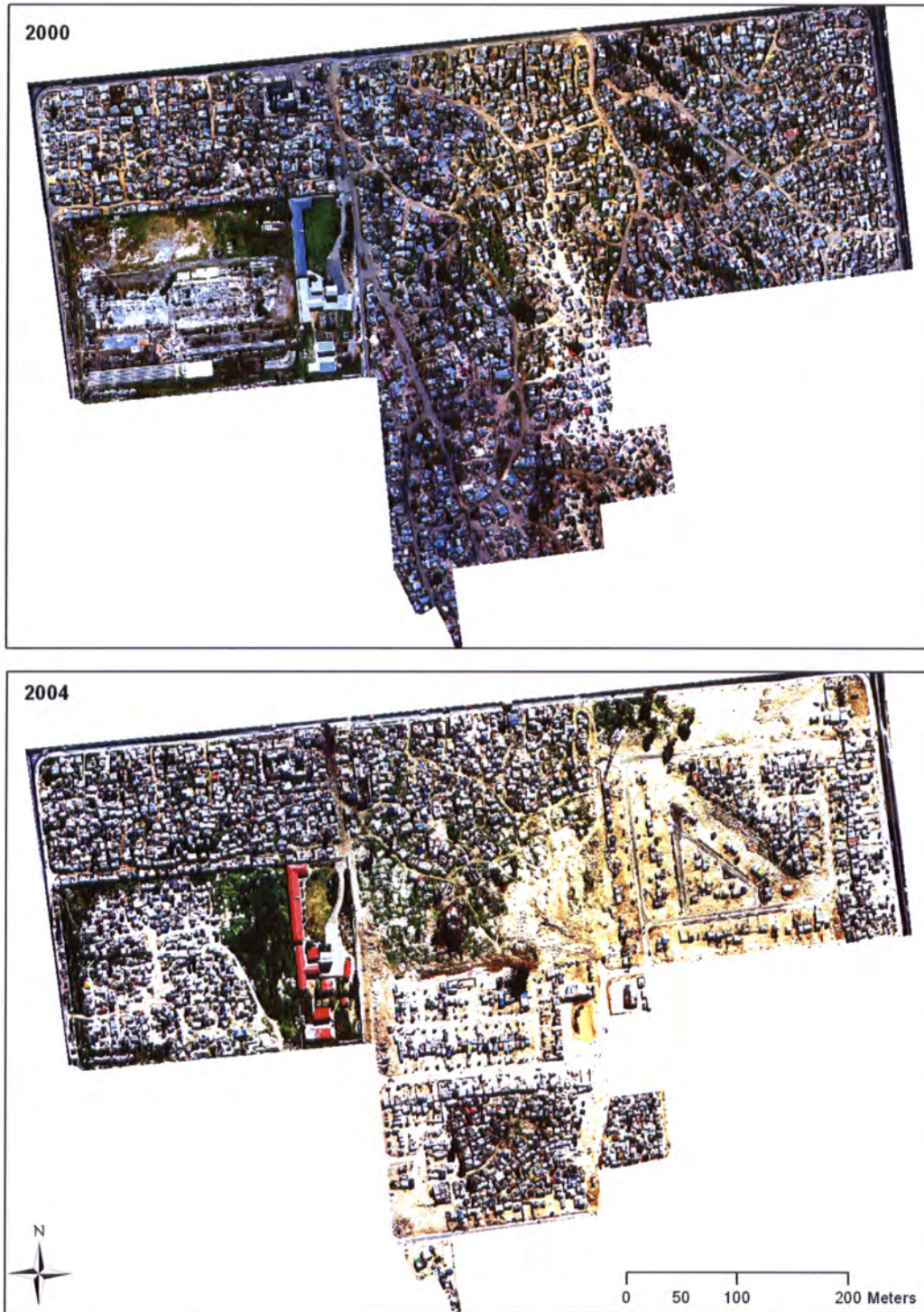


Figure 3.2: Aerial imagery showing the built environment of Brown's Farm during the years 2000 and 2004 (Source: City of Cape Town)

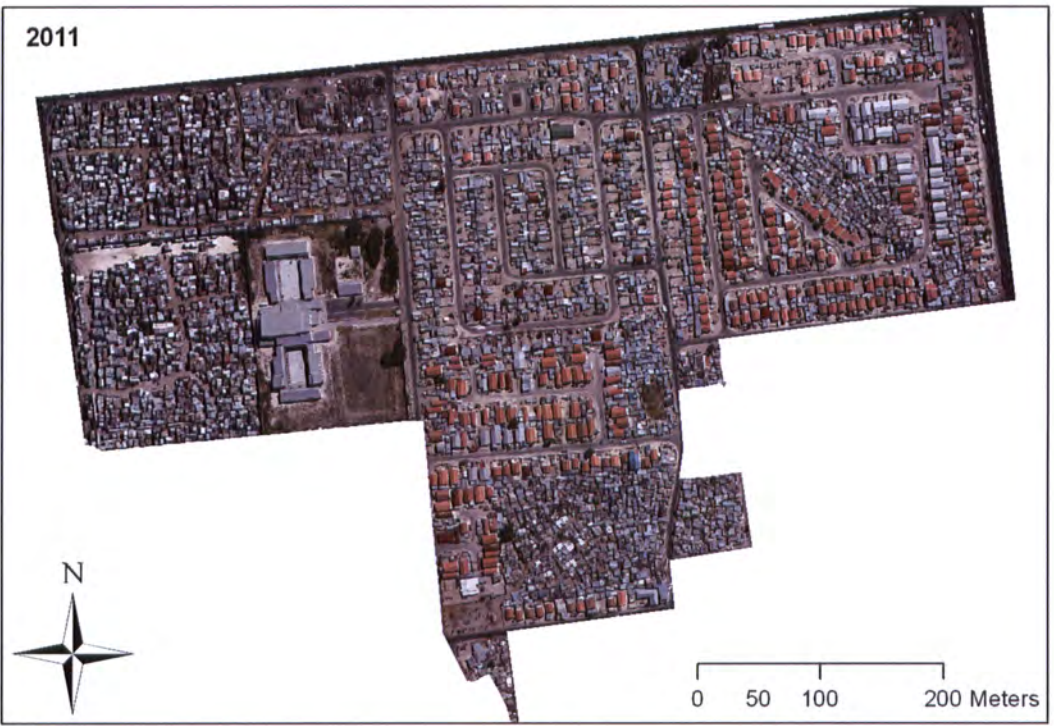
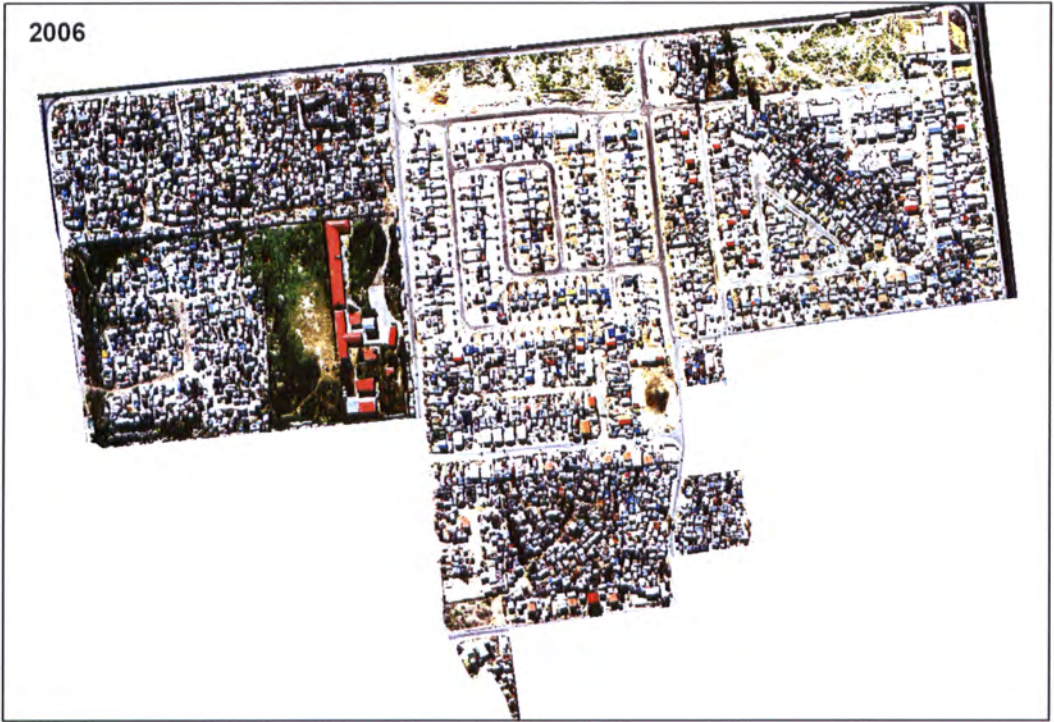


Figure 3.3: Aerial imagery showing the built environment of Brown's Farm during the years 2006 and 2011 (Source: City of Cape Town)

### 3.3 Brown's Farm Built Environment

As already alluded to, distinct variations between the formalised and informal built environments within Brown's Farm are mostly due to dwelling types, the roads, streets and municipal services. However, within the formalised areas, there still exist stand-alone shacks that are serviced with piped water and a flush-toilet whose owners are awaiting the construction of their RDP houses.

Walking through the streets of Brown's Farm is a very challenging task as there exists no foot paths or sidewalks, see figures 3.4 and 3.5. Sidewalks and footpaths used to exist before people extended their yards and built on them. Figure 3.4 shows how yards in the area are extended to cover the entire foot path. Figure 3.5 shows school children walking in the middle of road on their way home from school because shacks occupy most of the sidewalks.



*Figure 3.4: A Street in Brown's Farm, Philippi 2011*



*Figure 3.5: Children on a street in Brown's Farm, Philippi 2011*

### **3.4 Services**

Services are critical to the well-being of a community because where accessibility to services and amenities is improved, the well-being of households/individuals is enhanced and economic and social development is increased, environmental pollution is decreased, and health status is improved.

The formalised part of the area receives municipal services like roads, sidewalks, refuse collection, proper sanitation and streetlights while the informal areas are not properly serviced. While still awaiting the upgrade process, the informal areas are lightly furnished with communal toilets and taps. These facilities are poorly maintained. For instance, figure 3.6 below depicts communal toilets placed within a refuse dumping area in an informal part of the area. Both the dumping area and toilets are also very close to the shacks. Most of the communal taps for drinking water are planted besides public toilets as shown in figure 3.7.



*Figure 3.6: Toilets within Brown's Farm*



*Figure 3.7: Public toilets with taps for drinking water next to them*

Informal settlements residents have to put refuse in a plastic bag and dump it at a designated dumping area from where the municipal truck collects it. While the refuse collection system within the formal settlements involves collection of individual garbage bins from the houses by municipal trucks at specified dates. Figure 3.8 below depicts one of the informal settlements' designated dumping areas. This area is located next to a park used by children from a near-by pre-school.



*Figure 3.8: A designated refuse dumping spot right besides a pre-school park*

### **3.6 Social Facilities**

A three kilometre buffer around Brown's Farm area showed that there exists a sports complex with a swimming pool and gymnastics space less than three kilometres from Brown's Farm, (see figure 3.9 below). There is also a museum; library and soccer pitch nearby. There is one government hospital and eleven clinics located within 3 kilometres of the area, (see figure 3.9 below). The clinics offer free primary health care services. The author made two visits to each of the two clinics closest to the study area, Mzamomhle and Entsebenzisano primary health centres. During these visits the author observed that both centres had long queues of people waiting for services. The author asked two patients from each centre about services rendered and all complained that the centres each has one doctor who works only twice a week, hence the long queues. Some mentioned that they had arrived at the centre at 5 am and were still waiting for services around 3 pm. Nonetheless, both health centres were well finished and had clean and proper waiting areas.



Figure 3.9: A 3km buffer around Brown's Farm shows that there are a few social facilities nearby

### 3.7 Summary

The history of Brown's Farm's development shows that the settlement's built environment was well planned to comfortably house refugees from nearby settlements who were fleeing political instability within their settlements. However, some of the power struggles within these communities were carried over to Brown's Farm and ultimately interfered and frustrated the physical planning of the area as people randomly occupied sites that were tagged for other communities. Hence, the subsequent uncontrolled influx into the settlement exacerbated the increase of shacks on un-serviced land. Two decades after the settlement was created, Brown's Farm's built environment has greatly improved into a semi-formal township that continues to house a poor community that struggles to cope with unemployment, flooding and is greatly vulnerable to diseases.

## CHAPTER 4 – RESEARCH METHODOLOGY

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### 4.1 Introduction

Understanding of ill-health processes as they relate to environmental factors is paramount to retaining fidelity to the core principles of disease prevention and control (Williams & Wright 2007). Spatial epidemiology has been very critical in advancing this understanding by enabling investigation of relationships between the environment and the presence of disease; disease cluster analyses; prediction of disease spread etc (Auchincloss *et al.* 2012). However, spatial epidemiology studies, particularly studies that make use of GIS to understand how the built environment affects and influences health and healthy behaviours are still limited in South Africa. As a case study, this research seeks to evaluate the impact of the built environment on health in “Brown’s Farm” Philippi. This is achieved by using spatial statistics in GIS to determine disease hotspots areas within Brown's Farm. The diseases of interest are; diabetes, hypertension, obesity, HIV/AIDS and TB.

#### 4.1.2 Chapter Overview

This chapter entails details of the methods carried out in the study. The description of the data, its analysis and limitations are also discussed herein.

As already alluded to, the overall aim of this research is to evaluate the impact of the built environment on health with special focus on dwelling type and municipal services. The methodology carried out by the study is summarised in Fig. 11 below.

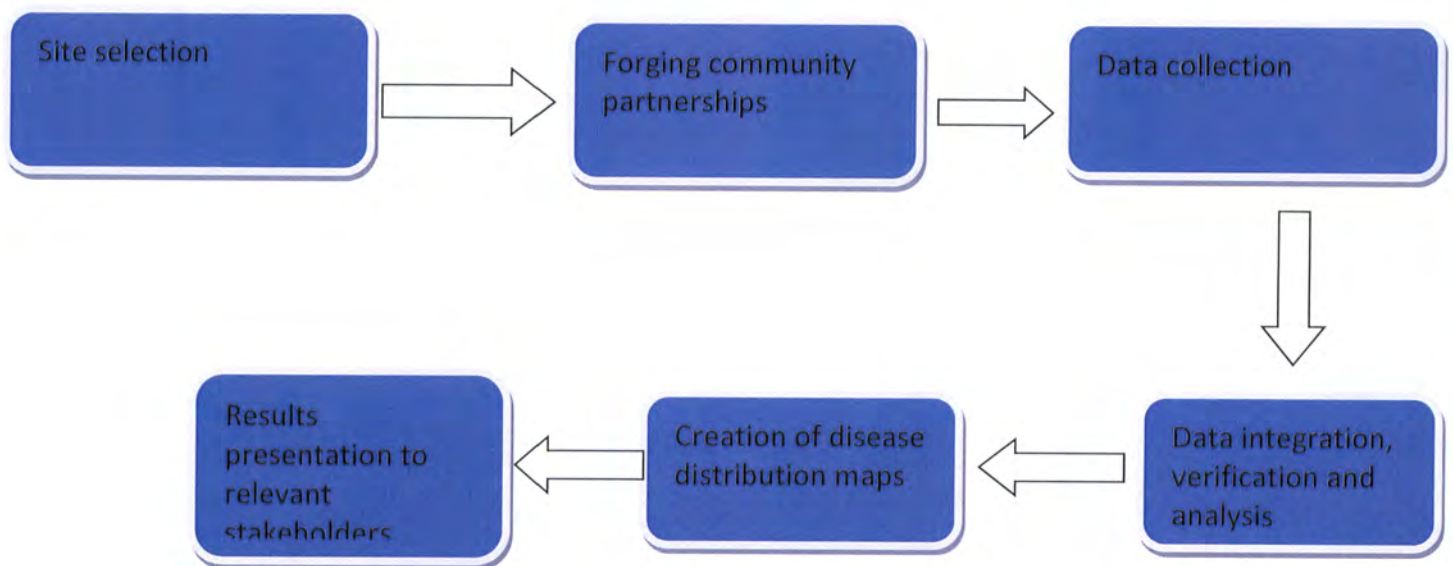


Figure 4.1: A summary of the steps taken to build the methodology followed in the study.

The following sections describe the steps carried out in the research methodology.

#### 4.2 Data Collection methods, Ethics Clearance and author's involvement

After the research design and settings were completed, it became apparent that the project data collection methodology would include human subjects as sources of data. Therefore, ethics approval was sought.

The research proposal, ethics clearance and consent forms were submitted to the Faculty of Engineering and the Built Environment (EBE) ethics committee at the University of Cape Town (UCT) for authorisation. The research was approved on the following conditions:

- To first acquire consent before including each person as a participant in the study
- To ensure that information provided by participants was kept confidential
- To ensure that there exist no conflict of interest and discrimination within the research.

This research project has adhered to the conditions prescribed by the committee.

Once the research proposal was approved and ethics clearance was acquired, the next stage involved data collection.

A combination of methods was utilized to gather the primary data. These included, testing participants for the diseases of interest, survey questionnaires, digitizing of

participants' dwellings and stakeholders correspondences. Additionally, secondary data describing the study area, roads, and social facilities was gathered from various databases. Where applicable, every step of the data collection was done in partnership with the relevant stakeholders.

The author's involvement in the data collection processes was active both in the case of questionnaire survey and in the case of participants' health tests. During questionnaire surveys the author provided guidance and training to the survey enumerators on the use of maps and the administration of the questionnaire. The author also took part in the questionnaire administration during the enumeration process. During health data collection, the author assumed the role of an organizer, being charged with the responsibility of setting dates and securing places where testing will take place.

Preceding the data collection stage, it was very important to establish partnerships with relevant stakeholders.

#### **4.2.1 Forging partnerships**

A request for access to clinics' data was made to the City of Cape Town's Department of Health. This was done by following the department's procedure of submitting the research's proposal and filling in a departmental data request form for review. Despite multiple attempts, this request was never responded to by the department. The researcher thus proceeded to form relationships with the Desmond Tutu HIV Foundation's Mobile Tester project in order to access their health database.

Desmond Tutu HIV Foundation is a non-profit making organisation headed by Professor Robin Wood and Professor Linda-Gail Bekker of the Faculty of Health Sciences, University of Cape Town and supported by Emeritus Archbishop Desmond and Mrs Leah Tutu. It is based at the University of Cape Town's Institute of Infectious Disease and Molecular Medicine and operates symbiotically with its local field sites in the Nyanga area of Cape Town and Masiphumelele, Noordhoek. The foundation's activities include the following:

- community-driven development and internationally recognised research
- HIV/AIDS prevention, treatment, and training,
- tuberculosis (TB) screening and management,
- screening for Sexually Transmitted Infections (STIs),
- and testing for Diabetes, Hypertension and Obesity .

The organisation serves the most vulnerable communities in the Western Cape. Within the foundation is the Tutu tester project which constitutes the mobile facility (truck) that provides services for testing diabetes, hypertension, body mass index measurements, HIV and sexually transmitted diseases, and screening for TB.

Two initial meetings were conducted with the foundation's management to initiate collaboration. During the first meeting, the author introduced the objectives of the study and its data requirements, collaboration possibilities were also established. The second meeting was held at the foundation's offices in Silvertown. During this meeting the author was given an opportunity to explore the foundation's databases and datasets in search for the appropriate health data. It was during this meeting that the author and the foundation's management decided that since the datasets available in the Tutu tester database did not have the geographical reference necessary for this research, the mobile facility (truck) would go into Brown's Farm for five days to test people so as to acquire the required health data for this study.

Establishment of relationships at the community level was also imperative if community participation was to be effectively achieved. The author had a meeting with Brown's Farm's ward councillor to introduce the study and to learn of the existing community leadership structures and community based organisations that could be relevant to the study in terms of their mandate. The ward councillor accepted the research as relevant due to the fact that a heavy burden of disease is one of the major challenges facing the area. After consultation with the community's executive committee, the ward councillor arranged that the author meets up with the community's health committee. The executive committee thought it wise that the author works with the health committee members during the questionnaire surveys and the health tests processes. The rationale behind this decision was that the

community members might be more open to participate in health tests if sensitised by health committee members as they interact with them on health issues often during the home-based care visits.

A community health committee serves primarily as liaison between the community members and the primary health care centres. Activities of the committee include organising community health campaigns such as know your status campaigns (KYS), nutrition campaigns and providing home-based care.

The author met up with the health committee members, first to sensitise them on the aims and objectives of the study. Five health committee members thereafter availed themselves to participate in the study, their key role being administration of the questionnaire. They were then trained on map reading and usage as well as the content of the questionnaire. The health committee then held community gatherings in Brown's Farm to present and sensitise people about the proposed research and its activities. Figure 4.2 below shows members of the health community learning how to use an aerial map.



*Figure 4.2: Community Health Committee members going through an aerial map during a training workshop*

### 4.3 Data Collection

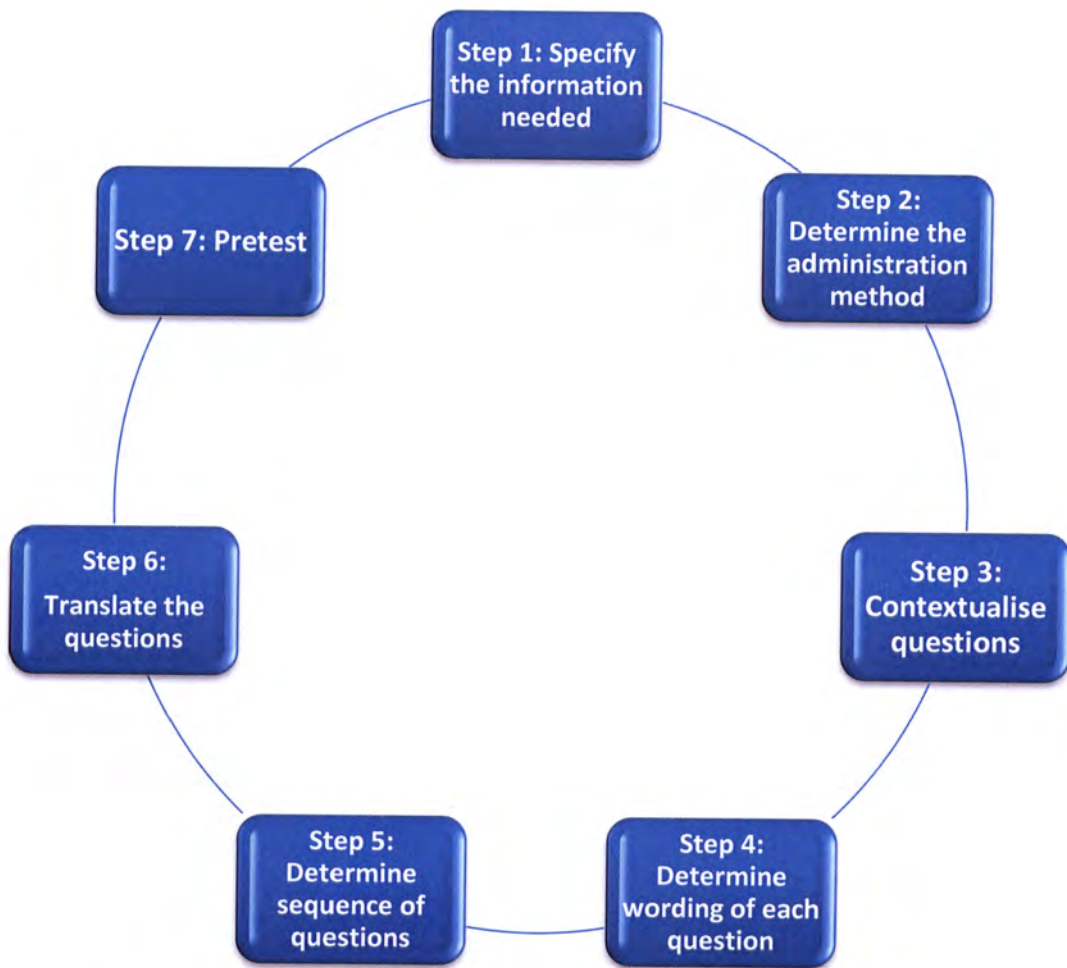
The data collection methodologies included questionnaire survey, digitization of spatial data and mobile clinic testing for the collection of health data. These methods were similarly utilised by (Abbot *et al.* 1998; Abbott 2000; Musungu 2011)

#### 4.3.1 Questionnaire Development and Design Process

As already alluded, the study used questionnaires to collect socio-economic data. Questionnaire surveys are popular amongst health researchers, (Choudhury *et al.* 2012). Questionnaire administration methods constitute post, telephone, on-line and face to face methods. The population of interest for the study was of low income class; therefore a face to face administration method was deemed more suitable.

Some questions in the questionnaire were adopted from the World Health Organisation's (WHO) Global Physical Activity Questionnaire (GPAQ). These questions were modified and used in the study in order to establish whether the built environment within the study area encouraged physical activity. The link between good health and physical activity has been well established and proven (Frank *et al.* 2004; Handy *et al.* 2002; Sallis *et al.* 2002). Also, some questions from Musungu's questionnaire on flooding in the informal settlement were modified and used (WHO 2010; Musungu 2012). Although not a major focus of this study, questions on flooding were used to establish the quality of housing units within the study area. They were also used because flooding could have direct effect on people's health, e.g through outbreak of cholera and diarrhoea.

The questionnaire development process followed seven steps as demonstrated by Figure 4.3 below.



*Figure 4.3: Steps followed in the development of the questionnaire.*

The finalised questionnaire was then translated from English to Xhosa and then pretested. In an effort to establish equivalence of meaning in each language, the method of “collaborative translation” as discussed by (Limpanitgul 2009) was used to translate the questionnaire and the consent form. The questionnaire and the consent form were submitted to a professional translator and a bilingual Xhosa who is also a member of Brown’s Farm community for translation (Douglas & Craig 2007; Gierl 2000). After each translator had come up with their own Xhosa translated versions of the questionnaire, a meeting was then set up to harmonise and integrate the two versions with the original questionnaire. The final English questionnaire was then pretested with a Xhosa speaking researcher and one Brown’s Farm community member.

#### 4.3.2 Questionnaire Design

There were 20 closed-ended questions in the questionnaire. The following discussion outlines the rationale behind the specific questions posed within each category of the survey.

- The first category of questions was on the participants' socio-demographics. This section contained questions pertaining to participants' age, education status, gender and employment status. These questions were included in the questionnaire because certain population demographics have been found to be more vulnerable to diseases than others (Campbell *et al.* 2001).
- The Household economic status section contained questions pertaining to household monthly income and whether any member of the house was a recipient of social wealth grants. The rationale behind these questions was to ascertain the financial standing of the households and establish if there were economic differences between participants living in informal settlements and those living RDP houses. Also, inadequate family income results in poor living conditions and increases the family's vulnerability to diseases. The last two questions in this section were on the location of participant's occupation and the mode of transport used to get there. These questions were meant to assess whether the built environment (roads and proximity to areas of employment) encouraged walking or cycling.
- There were also questions on whether the house gets flooded when it rains; the type of flooding and the length of time the house remain flooded after the has stopped. The materials used to construct participants' dwellings were also observed. This is because housing has been established as an important determinant of health, for instance, poorly constructed, cold, damp and insecure housing has been associated with increased risk of diabetes, cardiovascular and respiratory diseases among others (Schoutman *et al.* 2007; Keall *et al.* 2010; Dooley 2007).

- Another set of questions was on health and sanitation. This section mainly queried on the delivery and quality of Municipal services. There were questions pertaining to type of toilet used by the household, number of people using the toilet, access to water, distance walked to access water and frequency of refuse collection. Poor and insufficient sanitation infrastructure (such as toilets, access to water and refuse removal) can lead to unhygienic conditions and an increase in vulnerability to disease.

**Table 4.1 Summary of Survey questions as they appear in the Questionnaire**

<b>CATEGORIES OF QUESTIONS IN THE QUESTIONNAIRE</b>	<b>QUESTIONS INCLUDED IN THE QUESTIONNAIRE</b>
Socio-demographics of the participant	<ul style="list-style-type: none"> <li>• Age</li> <li>• Gender</li> <li>• Highest education attained</li> </ul>
Household Economic status	<ul style="list-style-type: none"> <li>• Participant's Occupation</li> <li>• Location of place of occupation</li> <li>• Mode of transport used to and from the place of occupation</li> <li>• Grants received</li> <li>• Household monthly income</li> </ul>
Dwelling type and quality	<ul style="list-style-type: none"> <li>• House type; formal/informal</li> <li>• Does the house get flooded when it rains</li> <li>• The type of flooding</li> <li>• How long the house remains flooded after the rain has stopped</li> </ul>
Services and sanitation	<ul style="list-style-type: none"> <li>• Type of toilet; communal/one family</li> <li>• Number of people using the toilet</li> </ul>

	<ul style="list-style-type: none"> <li>• The frequency of refuse collection</li> <li>• Access to water; in-house, communal etc</li> </ul>
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#### 4.3.3 Enumeration and Mapping

To ensure community participation, the enumeration process incorporated the deployment of literate members of Brown's Farm community (Brown's Farm health committee). The rationale behind this was to ensure the involvement of people who are both ethnically and linguistically matched to the study participants.

The survey was carried out by five members of the community health committee, the author and two other researchers. The health committee members were found to be most suited to help with the questionnaire administration and recruitment of participants to test for the diseases of interest based on the following attributes:

- they had lived in Philippi for over 10 years,
- they could read both Xhosa and English very well
- they had been involved in community development structures within Phillip
- they knew the area very well and
- they already had well-established relations with community members. They do regular home visits to provide home-based care to out-patients and basic health education in the area as part of the committee's mandate. Therefore people within the community are used to hosting them in their homes and responding to their health related questions.

Five teams of two constituting one health committee member and one researcher were formed. Since there were 3 researchers (including the author) and 5 health committee members, there had to be morning and afternoon shifts teams. Three teams went out in the morning to recruit participants while two teams would only go out in the afternoon. One researcher and the author had to work both morning and afternoon shifts. The teams were to each spend 10 days in the field, interviewing a minimum of 10 participants a day.

During the visits, all teams carried questionnaires and locality maps indicating the area to be surveyed. Participants' dwellings were marked on the locality map and these maps were later used to digitize the dwellings in GIS. In each team, the health committee member administered the questionnaire and the accompanying researcher marked the participant's house on the locality map and also sat-in to supervise the interview.

Each questionnaire had a number, so the house of a participant that responded to that particular questionnaire assumed that number on the map. After the interview participants were given cards bearing their questionnaire numbers to produce when they got to the Desmond Tutu Mobile Testing facility. These cards were attached to their test results and the number was used to give spatial reference to the health and the socio-economic data.

All questionnaires were checked by the author before data capture and validation.

Participants were recruited by house-type and longevity of their stay in the area (10 years minimum).

#### **4.3.4 Sample Size Methodology**

The health data for the study would ideally consist of clinic data of incidences of diabetes, hypertension, obesity, TB and HIV/AIDS of people aged 18-75 years. These people would have resided in 'Brown's Farm' Philippi for at least 10 years, living in either a shack or having moved from a shack to an RDP house in this time period. As already alluded to, the study could not access clinic data, so the Tutu Mobile Tester was used to test people within the study area in order to collect the health data for the study.

Financial and time constraints precluded the study to test the whole Brown's Farm population for the diseases of interest. Therefore, one section of the study area with the closest proximity of formal to informal housing was chosen and simple random sampling was used to select 558 households from that section. The information on the number of participants is summarised in Table 4.2 below.

Recruiters went to the selected households to recruit one member from each household to take part in the study. Any eligible member of the household (given age

and length of stay in the house) who could avail themselves was invited to participate in the study. Table 4.2 below illustrates proportions of the sampled households by house type and the number of people that got tested. The total number of people from each dwelling type was based on the total proportion of that particular dwelling type within the entire study area as estimated in the community socio-economic profile survey by the department of human and economic development (The City of Cape Town 2010).

*Table 4.2 Break down of the number of people contacted to take part in the study*

<b>Dwelling Type</b>	<b>Number of units surveyed</b>	<b>Percentage of the total sample</b>	<b>Percentage of the total dwellings within the study area</b>	<b>Number of people tested</b>	<b>Percentage of the total sample</b>
Formal/RDP Housing	194	35	26.10	63	39
Informal/Shack Residence	364	65	73.90	99	61
<b>TOTAL</b>	<b>558</b>	<b>100</b>	<b>100</b>	<b>162</b>	<b>100</b>

Based on the 2011 aerial imagery roof count and the economic and human development survey, (The City of Cape Town 2010).

Of the 558 people approached to take part in the study, only 162 agreed to get tested and consented that their results be used for the purpose of the study.

#### **4.4 Social Data**

The questionnaire responses were captured on an excel spreadsheet, using the allocated dwelling number as the primary identifier for each questionnaire.

#### **4.5 Spatial Data**

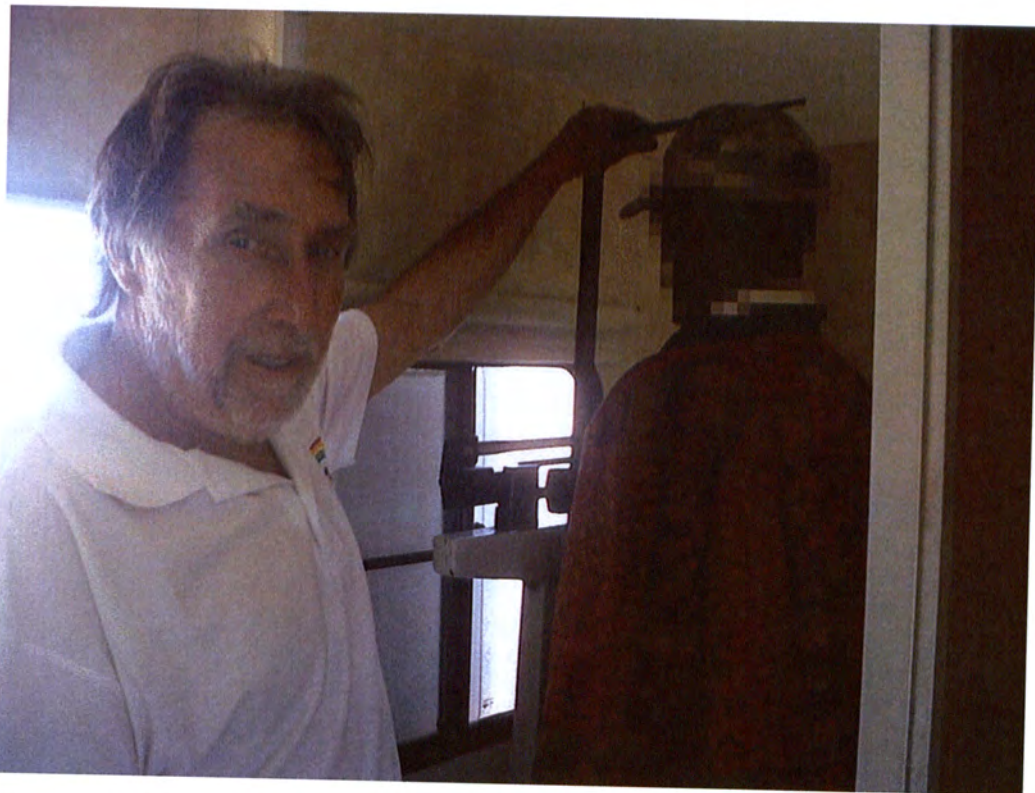
The City of Cape Town was the primary source of the spatial data for the study. However, some data was captured through digitization. Spatial data included key built environment factors such as roads, sewer lines, recreational facilities, railway lines, clinics and taxi, bus and railway routes shapefiles and 2011 aerial photography. The house [dwelling type] was adopted as the basic spatial unit in GIS.

After the completion of the survey, the printed aerial photographs, which the health committee members used to mark house numbers/participants numbers during enumeration, were used to digitise the houses as points in GIS. The houses were digitised from the aerial photographs, taking into account any amendments recorded by the enumerators on the printed aerial photographs. The resultant shapefile was then called the “dwelling type shapefile”.

#### 4.6 Health Data

Health data was collected in collaboration with the Desmond Tutu Foundation's Mobile Tester facility. The Desmond Tutu Mobile Tester came into the Brown's Farm community at specified dates to test the study participants. The testing process took five days. A query was then run on the Tutu tester database to extract the study's participants' test results. The health results data was then exported and saved as an excel spreadsheet with the allocated house number/participants' number as the primary identifier for each participant.

Figure 4.4 below shows Tutu Tester officer taking participants' height measurement for BMI calculations.



*Figure 4.4: Officer at the Tutu Tester measures a participant's height on the mobile in preparation for BMI calculation*

## 4.7 Data Analysis

The above-mentioned data-sets all had one thing in common, the allocated house/project/participants' number. This number was used to integrate the three data sets. Firstly, to produce one spreadsheet containing participants' socio-demographic and health data, the health test results spreadsheet was merged with the socio-demographic data spreadsheet using participants' project number as a unique identifier. Since both the resultant spreadsheet and the shapefile in GIS had corresponding participants' project numbers as database identifiers, a spatial join was carried out in GIS to link the attribute data to the corresponding dwelling type shapefile. This resulted in both attribute and spatial data being located in a singular GIS database.

Descriptive statistical analysis was carried out in excel in order to outline an overview of the socio-economic data. These statistics included information on gender, age, occupation, household income; refuse removals, sanitation and health facilities etc. Thereafter, Local Moran's I and Getis-Ord statistics were used to detect diseases distribution patterns in a GIS.

### 4.7.1 Detection of Spatial Patterns of the diseases

Disease clusters have been defined as regions of significant elevated risk for diseases within a study area as determined by a null hypothesis (Chen *et al.* 2008). The general aim of spatial statistic cluster detection tools is to detect and evaluate the statistical significance of a spatial cluster of events that can be explained by an underlying probability model defined by a null hypothesis of spatial randomness (Day & Pearce 2011). There exists three cluster tests; global, local and focusing clustering tests. Global clustering tests evaluate the existence of spatial clustering without indicating the specific locations of clusters, whereas local clustering tests are spatial specific small-scale clusters and focused clustering tests assess clustering around a prefixed point source such as a nuclear installation (Anselin 1995; Scott & Janikas 2010).

Local cluster detection tools (Cluster and outlier analysis tool and hotspot analysis tool) were used in this study, to identify statistically significant spatial clustering of incidences of Diabetes, Hypertension, Obesity, TB and HIV/AIDS in GIS. These tools

use Getis-Ord  $G_i^*$  and Anselin Local Morans I statistics respectively, see table 4.3 below. The hotspot analysis tool was basically used to detect disease clusters whereas the cluster and outlier also detected outliers from the data. The statistics used by the tools were classified by (Anselin 1995) as Local Indicators of Spatial Association (LISA) mainly because for each feature in a dataset, the statistics determine the extent of significant spatial clustering of similar values around that feature up to a specified distance from that feature. These tools were similarly used and recommended by (DeGroot *et al.* 2008; Anselin 1995; Haque *et al.* 2012).

**Table 4.3: Functions of Clusters detection tools**

<b>Arc Map Clusters Mapping Tools</b>	<b>Functions</b>
Cluster and outlier analysis tool (Anselin's local Moran's I)	Detects clusters of high or low values and spatial outliers on a set of weighted features.
Hot spot analysis (Getis-Ord $G_i^*$ )	Detects clusters of features with high values (hot spots) and clusters of features with low values (cold spots) on a set of weighted features.

\*Adapted from (Scott & Janikas 2010)

#### 4.7.2 Cluster and outlier analysis tool

Cluster and outlier analysis tool uses the Anselin local Moran's I statistics, see equation 1 (Anselin 1995). For each point/dwelling in the study area, the statistic provides a measure of the point's tendency to have an incidence value that is correlated with incidence values in nearby areas (Anselin 1995). For each disease, the statistics gave an indication of significant spatial clustering of similar or dissimilar incidence values within the study area. Furthermore, the statistics also identified errors (outliers) in the data.

$$I_i = \frac{x_i - \bar{X}}{S_i^2} \sum_{j=1, j \neq i}^n w_{ij} (x_j - \bar{X}) \quad (1)$$

Where:

$i$  is the  $i$ th point for which  $I_i$  was computed

if  $x_i$  is a disease incidence at point  $i$ , and  $\bar{X}$  is the mean of the corresponding disease incidence and  $w_{ij}$  is the distance between disease incidences at points  $i$  and  $j$

$$S_i^2 = \frac{\sum_{j=1, j \neq i}^n w_{ij}}{n-1} - \bar{X}^2 \quad (2)$$

To ascertain the statistical significance of clusters or outliers the statistics also computes a Z score, see equation 3 (Francis *et al.* 2012). The z-score test identifies a null hypothesis stating that there exists a complete spatial randomness in the way features (points) themselves or values (incidences) associated with them are distributed. The z-score values are used in a decision to accept or reject the null hypothesis at a certain level of confidence.

The Z score for the statistics is computed as:

$$z_i = \frac{I_i - E[I_i]}{\sqrt{V[I_i]}} \quad (3)$$

$$E[I_i] = \frac{\sum_{j=1, j \neq i}^n}{n-1} \quad (4)$$

Where

$$V[I_i] = E[I_i^2] - E[I_i]^2 \quad (5)$$

The following are the universal z-score values for the following levels of statistical significance:

- 90% statistical significance:  $\geq 1.645$  –
- 95% statistical significance:  $\geq 1.960$  –
- 99% statistical significance:  $\geq 2.576$
- 99.9% statistical significance:  $\geq 3.291$

A positive z-score, higher than the significance level indicates the presence of a cluster and hence would suggest that the null hypothesis be rejected (Anselin 1995).

A large positive value for  $I$  indicates that the feature is surrounded by similar features and hence there exists a cluster and a negative value for  $I$  indicate that the feature is surrounded by dissimilar features indicating the presence of an outlier (Langlois 2008). However the cluster and outliers will only be statistically significant if the subsequent z-score is equal to or higher than the chosen significance level.

The study used the 95% statistical significance for both tools used, meaning that only 0.05 margin of error would be allowed on the data.

#### 4.7.3 Hot spot analysis tool

Hot spot analysis tool uses the Getis-Ord  $G_i^*$  statistics, see equation 6 below (Chainey 2008). The  $G_i^*$  statistic determined where a point with a certain incidence value was surrounded by points with similar incidence values within the study area, thereby producing hotspot and cold spot maps (Scott 2006). The Getis-Ord  $G_i^*$  statistic works by comparing the local mean rate (the incidence rate for a dwelling/point and its nearest neighbouring dwellings/points) to the global mean rate (the incidence rates for all dwellings/points within the study area) (Erdoğan *et al.* 2011).

Computations:

$$G_i^* = \frac{\sum_{j=1}^n w_{i,j} x_j - \bar{X} \sum_{j=1}^n w_{i,j}}{S \sqrt{\frac{n \sum_{j=1}^n w_{i,j}^2 - (\sum_{j=1}^n w_{ij})^2}{n-1}}} \quad (6)$$

where  $x_j$  is the incidence value for point  $j$ ,  $w_{i,j}$  is the distance between points  $i$  and  $j$ ,  $n$  is equal to the total number of points and

$$\bar{X} = \frac{\sum_{j=1}^n x_j}{n} \quad (7)$$

$\bar{x}$  denotes the sample mean of incidences within a specified distance

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{X})^2} \quad (8)$$

$S$  denotes the sample variance of incidences within a specified distance.

Unlike the Moran's I statistic, the  $G_i^*$  statistics is essentially a z-score and hence no further computations are required for it (Haque *et al.* 2012). The z-score is calculated based on the following premise; a feature with a high value is interesting, but may not be a statistically significant hot spot. To be a statistically significant hot spot, a feature will have a high value and be surrounded by other features with high values as well. The z-score/ $G_i^*$  was produced for each point/dwelling, indicating whether the local and global means were statistically significant or not. A statistically significant positive z-score/ $G_i^*$  reflects hot spots, showing clustering of high values. Similarly, a statistically significant negative z-score/ $G_i^*$  reflects cold spots, showing clustering of low values.

## **4.8 Data Integrity**

This section will describe the ways in which the reliability of the data collected for the study area was checked.

### **4.8.1 The Questionnaire data integrity checks**

The first data integrity check was embedded on the questionnaire design. The questionnaire was firstly pretested to minimise any ambiguity that might have been prompted by translating it from English to Xhosa. The questionnaire was divided into four sections (Table 4.1) and was to be administered in the laid out order. Across sections, the questions might have appeared disintegrated to both the enumerator and the respondent, nonetheless, some of the questions were actually interrelated. For instance, there is a correlation between the number of people staying in a house on the dwelling type section of the questionnaire and the number of people using the household toilet on the health and sanitation section of the questionnaire. It would be inconsistent for a respondent to report varying number of people staying in the house and people using the family toilet when the toilet is in fact an in-house toilet. Similarly, there was a correlation between the questions in the household economic status and health and sanitation section. The respondent who reported unemployment would not be expected to report seeing a private doctor. It would be inconsistent for someone without any form of employment or a person dependent on social welfare grant to say that they use private doctors when they are sick. It is very likely that, if they used such health facilities, they must have had some form of

employment or another source of income. There was also a relationship between questions in the household economic status and the number of children in the family. A person who reported unemployment, child support grant and less than 40 children would not be expected to report R10000+ as household monthly income etc.

These data integrity evaluations were meant to identify bias on the part of both the respondents and enumerators.

#### **4.8.2 Comparisons between the Spatial and Social Data**

Participants' responses were also checked against the aerial imagery. For instance, it was possible to confirm from the aerial imagery how long respondents might have lived in their house. If a respondent claimed to have lived in the settlement for ten years, the respondents dwelling should appear in the archived aerial images from ten years ago (unless for some reason the individual has moved from one shack to the next within the study area, e.g due to fire outbreaks). The validated questionnaire responses were integrated into the GIS as attribute data of the corresponding shacks. After carrying out all these checks, the validated data was deemed to be reliable enough for the diseases distribution and cluster detection.

#### **4.9 Problems and Limitations of the Methodology**

Use of study questionnaires was found to be the most viable means of collecting socio-economic data. As already alluded to, recruiters were arranged into 5 pairs that constituted 3 researchers and 5 community health committee members. Each pair had their own participants to recruit. Despite the training that was held to ensure homogeneous comprehension of the questionnaire, unavoidably each recruiter might have understood the questions their own way; subsequently introducing multiple bias to the way the data was collected. Also, even though the questionnaire was pretested, it is hard to state with certainty that none of the questions were misinterpreted by the respondents. For one reason or the other, questionnaires are usually liable to a certain level of superficial responses. However, it is an axiom that research will never reveal the "truth". It simply provides way-markers.

The study depended on people to volunteer to test for the diseases of interest in order to acquire the health data. Therefore, this made it liable to selection bias as

people with certain health outcomes are more likely to self-select into participating into certain health testing programmes given their perception of risk about diseases (Hernán *et al.* 2004). For instance people with risky sexual behaviours are more likely to shy away from undergoing HIV tests while those with low risk perception are usually more willing to undertake such tests. Also, some people with perceived benefits might be more willing to consent to participate. For example a person with a high risk perception about TB might agree to the test with hope that should he/she test positive, the clinic referral letter that he will be issued at the mobile facility will ensure that he will not have to queue for services at the local clinic (Sidney 2012; Hernán *et al.* 2004; Cali- *et al.* 2006). This can lead to over or under representation of such a disease within the study area.

The recruitment of participants for the health tests was done a day ahead of the actual testing day. Participants were given a time and a place (usually not more than 250 meters away from their residence) where the Tutu mobile would be located. Some respondents would turn-up late and others did not turn up at all. The recruiters had to use the aerial imagery to relocate those respondents' residences and go back to their residents to remind them of their appointment. If the respondent was not found at home, then the recruiters would have to recruit new respondents. This would usually be the next willing resident in the area, despite their dwelling type or gender.

Navigating through shacks was very challenging as the shacks were very often located too close to each other making movement very difficult. Also the volunteers did not have prior experience of the use of aerial imagery, so since the accurate analysis is contingent on the input of accurate data the researchers had to spend more time in the field ground-truthing the houses noted on the enumeration maps. In cases where it was discovered that the house on the map did not coincide with the actual house on the ground, the respondent was disqualified and replaced.

#### **4.10 Summary**

The study used high resolution health data to investigate the geographical patterns of HIV/AIDS, TB, Diabetes, Hypertension and obesity in search of environmental and

social determinants of the diseases events within the study area. The computational power and algorithmic ability of a GIS was used to compute spatial statistical analysis and map out the diseases distributions. The data collection methodology for the research included survey questionnaires, participants' health test and a mapping exercise. Various primary and secondary data such as socio-economic data, the health test results, aerial photography and built environment data were used. Data processing techniques such as spatial joins, digitizing, geo-referencing, layering and map production were also incorporated.

# CHAPTER 5 – RESULTS PRESENTATION

## 5.1 Introduction

This chapter presents the findings based on the analysis of both the spatial and socio-economic data collected for the study during the survey. The presentation includes tables and charts showing the results of the descriptive statistical analysis of participants' responses to the questionnaire, as well as maps indicating the distribution of socio-economic variables and the diseases across the study area.

As already alluded to in chapter four, the study used 558 participants (162 both tested and questionnaire enumerated + 396 not tested but questionnaire enumerated). Section 5.1 below presents an overview of the socio-economic and housing status quo of the entire 558 sample.

### 5.1.1 Dwelling types

The majority of the study questionnaire respondents (65%) were informal settlements residents while a total of (35%) respondents resided in the formal part of the study area (see figure 5.1 below). Figure 5.1 below is a bar chart illustration of the number of participants by their dwelling type.

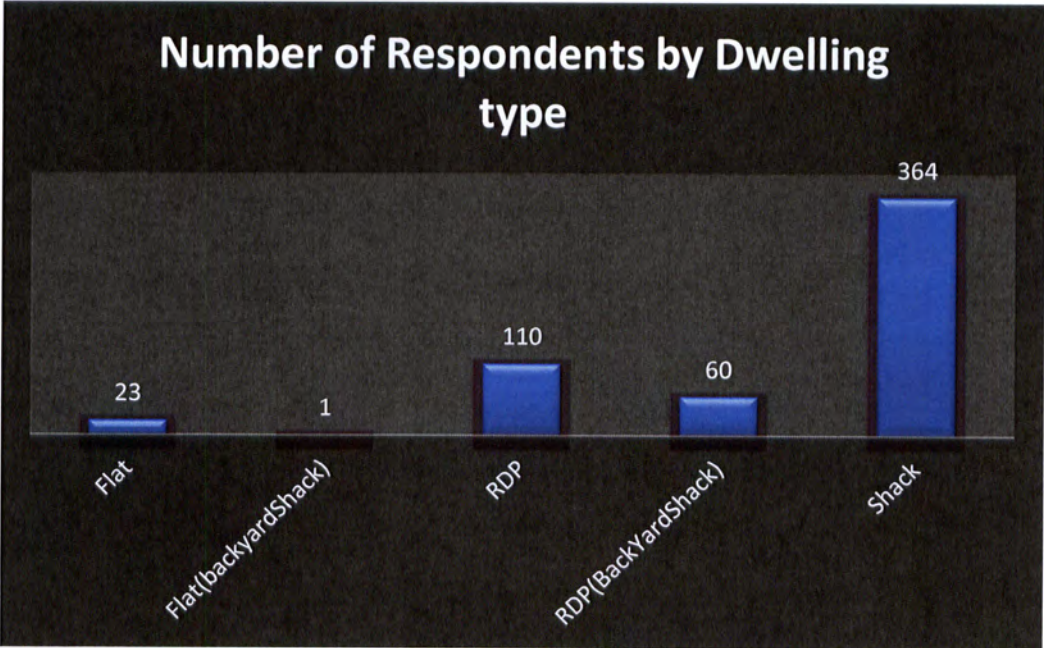


Figure 5.1: Number of Respondents by dwelling types

Sixty two percent (62%) of the participants cited that their dwellings got flooded every time it rained, and in the majority of cases, the houses were reported to remain flooded for more than one day after the rain had stopped (See figure 5.2). The most affected being the informal part of the study area 70% versus 48% of formal residents. Figure 5.2 below is a map illustrating the length of time a dwelling remains flooded after the rain has stopped.

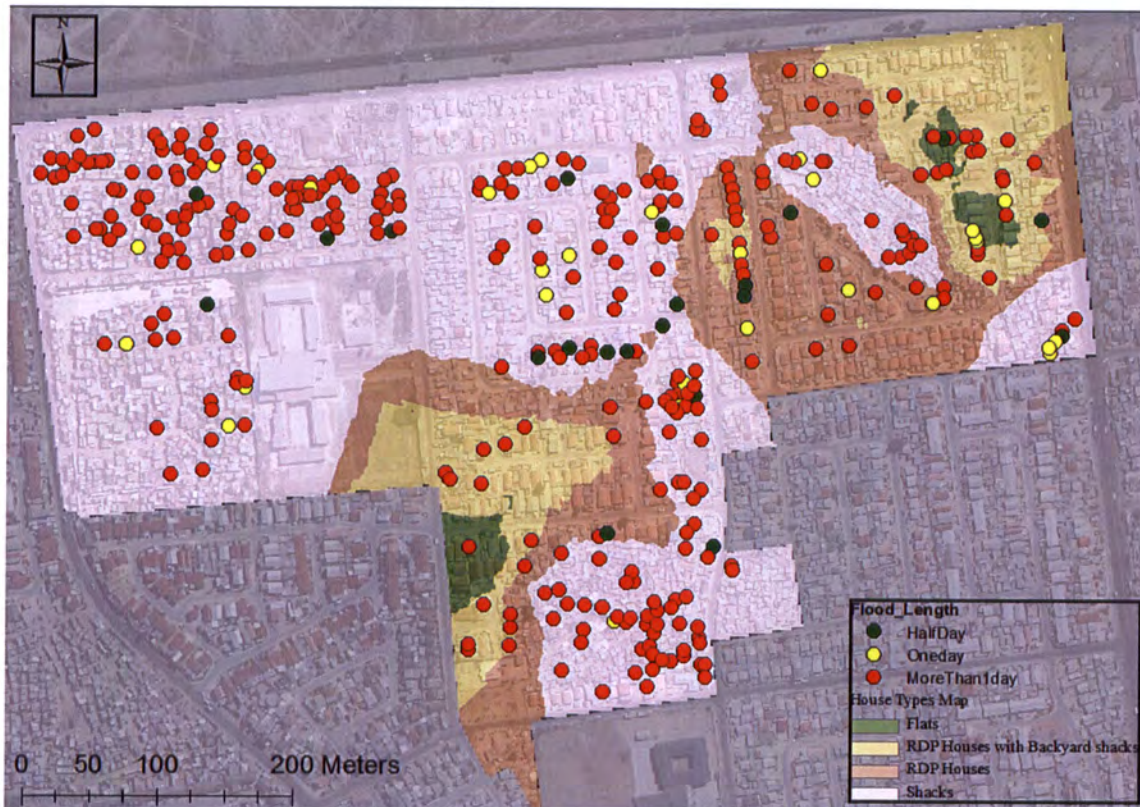


Figure 5.2: Length of time that households remain flooded after the rain stops

Figure 5.3 below shows the type of flooding affecting individual dwelling type. Whilst the informal part of the study area mostly suffered underground flooding and the government subsidized formal (RDP) houses from flooding caused by leaking roofs, both the informal houses/shacks and the RDP houses seemed to be almost equally affected by flooding (see figure 5.3 below).

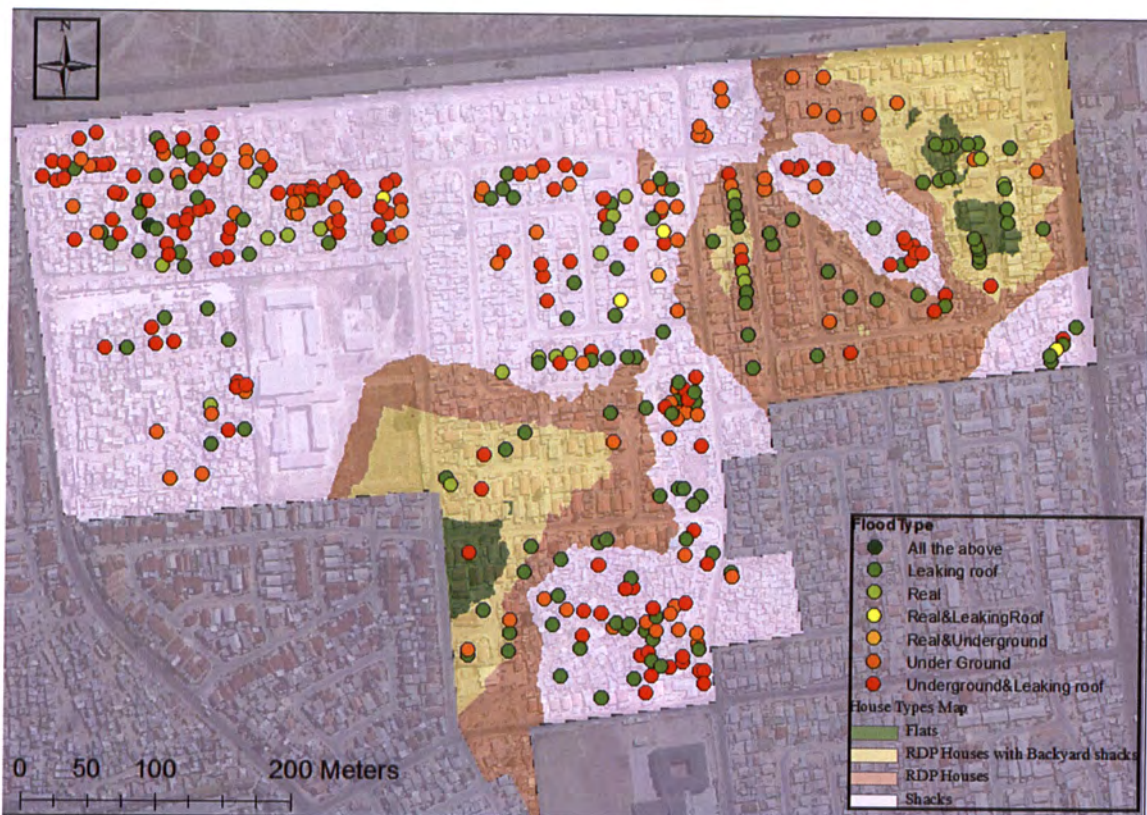


Figure 5.3: Types of flooding experienced in Brown's Farm

Also, 97% of the respondents who claimed that their houses got flooded when it rained reported that at least one of their household members suffered from diarrhea, flu and skin rash presumably due to the effects of the house flood (see figure 5.4 below). Figure 5.4 below is a map indicating the distribution of diseases presumed to have been caused by flooding within individual dwelling.

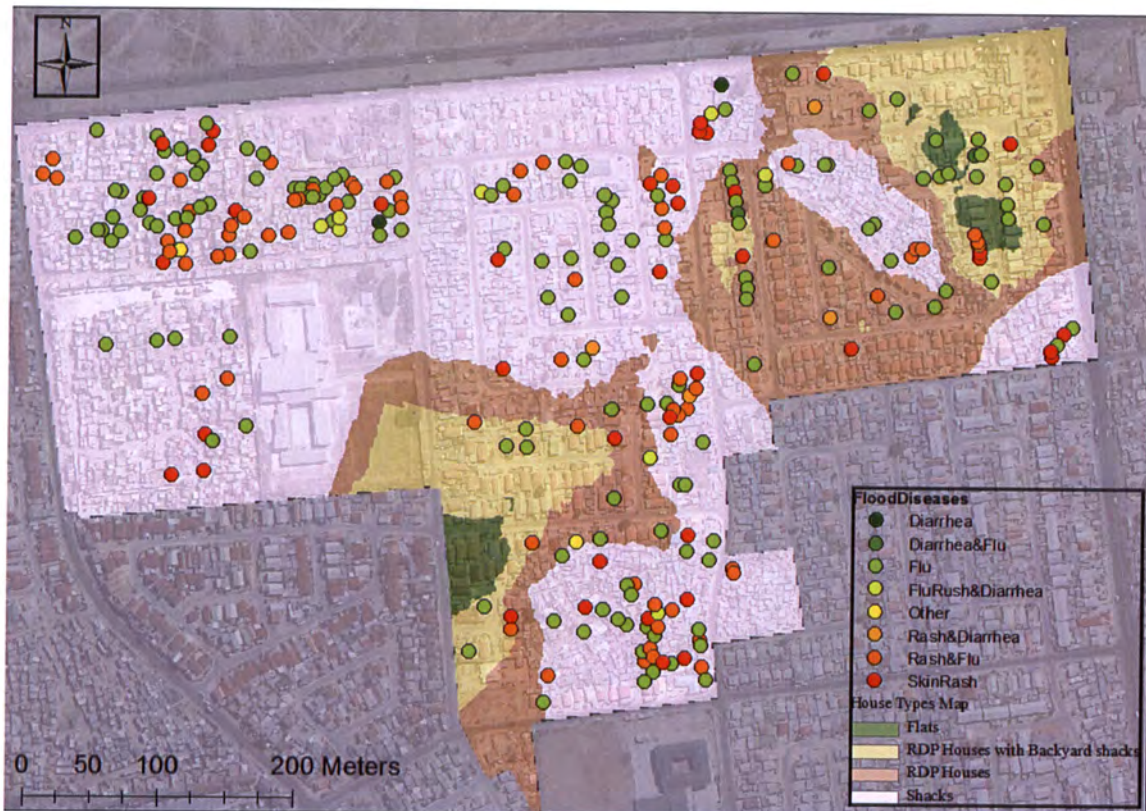


Figure 5.4: Distribution of diseases reported to have been caused by house flooding

The effects of flooding were more prevalent in the informal part of the study area than the formal part. However, the affected RDP residents reported that the flooding started since when they moved in, rendering the quality of their houses questionable.

### 5.1.2 Socio-Economic Status

There exists an internationally established relationship between deprivation or relative social and material disadvantage and ill-health (Cubbin *et al.* 2000; Pickett & Pearl 2001; Stewart *et al.* 2011). Different socio-economic factors have been found to affect health at different times in the life course, operating at different levels (e.g, individual, household, neighbourhood) (Bell *et al.* 2007).

Hence, this study made use of the City of Cape Town's socio-economic status index indicators (Education, Occupation and Income) to establish participants' socio-economic status. The City of Cape Town's socio-economic status index is built on the premise that a person gains entry to an occupation given a relevant education qualification. The nature and level of the occupation is determined by the level of the

educational attainment. Henceforth, as a consequence of pursuing an occupation the person receives an income (Romanovsky & Gie 2006).

### 5.1.3 Occupation

Almost 70% of the respondents reported that they were unemployed. The unemployment rate was almost evenly distributed among both formal (70%) and informal (71%) settlements (see figure 5.6 below). Participants from both house types were equally affected by unemployment. Figure 5.6 below shows that unemployment (represented by the red dots) was evenly distributed across both the formal and informal areas of the study area.

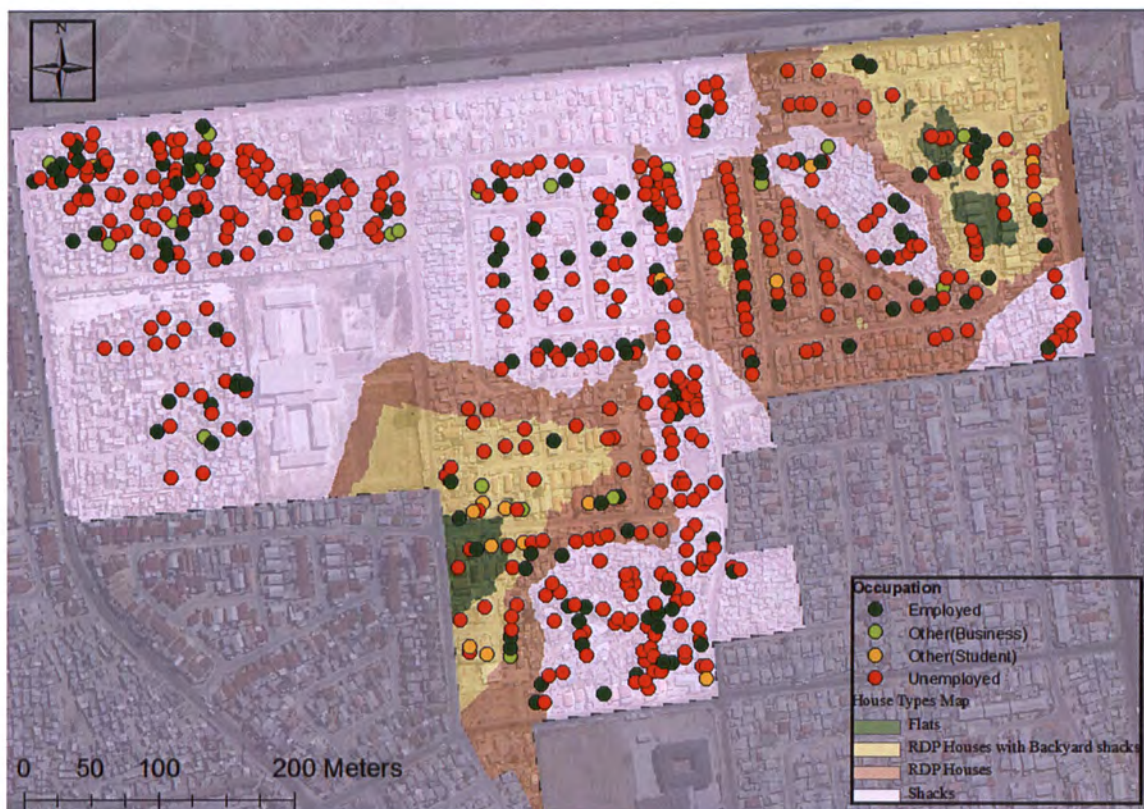


Figure 5.6: Map showing Distribution of Occupation status across different house types

### 5.1.4 Household Income

Most of the employed respondents (78%) reported a monthly household income of R0-R2000 (See Figure 20 below), 73% of the formal settlements respondents reported a monthly household income of R0-R2000, while 68% of the informal settlements respondents reported household income of R0-R2000. Figures 5.7 and

5.8 below are an illustration of the distribution of different monthly income brackets across the study area inclusive of welfare grants and stipends. The higher income classes were also not skewed to any dwelling type, in fact they indicated an even distribution between both formal and informal dwelling types (See both figure 5.7 and 5.8 below). In addition, only 3% of the interviewed respondents claimed that more than one person was employed in their household.

Furthermore, 57% of the respondents claimed that a certain percentage of their monthly household income was from governmental social welfare grants (see figure 5.9 below). The majority of these were child support grants. There was no variation in a way that the income status was distributed across different dwelling types (formal or informal) within the study area.

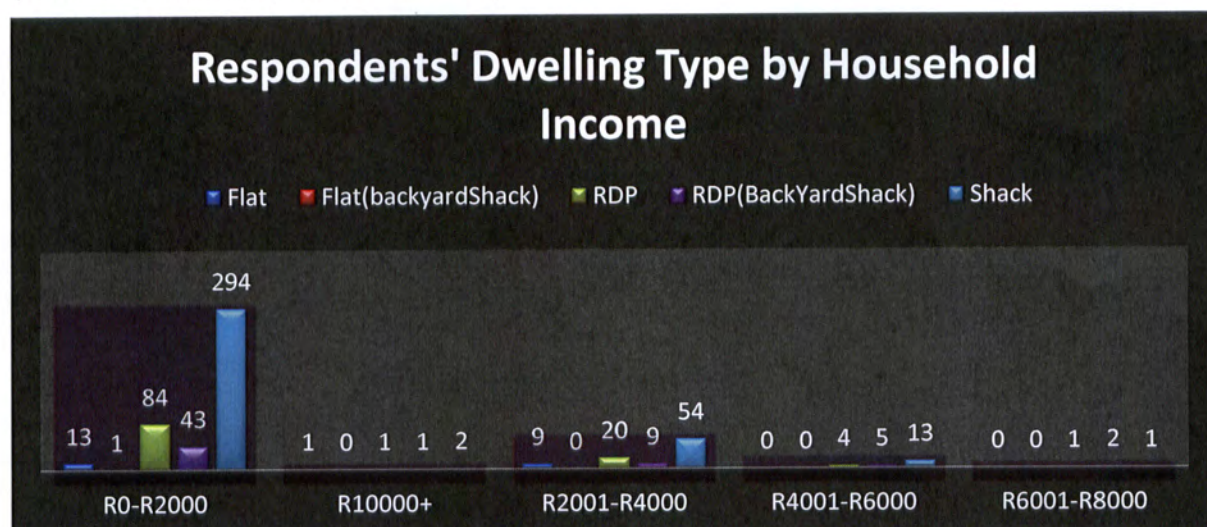


Figure 5.7: Respondents by dwelling type and household income

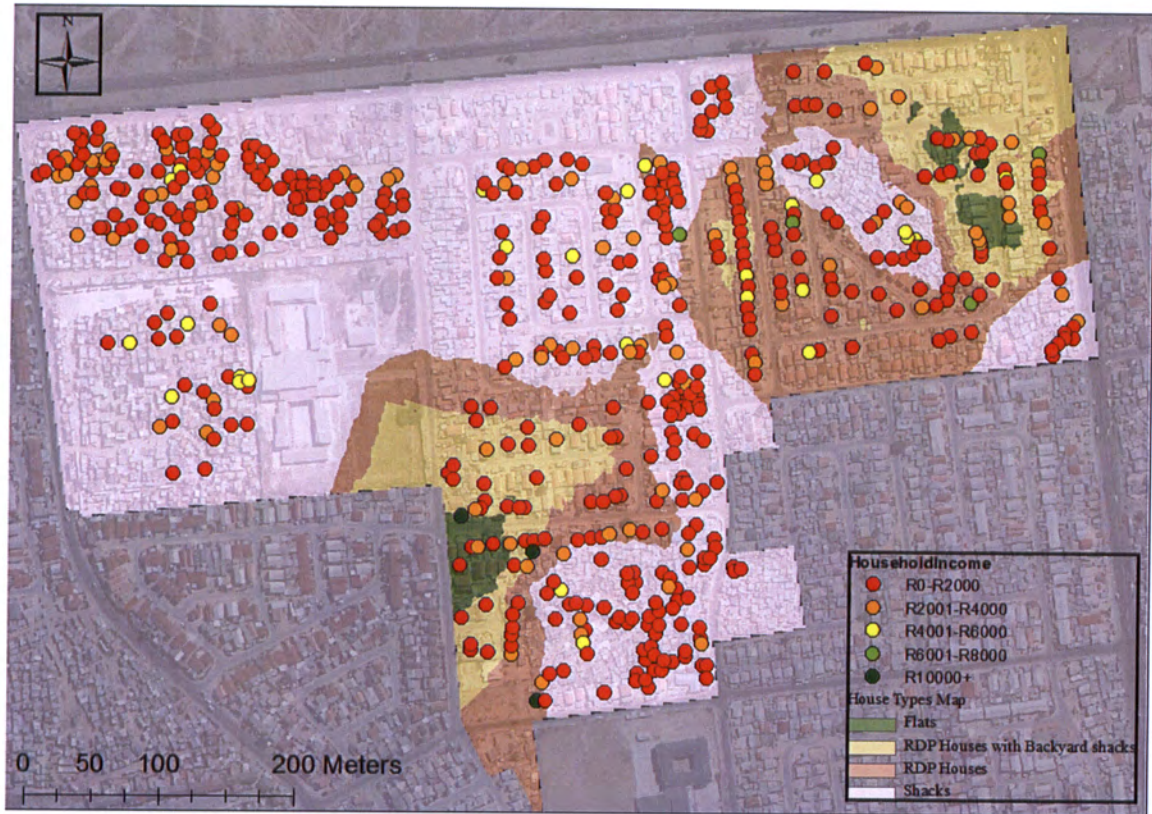


Figure 5.8: Map showing monthly household income brackets distribution across different dwelling types

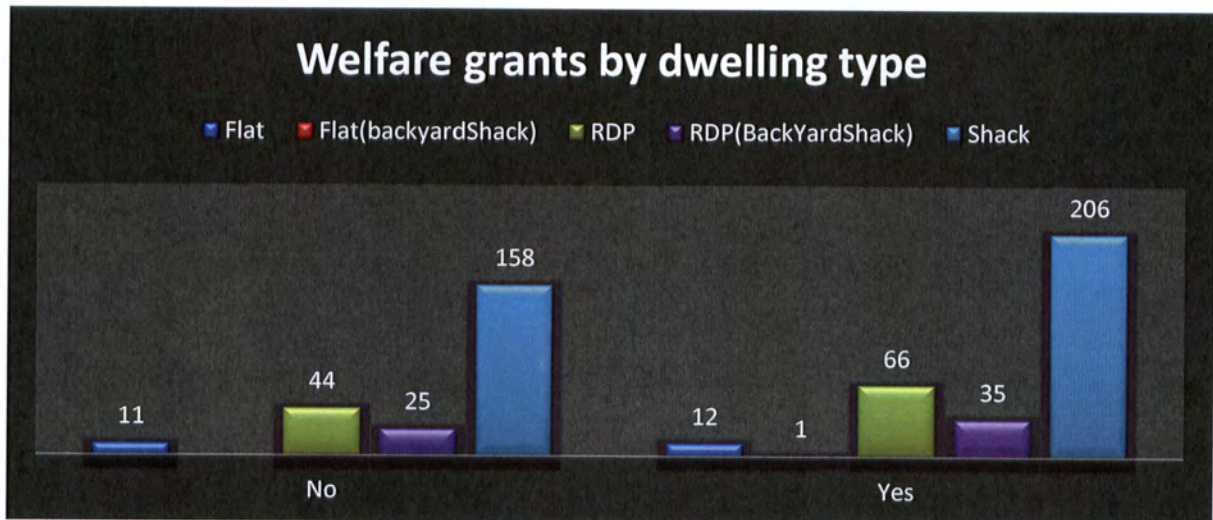


Figure 5.9: Number of respondents that received grants by dwelling type

### 5.1.5 Qualifications

Figure 5.10 below shows the number of participants from both the formal and informal part of the study area and their qualification status, whilst Figure 5.11 maps the distribution of the qualification status across the study area.

The majority of the respondents (51%) reported that they did not complete high school (they did some high school), with 54% of them residing in informal settlements and 46% residing in formal settlements. All the categories of qualifications (see figures 5.10 and 5.11 below) showed a random distribution among different dwelling types. There was no variation in qualification status of the participants across the study area.

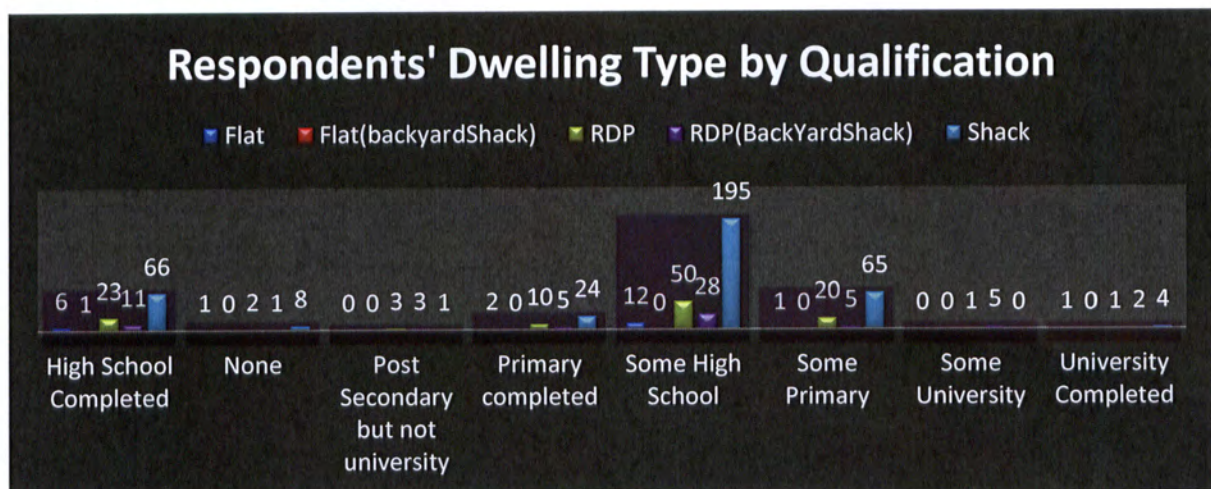


Figure 5.10: Respondents by dwelling type and qualifications

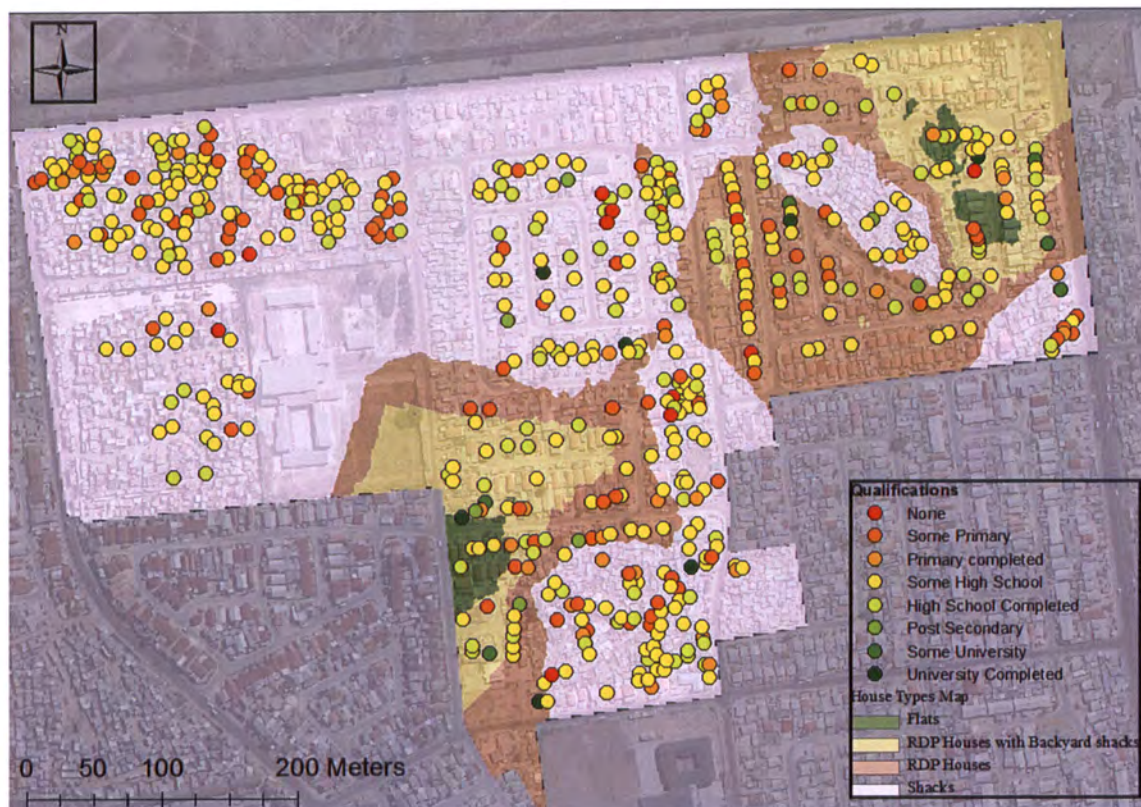


Figure 5.11: Map showing qualifications distribution by dwelling type

### 5.1.6 Municipal Services (Sanitation)

Where accessibility to services and amenities is improved, the well-being of households/individuals is enhanced and economic and social development is increased, environmental pollution is decreased, and health status is improved.

The delivery of municipal services varied greatly across the study area, with the formal part being serviced while the informal part hardly serviced.

### 5.1.7 Refuse collection

Proximity and density of open space refuse dumps have been found to play a contributory role in disease infections and a decline in general enjoyment of outdoor activities (Osei & Duker 2008).

Figure 5.12 below is a map showing the frequency of refuse collection across the study area. All the respondents from the formal settlements generally reported that the municipality collected refuse once every week (see figure 5.12 below). On a

specified day, the residents are to put their refuse bins by the road side where a municipality truck will pass by and pick them up. Participants residing in the informal settlements reported that they have been allocated dumping sites where they dump their refuse and the municipal truck picks it from there, but it was not clear how frequent the refuse was removed as some participants reported once a week, others once a month, some said never while some said they were not sure. (See figure 5.12).

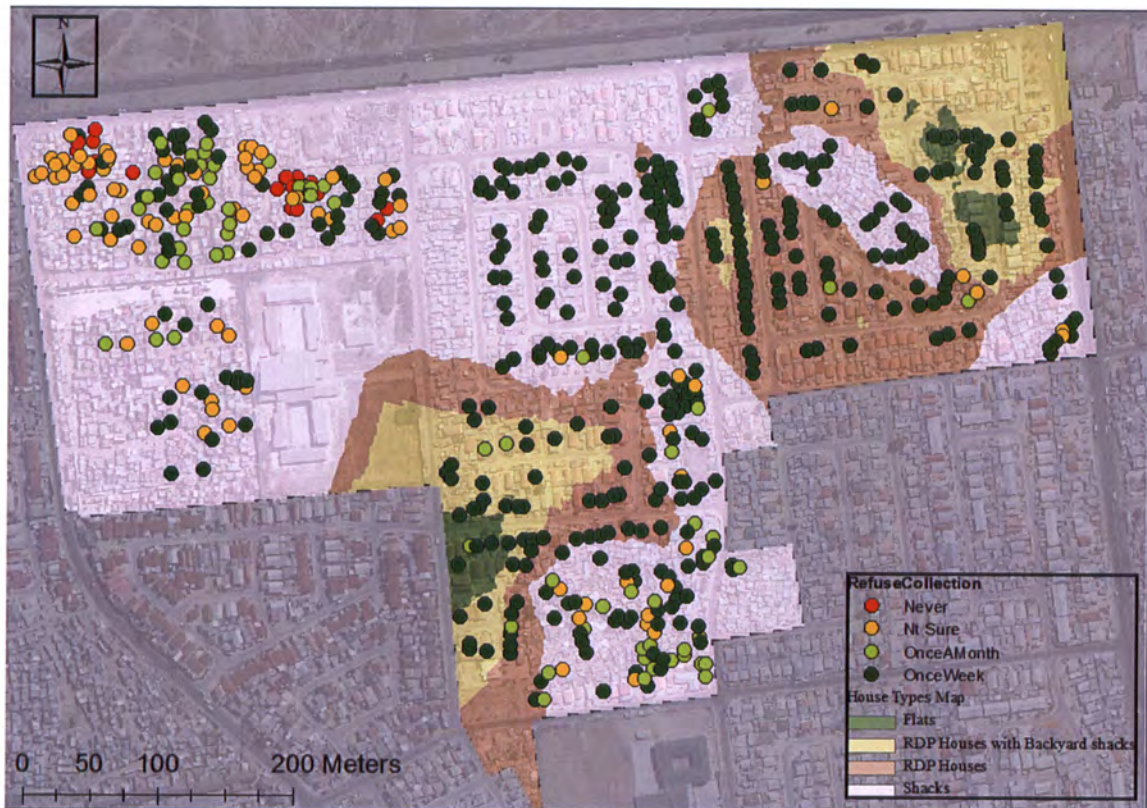


Figure 5.12: Map showing a Refuse removal frequency

### 5.1.8 Access to Water

Figure 5.13 below shows that within the study area, water is accessed through individual family taps and communal taps.

Furthermore, 88% of the informal settlements respondents reported to be using communal taps to access water while 94% of the formal settlements respondent had access to one family tap either inside or outside the house (see figure 5.13 below). Some informal residences were already in the process of acquiring an RDP house and so had one family toilets and taps. The rest used the neighbour's taps. The communal taps were mostly located besides the communal toilets (see figure 3.7 in

chapter 3), a situation that most of the respondents from the informal settlements termed as being very unhealthy especially for children.

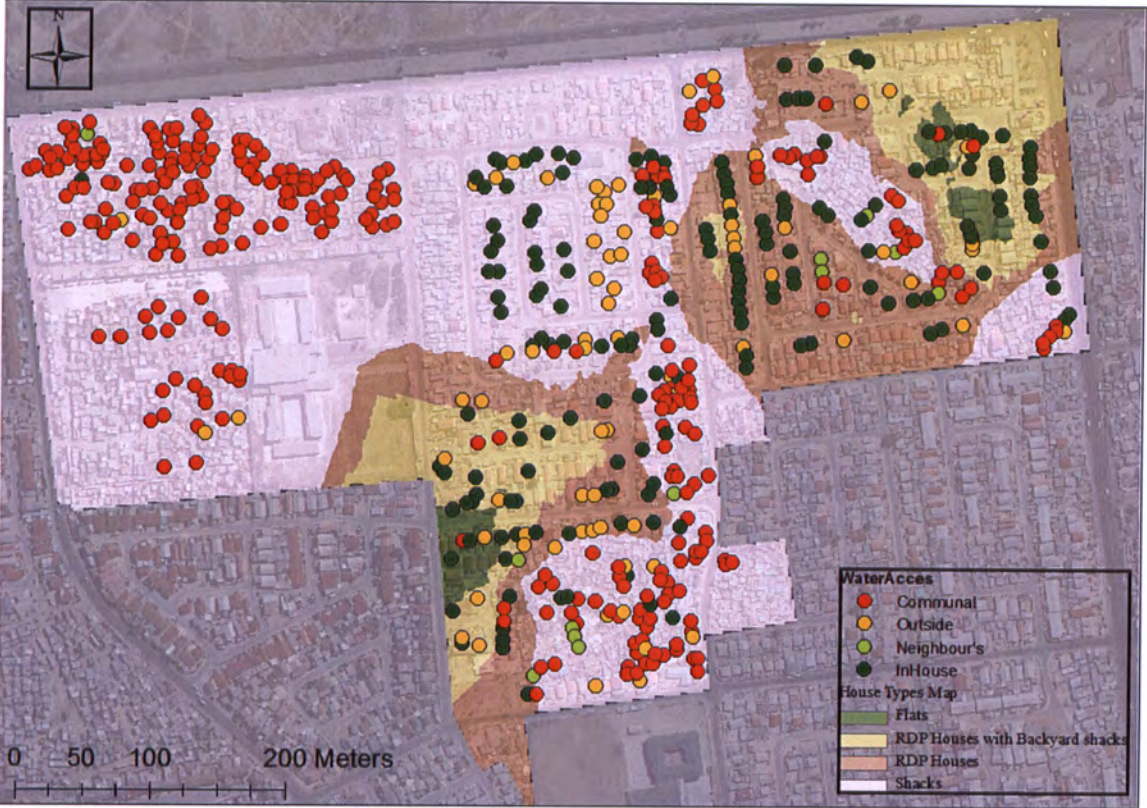


Figure 5.13: Map showing of access Water

5.1.9 Toilet type

Figure 5.14 below is a map showing the distribution of types of toilets used by respondents within the study area.

The majority of informal settlements respondents reported that they used communal toilets while respondents from the formal residences used private toilets with running water. Also, 60% of the respondents using communal toilets reported that they share a toilet with 10 or more other people.

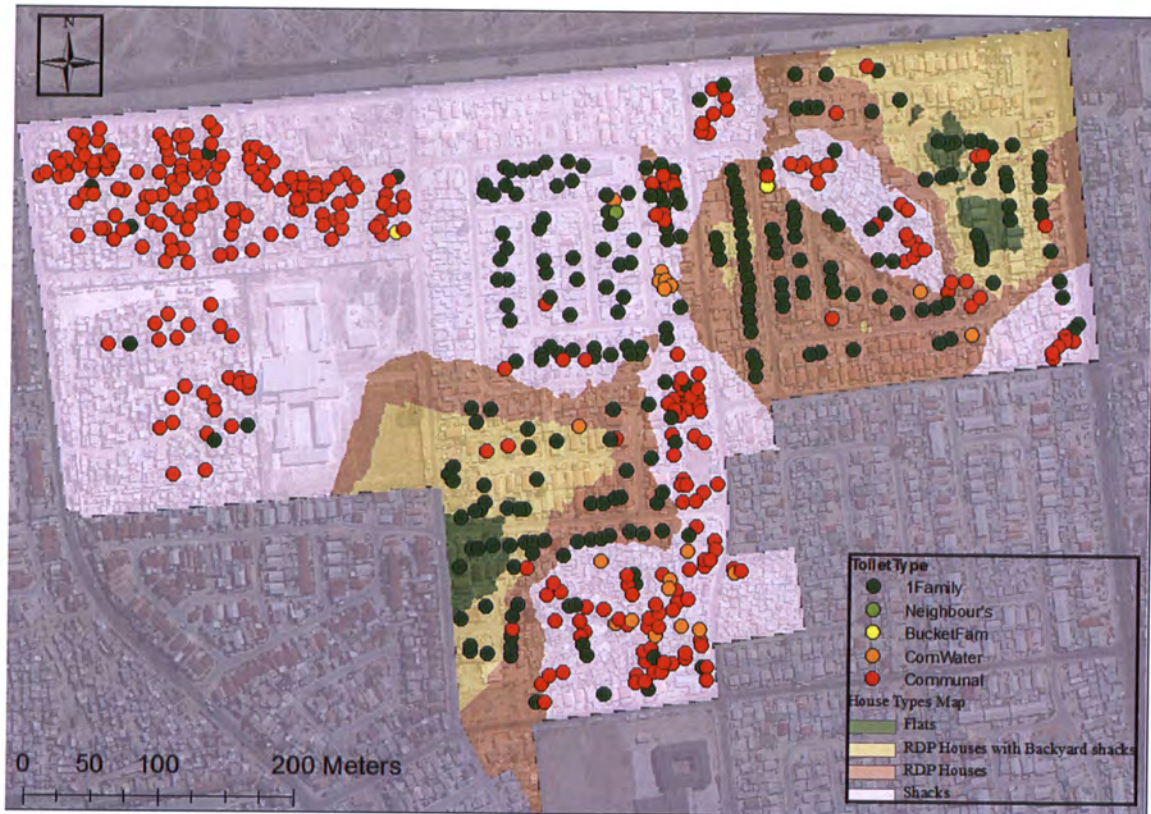


Figure 5.14: Map showing Types of Toilets used

The distribution of Municipal Services was generally found to be greatly varied between formal and informal settlements. The informal settlements that were not yet tagged for the RDP upgrade were greatly disadvantaged in this regard. However, given the proximity of these settlements to the upgraded formal settlements, some of the effects of this disadvantage affected the formal settlements as well. For instance, an open refuse dumping area that was next to a day-care centre (refer to section 3.4.6) affects all the children at the day-care centre and their parents (from both formal and informal settlements) as well as anyone who passes by the street where day-care centre is located.

#### 5.1.10 Physical activity

Proximity to recreational and physical activity sites and offices or schools have been linked to an increase in active behaviours, and positive impacts on health outcomes such as lower rates of cardiovascular disease, diabetes, and obesity (Maroko *et al.* 2009). This is because people living in close proximity to their offices, schools and malls or shopping complexes are more likely to walk to these establishments.

Similarly, those that stay in close proximity to recreational and physical activity sites were found to be more likely to make use of these facilities. Nonetheless, it was discovered from the questionnaire responses that due to both environmental and personal reasons, the study participants generally had very low levels of physical activity.

Questionnaire questions for this section were designed to expose the respondents' daily participation in physical activity. Physical activity information was collected in three settings (or domains) and sedentary behaviour (WHO 2012; CDC 2009).

These domains were:

- Activity at work
- Travel to and from places
- Recreational activities

The mode of transportation a participant uses to travel to and from places was used as a measure of intensity of physical activity in the "travel to and from places" domain. The type of activities that a participant undertook during their spare time was used as indicator of whether they demonstrated sedentary behaviour or not. While for activity at work and recreational activities domains, the following categories were used as measurements:

**Table 5.1 Categories of physical activities**

<b>DOMAIN</b>	<b>CATEGORY</b>	
Activity at Work	Vigorous	Involves work that causes large increases in breathing or heart rate like carrying or lifting heavy loads, digging or construction work.
	Moderate	Involves work that causes small increases in breathing or heart rate such as brisk walking or carrying light loads for at least 10min.
	No activity	No physical activity e.g office work
Recreational Activities	Vigorous	Involves regular sports, fitness or recreational (leisure) activities that

		cause large increases in breathing or heart rate e.g running, football.
	Moderate	Involves sports, fitness or recreational (leisure) activities that cause small increases in breathing or heart rate e.g brisk walking, cycling, swimming
	None	No Sports at all

Figure 5.15 below shows the number of participants that reported to engage in a certain type of physical activity. It was found that (94%) of the respondents with some sort of occupation did moderate physical activity while at school, work or at own business (See figure 5.15 below).

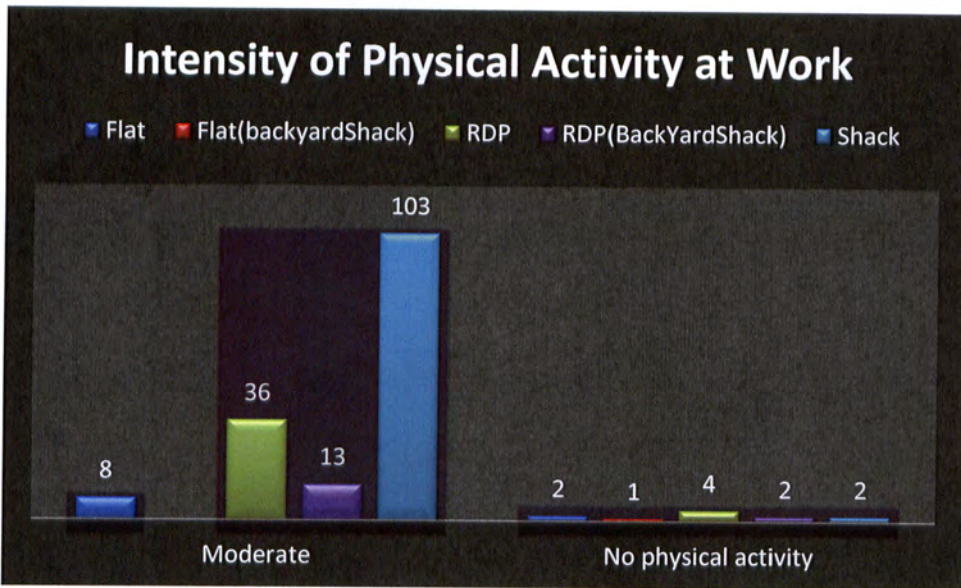


Figure 5.15: The number of respondents whose job involved some physical activity

On the other hand, despite the fact that there is a sports complex with a public swimming pool, cricket pitch and gymnastics facility about three kilometres from Brown’s Farm, only 9% of the participants reported that they moderately participate in sports, fitness or recreational activities (See figure 5.16 below).

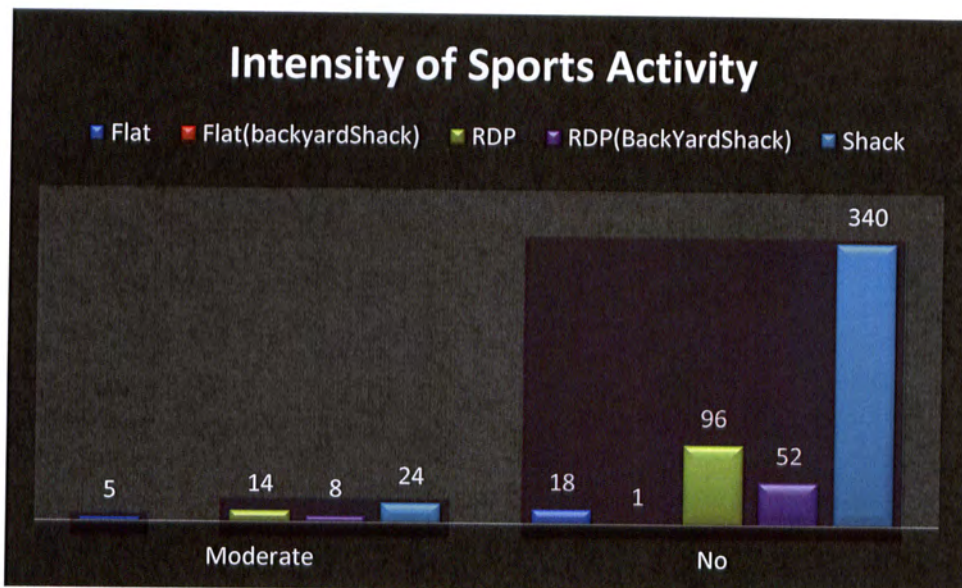


Figure 5.16: The number of respondents who regularly engage in sports

Figures 5.17, 5.18 and 5.19 below are maps showing participants' preferred modes of transportation. Of the 165 employed participants, only 1 reported to cycle to work, while 56 participants reported that they walk. Furthermore, 42% of the participants reported that they walk to access grocery stores, 41% use a taxi and 17% bus or own transport. Many people walk to do groceries shopping because the popular grocery stores (spaza shops and supermarkets) are located within less than two kilometres from Brown's Farm (See figure 5.17). Additionally, 57% of the participants claimed to walk to a health facility and 43% reported that they use a bus, taxi or train (See figure 5.18). Also, 96% of the participants reported that they either sleep or watch television during their spare time.

Physical inactivity was not more of a concern in one particular part (formal or informal) of the study area than the other.

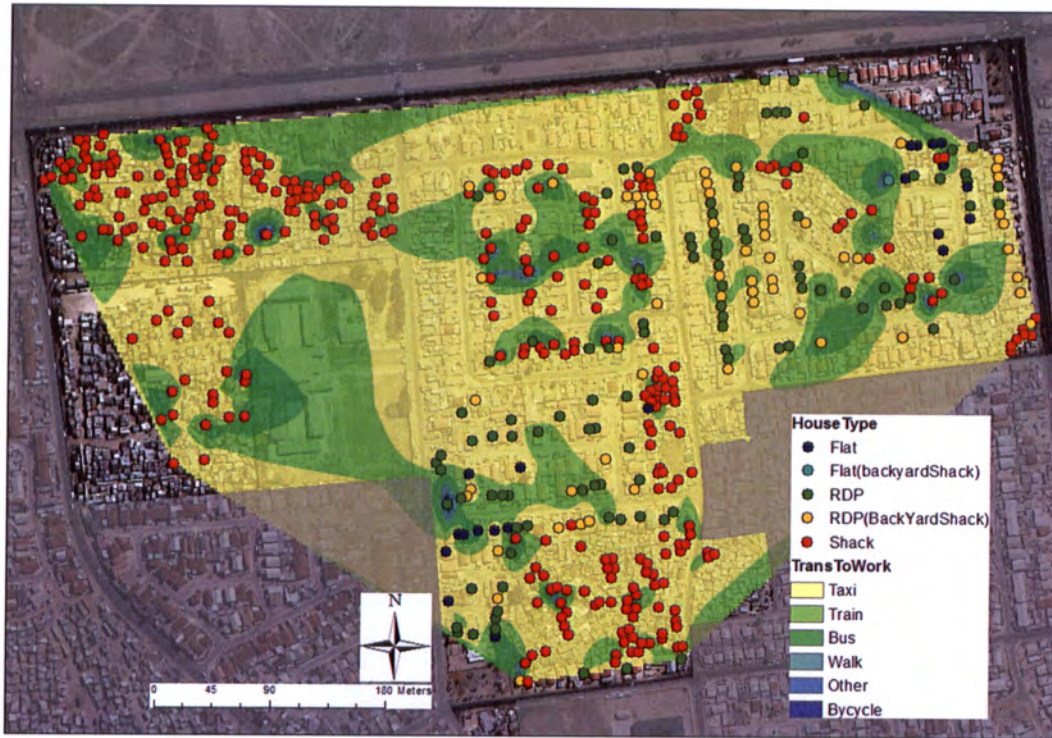


Figure 5.17: Mode of transport to work

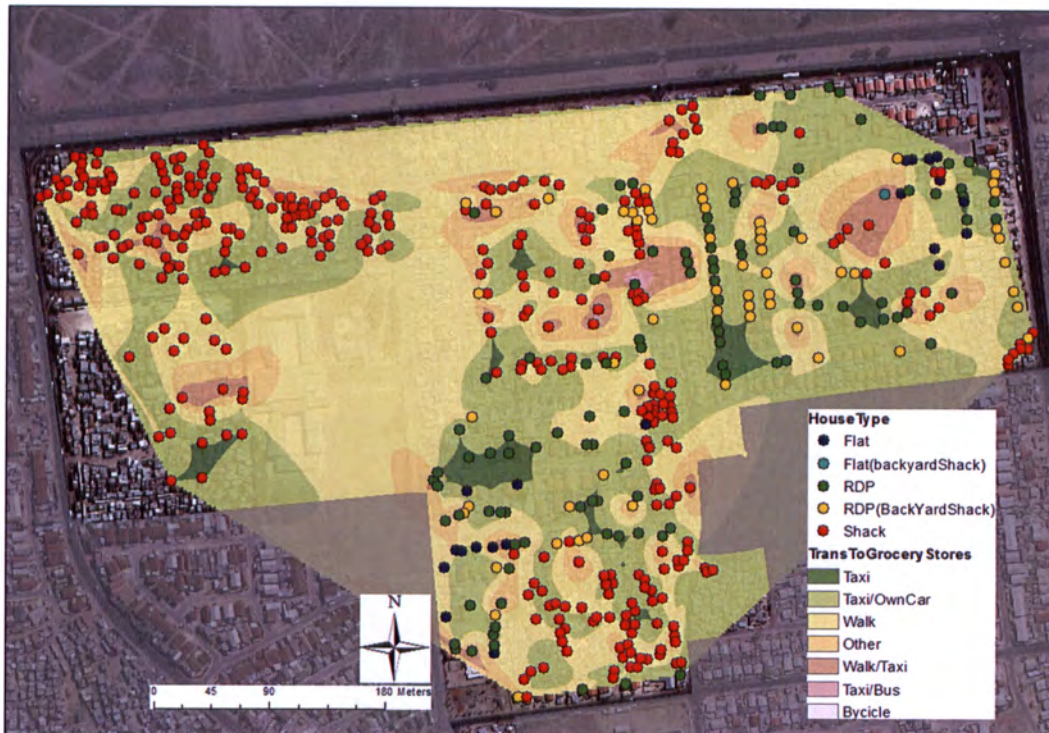


Figure 5.18: Mode of transport to Grocery Stores

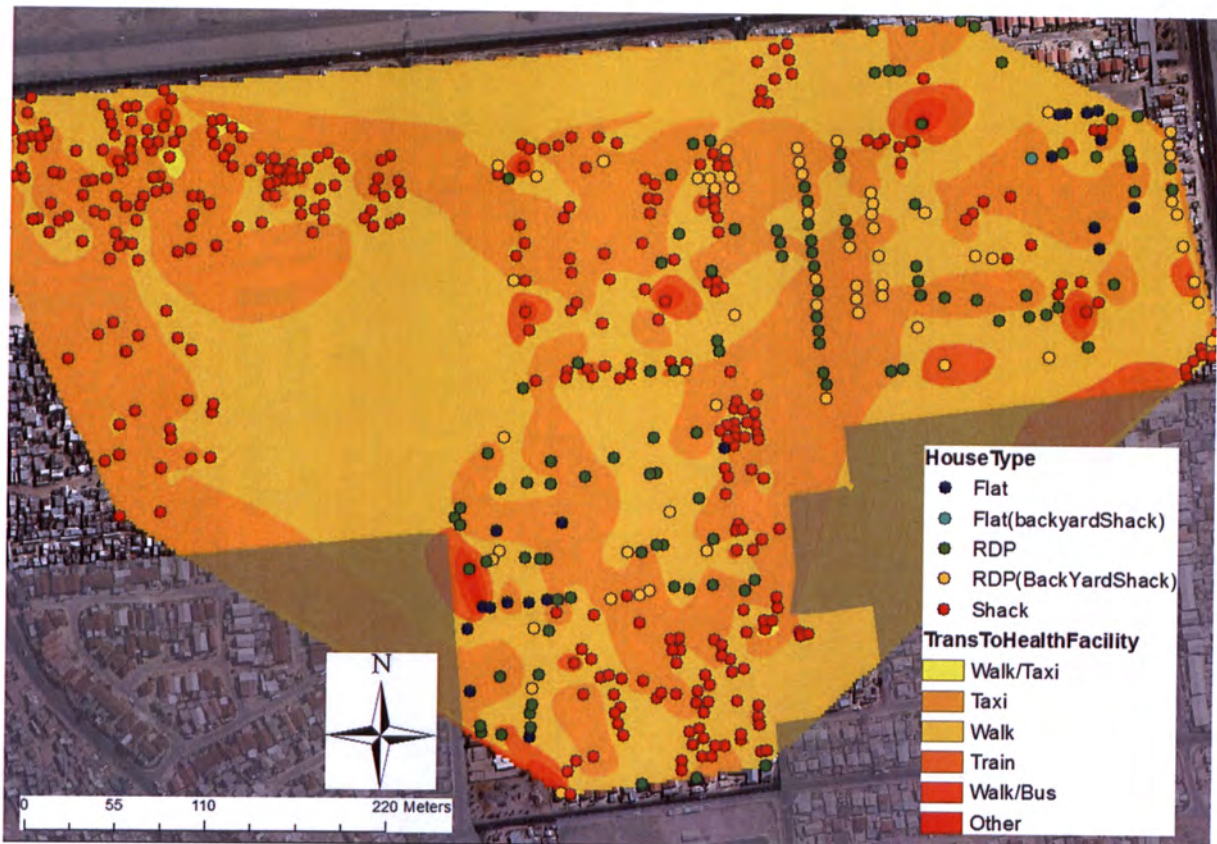


Figure 5.19: Mode of transport to Health Facilities

## 5.2 Analysis of Health Results

This section presents results showing spatial distribution of HIV/AIDS, TB, Obesity, Hypertension and Diabetes hotspots. The Inverse Distance Weighting (IDW) method of interpolation was applied to the hotspots results to create a raster map and present the results as aggregated data (Kamel Boulos *et al.* 2011). Health data was available for only 162 participants that consented to test on the Tutu mobile. The analysis results cover only the areas of residence of those that tested positive to the health tests (indicating the presence of the diseases). To identify possible relationships, maps of social and environmental variables were also overlaid on the hotspots maps.

### 5.2.1 HIV/AIDS Cluster Detection Results

This section presents the results of Getis-Ord $G_i^*$  and Moran's I statistics for HIV/AIDS.

Getis-Ord $G_i^*$  statistic detected complete randomness in the way that the HIV/AIDS incidences were distributed across the study area. This means that the Cluster and

outlier analysis tool detected no statistically significant outliers and clusters in the HIV/AIDS incidence data. Nonetheless, hotspot analysis tool detected very weak statistically significant clusters of HIV/AIDS with the Zscores of 1.68 and 2.44 and the P-values of 0.09 and 0.05 respectively. This clustering was detected around the informal settlement area. Figures 5.20 and 5.21 below show the HIV/AIDS hotspots map overlaid with the income and qualifications categories distribution maps respectively. Literature on the association between economic deprivation and HIV/AIDS was confirmed as the majority of the participants within the hotspot were unemployed, went only as far as some high school (only 5 completed matric) with their studies and reported a monthly household income brackets of R0-R2000 and R2001- R4000 (See figures 5.20 and 5.21 below) (Obbo 1993; De Cock *et al.* 1992; David *et al.* 2007).

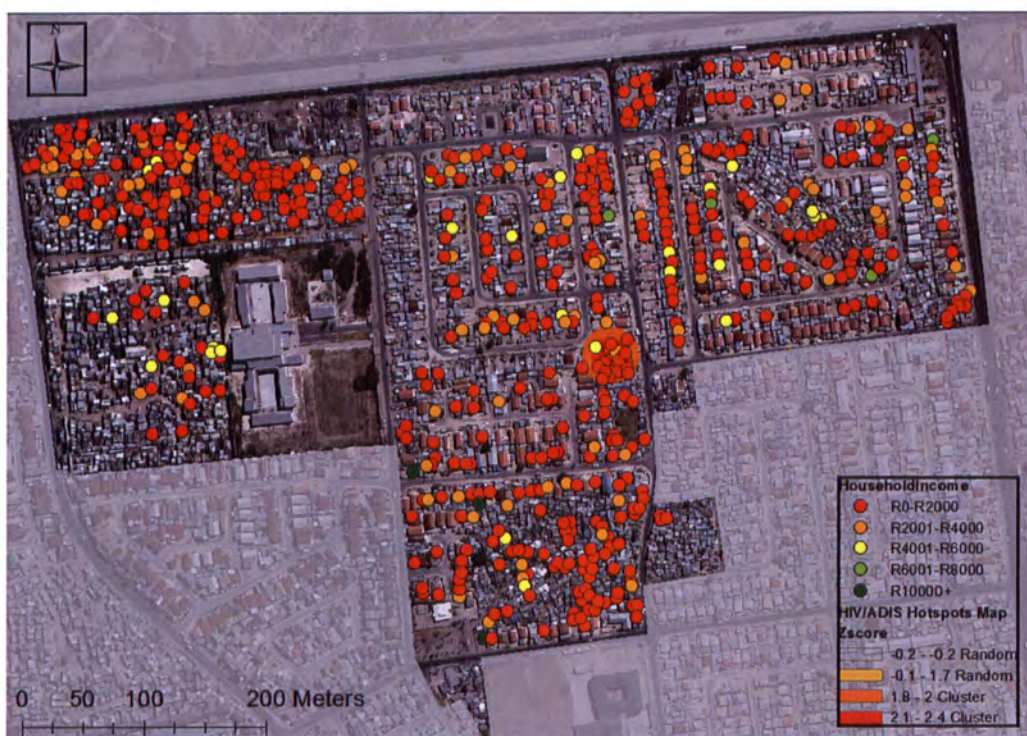


Figure 5.20: Overlay map of HIV/AIDS hotspots and participants' monthly household income

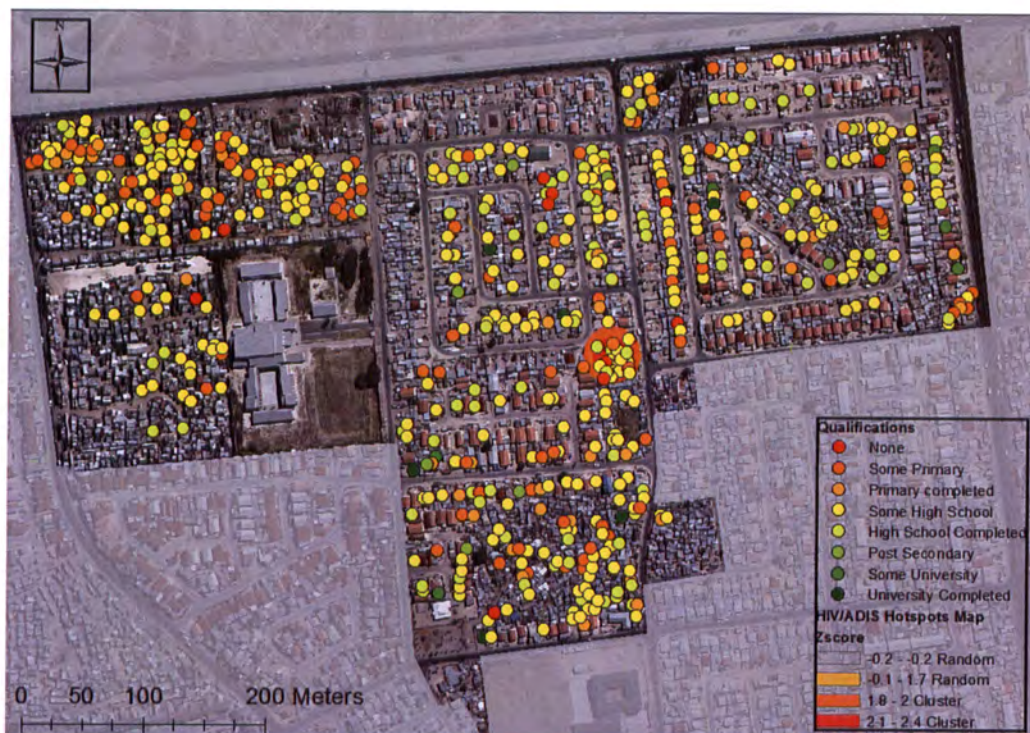


Figure 5.21: Overlay map of HIV/AIDS hotspots and participant's qualifications

### 5.2.2 TB Cluster Detection Results

Low socio-economic status, overcrowded households, neighbourhoods, schools and public transport facilities have been established by literature as contributing factors to high TB transmissions in South Africa (Baker *et al.* 2008; Dye *et al.* 2012).

Presented herein is the results of Getis-Ord $G_i^*$  and Moran's I statistics for TB incidences. Getis-Ord $G_i^*$  statistic detected complete randomness in the way that TB incidences were distributed across the study area. This means that the Cluster and outlier analysis tool detected no statistically significant outliers and clusters from the TB incidence data. The hotspot analysis tool detected very weak statistically significant clusters of TB with the Zscore of 2.68 and the P-value of 0.007. This clustering was detected around the informal settlement area.

Figures 5.22, 5.23 and 5.24 below show the TB hotspots maps overlaid with income, qualifications and mode of transport to work category distribution maps respectively. The following monthly household income classes were found within the hotspot;

R0 – R2000 and R4000 – R6000 (see figure 5.22). The participants within the hotspots area had not completed matrix (see figure 5.23). Public transport was reported as the mode of transportation used by participants within the hotspot (see figure 5.24).

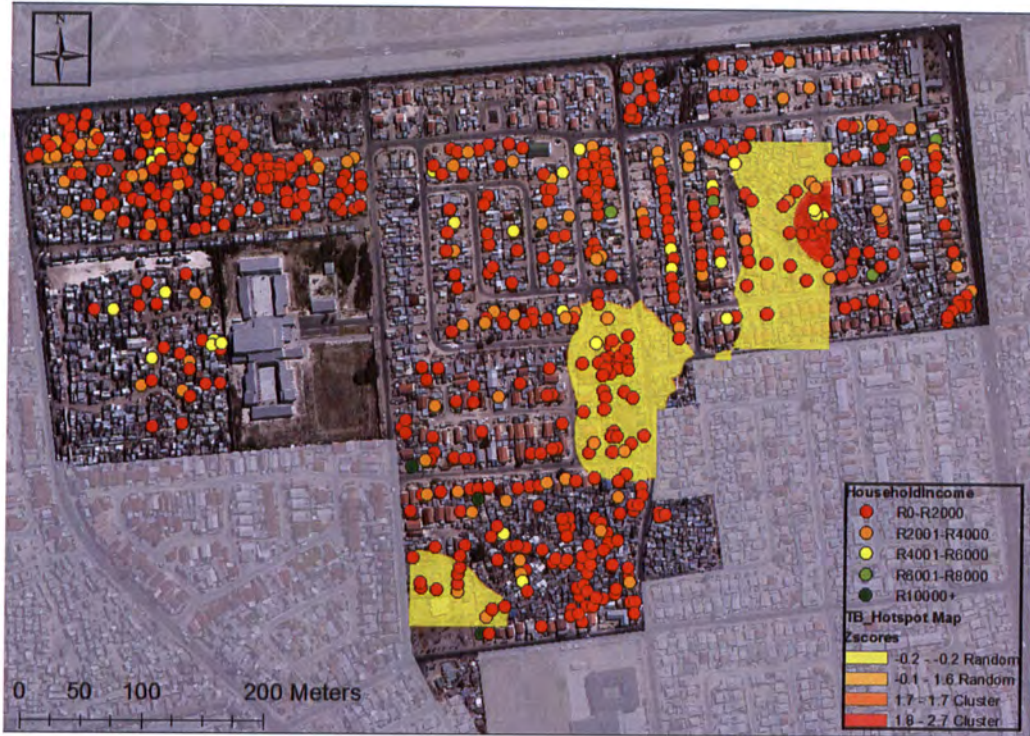


Figure 5.22: Overlay map of TB hotspots and participants' monthly household income

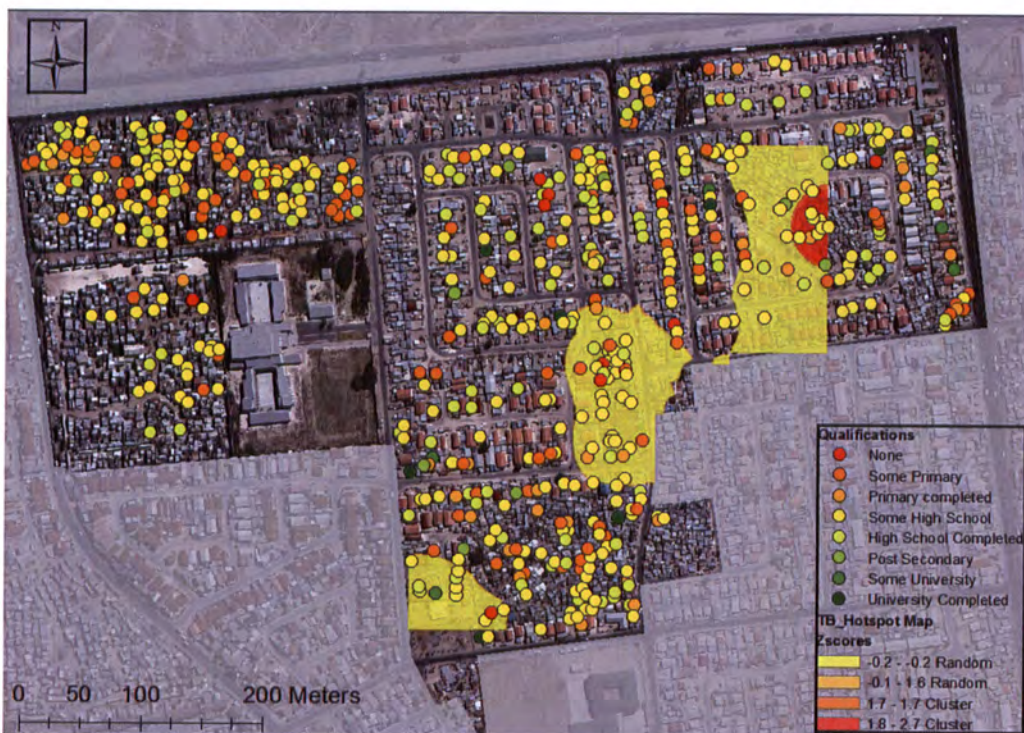


Figure 5.23: Overlay map of TB hotspots and participants' qualification

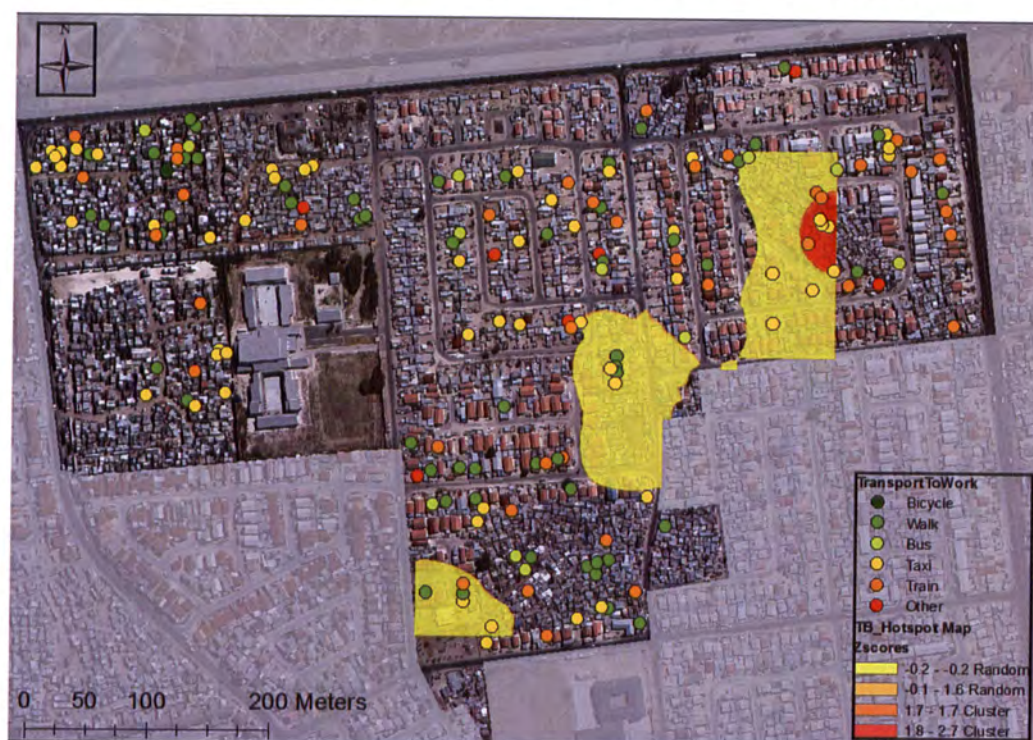


Figure 5.24: Overlay map of TB hotspots and participants mode of transport to work

### 5.2.3 Obesity and overweight Cluster Detection Results

This section is a presentation of Getis-Ord $G_i^*$  and Moran's I statistics results for obesity and overweight incidences. The results of the exploration of possible socio-economic contributing factors to the distribution of obesity and overweight across the study area are also presented herein.

The Cluster and Outlier analysis tool identified statistically significant outliers with the Zscores of -2.94, -2.23 and Pvalues of 0.00 and 0.03. The outliers were removed from the data before the hotspot analysis was run. The hotspot analysis tool detected statistically significant clusters of obesity and overweight with the Zscores of 1.91, 2.28, 2.20, 1.73 and the Pvalues of 0.06, 0.02, 0.03, 0.08 respectively. The clusters were detected around an informal settlement area.

Generally, the risk factors for obesity and overweight have been shown to be lack of physical activity and healthy diet (Lopez-Zetina *et al.* 2006; Booth *et al.* 2005; Frank *et al.* 2004). Lately obesity has been found to be more prevalent amongst the urban poor (Ziraba *et al.* 2009).

Hence figures 5.25, 5.26, 5.27, 5.28 and 5.29 below show the obesity and overweight hotspots map overlaid with occupation, income, qualifications and preferred mode of transport categories distribution maps respectively.

All the participants within the area of the hotspot watched TV or slept during their spare time, 90% of them did no sports whatsoever, and their preferred mode of transport from one place to another was almost an equal mixture of taxi and walking (See figures 5.28 and 5.29 below). The participants within the obesity and overweight hotspot area were also found to be economically disadvantaged (See figures 5.25, 5.26 and 5.27).



Figure 5.25: Overlay map of Obesity & Overweight hotspots and participants' occupation

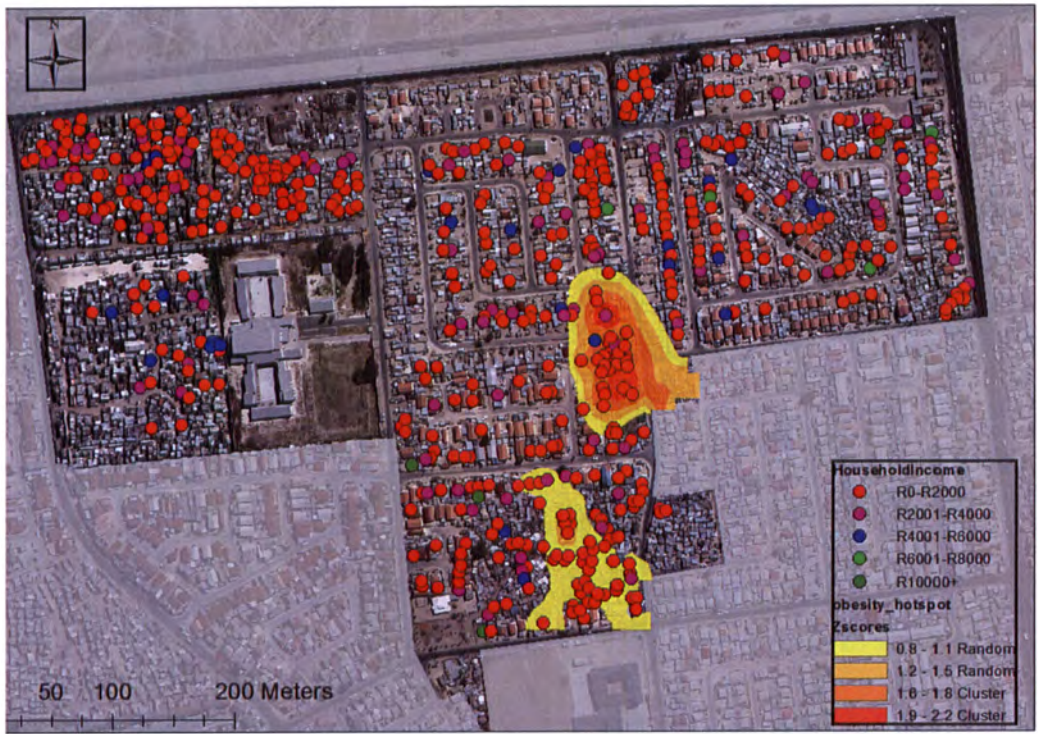


Figure 5.26: Overlay map of Obesity & Overweight hotspots and monthly household income

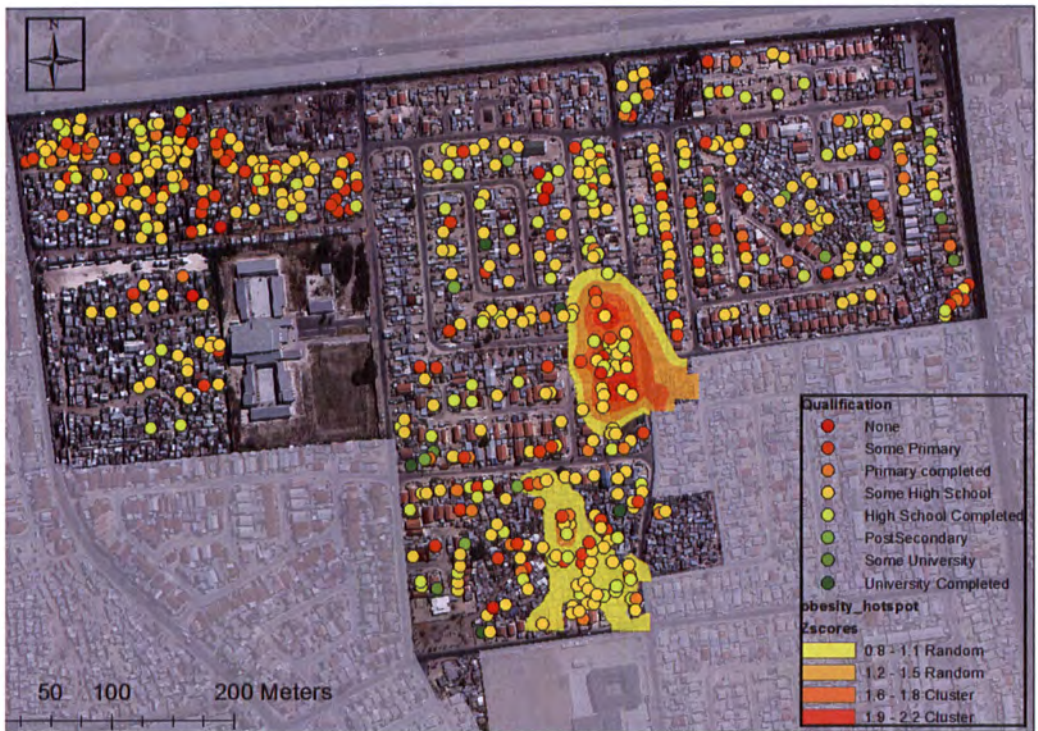


Figure 5.27: Overlay map of Obesity & Overweight hotspots and participants' qualifications

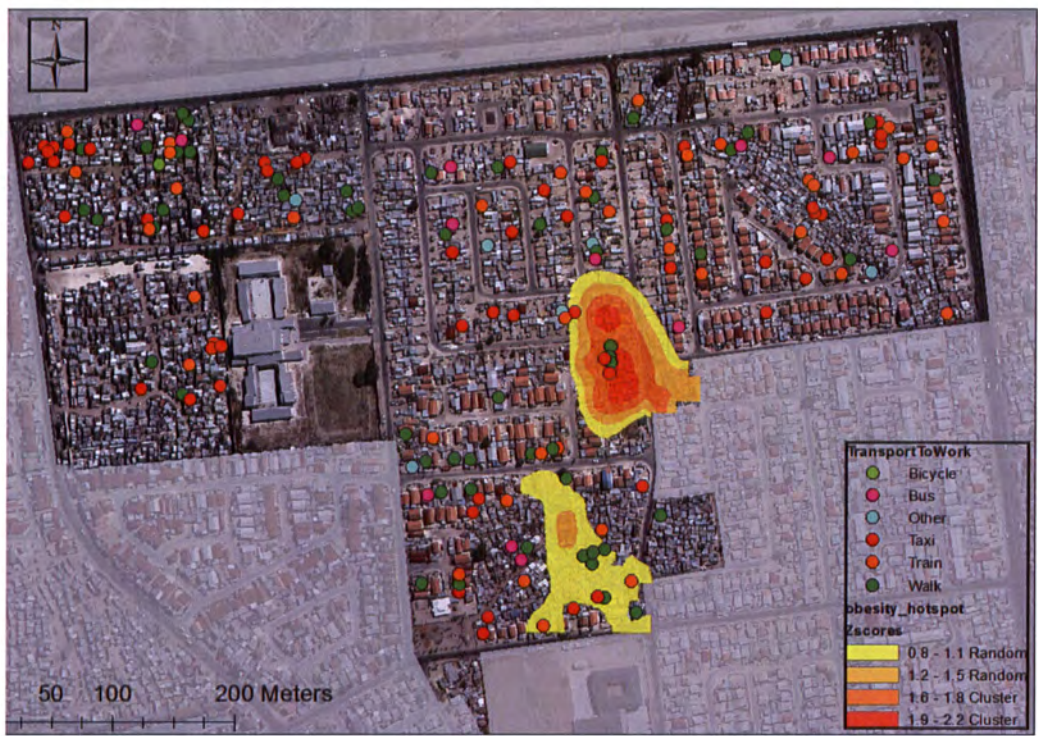


Figure 5.28: Overlay map of Obesity & Overweight hotspots and preferred mode of transport to work

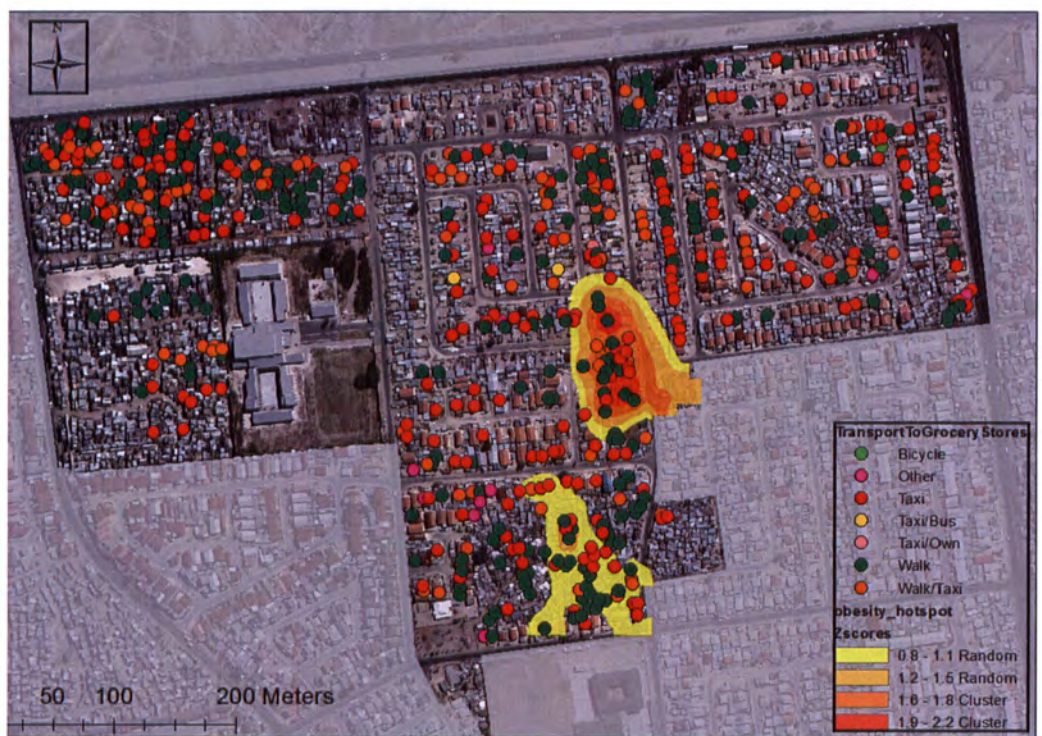


Figure 5.29: Overlay map of Obesity & Overweight hotspots and preferred mode of transport to grocery stores

#### 5.2.4 Hypertension Clusters Detection

Herein presented is the results of Getis-OrdG<sub>i</sub>\* and Moran's I statistics for hypertension incidences. The results of the exploration of possible socio-economic contributing factors to the distribution of hypertension across the study area are also presented herein.

The cluster and outlier analysis tool detected no outliers on the hypertension incidences data. On the other hand, hotspot analysis tool has noted statistically significant clusters with the Zscores of 1.70 and a Pvalue of 0.09. The cluster was within the informal part of the study area.

Figures 5.30, 5.31 and 5.32 below show the hypertension hotspots map overlaid with, preferred mode of transport to work, income and qualifications categories distribution maps respectively.

The monthly income class of the participants within the hypertension hotspot was R 0 - R 2000, also none of them completed matric (see figures 5.31 and 5.32). The participants within the hotspot also reported to be generally inactive, only one reported walking as a mode of transport from work because they worked within the Brown's Farm area (See figure 5.30 below).

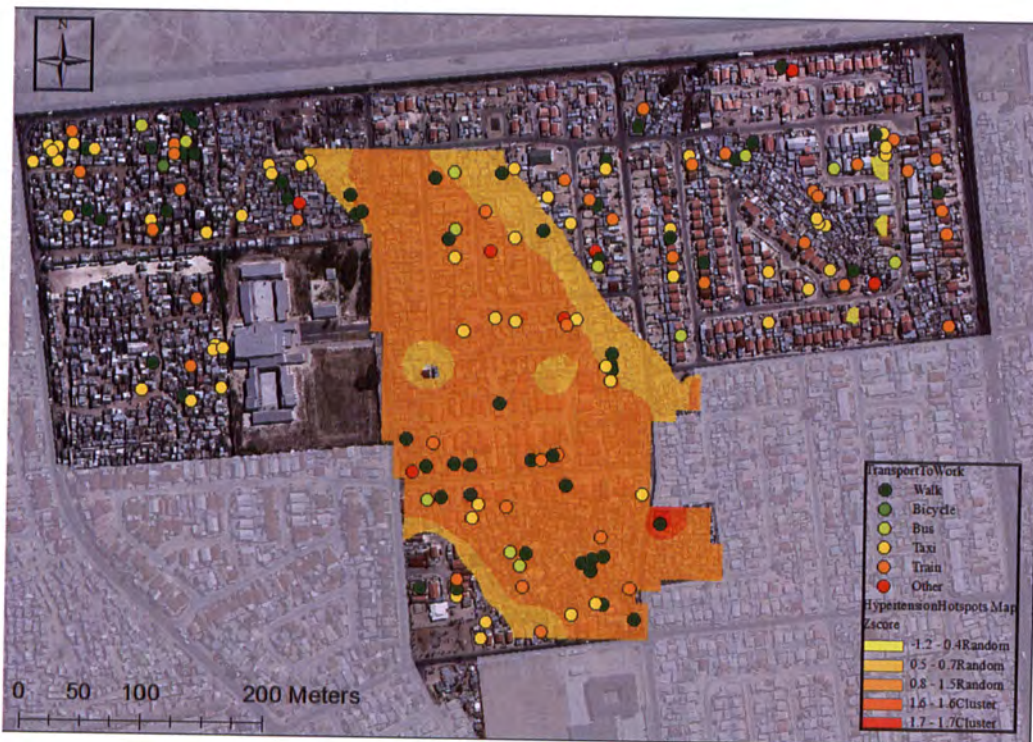


Figure 5.30: Overlay map of hypertension hotspots and preferred mode of transport to work

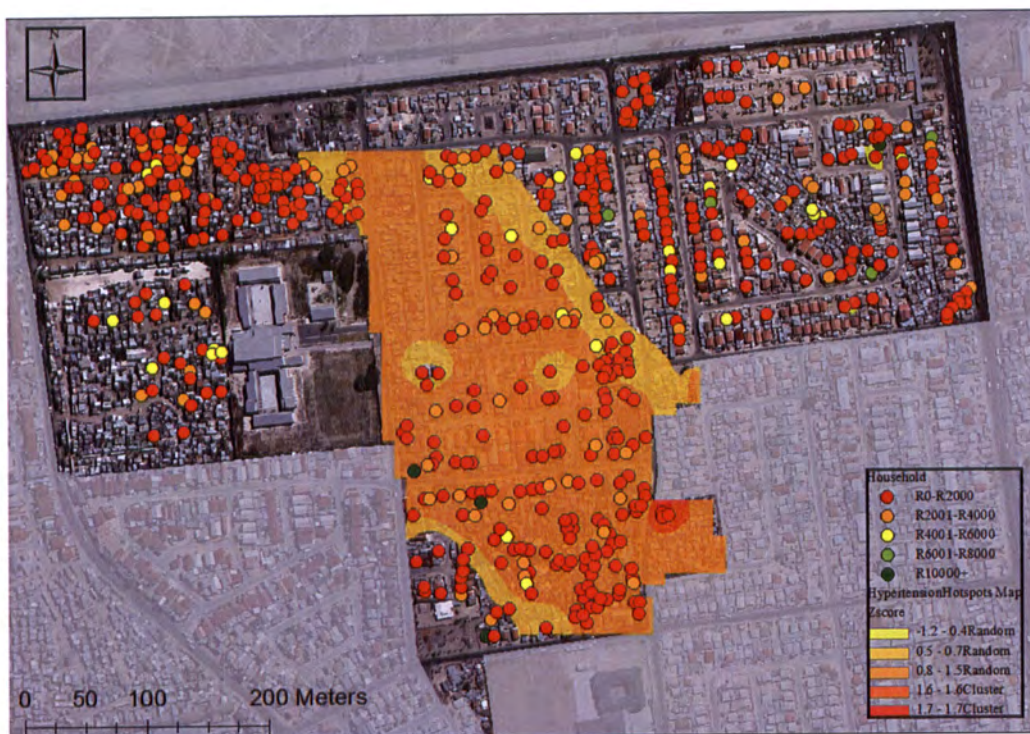


Figure 5.31: Overlay map of hypertension hotspots and monthly household income

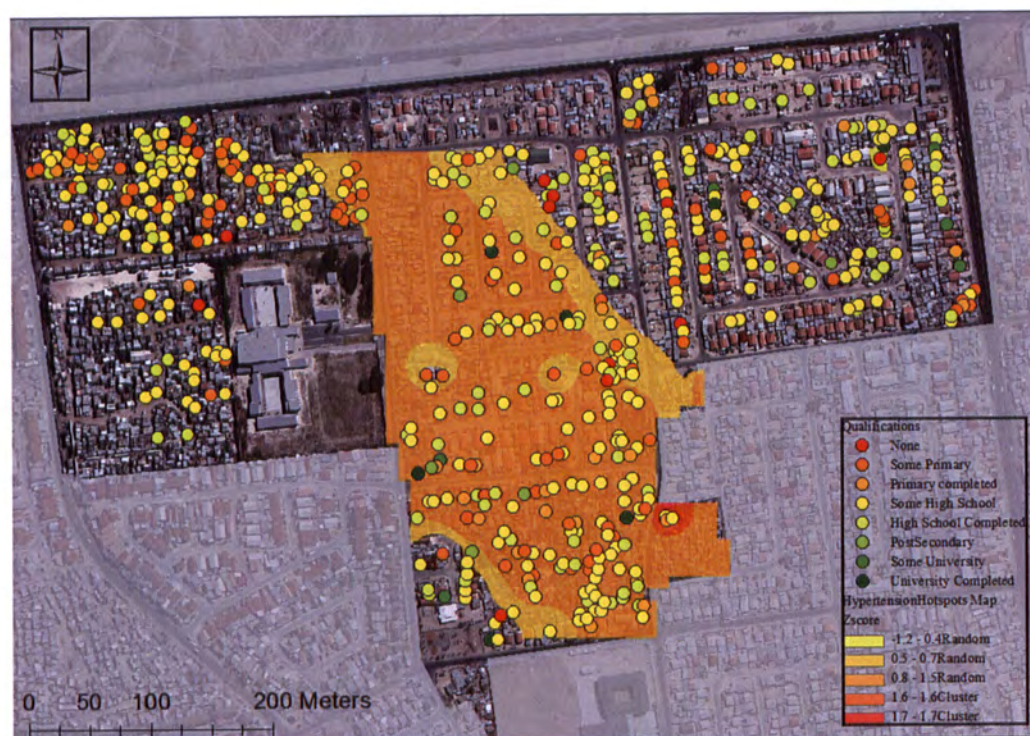


Figure 5.32: Overlay map of hypertension hotspots and participants' qualifications



### **5.2.5 Diabetes Cluster Detection Results**

There was a complete random distribution of diabetes incidences within the study area. This was noted by both cluster and outlier and hotspot analysis tools. This means that there was no particular area within Brown's Farm where high incidences of diabetes were clustered together enough to call for statistical concern.

### **5.3 Summary**

The socio-economic status within the study area was found to be quite homogeneous. There was no difference in socio-economic status between participants from the formal and informal part of the study area. Municipal services such as collection of refuse, provision of water and sanitation were greatly varied, with the formal area being at an advantage in this regard. Also, the weak clusters of diseases within the informal part of the study area shows that the data used in the study generally indicates very limited variation in the way that the diseases test results are distributed across different dwelling types in Brown's farm. This suggests that in terms of health status there was not much of a difference between people who stay in a shack and those that stay in an RDP house.

## **CHAPTER 6 RESULTS DISCUSSION AND INTERPRETATION**

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### **6.1 Introduction**

The burdens imposed by diseases extend beyond the physical and monetary, impacting the sick and those around them in immeasurable ways. This thesis sought to answer the question: what are the spatial patterns of diseases, as embedded in the built environment in "Brown's Farm" Philippi? To answer this question, GIS was used as an exploratory tool for examining spatial datasets and also as a quantitative tool; testing statistics against a hypothesis of a random distribution of HIV/AIDS, TB, Diabetes, Hypertension and obesity across the study area. This chapter discusses and interprets the findings that were presented in Chapter Five.

### **6.2 Socio-economic status**

As shown in chapter 5, the descriptive statistics run on the socio-economic data suggested that there existed a great deal of socio-economic status homogeneity across different built environments in Brown's Farm. Indicating that socio-economic profiles; occupation, income and qualifications of the study participants were similar, despite the difference in built environments of residents. Since people staying in the RDP houses were previously from the informal settlements, they continue to be poor, unemployed and uneducated even after the settlement upgrade. The findings of clustering of HIV/AIDS, TB, Obesity and Overweight and Hypertension amongst the low socio-economic class participants is consistent with the literature which states that the poor are more vulnerable to diseases (Sclar *et al.* 2007). However, the lack of variation in the distribution of the socio-economic status across the study area was the reason why socio-economic status was unable to explain why the hotspots of HIV/AIDS, TB, Hypertension and Obesity and Overweight were located within the informal settlements.

### **6.3 Physical activity**

The low level of physical activity reported in the study was also found to be homogeneous and did not vary across different house types. This to a certain extent could be tied to societal behavioural factors, in that, even though there exist

recreational facilities within 1km buffer of Brown's Farm area, the community members (both formal and informal) do not utilize them. All the participants within the diseases clusters areas were found to exhibit sedentary behaviour as they reported that they preferred to watch TV during their spare time. Another contributing factor to the low levels of physical activity was observed to be the limited job opportunities within the study area; forcing people to work as far as the city bowl, southern suburbs or northern suburbs etc, having to travel at least 20km to work every day by car or bus.

Hence, physical activity as a variable was unable to explain why clustering of HIV/AIDS, TB, Hypertension and Obesity and Overweight were located within the informal settlements part of the study area. Even though the fact that the participants within the disease clusters were found to be very sedentary might be consistent with the existing literature on the link between health and physical activity (Lopez & Hynes 2006; Handy *et al.* 2002). It is the author's opinion that in this study physical activity was not an independent predictor of the distribution of diseases across the study area. This is because the data revealed homogeneity in the distribution of physical activity behaviours of the study participants across the study area.

#### **6.4 The built environment**

The absence of pedestrian routes and lack of streetlights within the area were highlighted as major factors that might discourage walking for leisure and jogging across the study area. This was the case for both formal and informal part of the study area. Nonetheless, all communal service facilities (clinics, libraries, schools, shopping centres etc) were within 3km (less than the 5km recommended by the CSIR in the CSIR Guidelines for the provision of communal service facilities in South African Settlements of 2012) of Brown's Farm and could be accessed by foot. This explains why over 80% of the study participants (formal and informal) walked to access all the communal service facilities. Conversely, the dwelling type and municipal services were greatly varied across the study area, with the formal houses (RDP) in the formal area and the shacks in the informal area. Municipal services were also only accessible to the formal part of the study area.

The clusters of HIV/AIDS, TB, Hypertension and Obesity and Overweight were found in the informal unserviced parts of the study area. Hence, the data used in the study has proved the study hypothesis which stated that the disease profiles of "Brown's Farm" Philippi is influenced by the built environment (house types and services) factors of where people reside. A fact that coincides with the literature (Sclar & Northridge 2003).

## **6.5 Data and Methods**

Access to clinic data was vital to the analysis conducted in this thesis. While not an explicit topic within this thesis, the value of effective and comprehensive processes for attaining health data for research cannot be understated. However, the author is very much aware of the importance of striking a balance between respect for the confidentiality of patients and health care workers and the broader societal benefits of data provision for health research.

Nonetheless, reliable and timely information on the leading causes of death in populations, and how these are changing, is a crucial input into health policy debates and disease surveillance programmes, especially in Africa.

The use of questionnaires for socio-economic data collection was a generally successful approach, more so for achieving community participation in the processes of the study, however, it was expensive and time consuming. Mobile phones questionnaire methodology could have been cheaper, quicker and would have captured real-time socio-economic data capture. However, mobile phones questionnaires are usually characterised by low response levels. Therefore, since the dwelling types had to be manually captured on site anyways it was found feasible to concurrently administer the face-to-face questionnaire.

## **6.6 Study Outcomes**

- It was found that both the formal and informal housing conditions within the study area were vulnerable to flooding. This puts the quality of the government subsidized formal houses in the area into question.

- The analysis of the participants' socio-economic data indicated similar socio-economic status across the residents of both formal and informal built environments.
- An evaluation of the spatial distribution of the diseases reflected very weak diseases clusters within the informal part of the study area.

## **6.7 Conclusions**

The study results have proved the hypothesis which stated that the disease profile of a society is influenced by built environment factors of where people live.

While the relationships between health and socio-economic status and built environment variables revealed by the data are consistent with the literature studied in chapter one, the data used was not significant enough to reveal how these variables could explain variations in diseases distributions.

## **6.8 Recommendations**

The recommendation of this research is therefore that a long term study with clinic data has more potential to show more variations in the disease distributions and provide more insight into the relationship between the built environment factors and health. Also, a more significant amount of time is required to investigate the impact of RDP housing on residents' health as the case study site is still in the process of being upgraded. This study forms a pilot and could be seen as establishing the methodology for future more exhaustive investigations.

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