A socio-economic and spatial investigation into the health implications of air pollution in Richards Bay, KwaZulu-Natal, South Africa

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DECLARATION

The Registrar Academic
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Dear Sir/ Madam

I, Jyotikumarie Jaggernath, Registration Number 200000983, hereby declare that unless otherwise indicated, this thesis is my work and has not been submitted in part or full for any other degree purposes at any other University.

15 March 2013

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DEDICATION

This thesis is dedicated to the loving memory of my late parents

Mr Sathish Tirubeni Jaggernath
&
Mrs Nimmi Jaggernath

whose advice, encouragement and wisdom has paved the path for my future successes.

Your spirits are my guiding light and inspiration.

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ABSTRACT

There is increasing recognition of the links between air pollution and human health. Epidemiological studies have shown that there are numerous air pollutants that are associated with indoor energy use and with the production processes of industries, and most represent some sort of health implication. However, in-depth and fundamental knowledge of the health impact relationship of most pollutants is limited. This research evaluates the socio-economic and spatial aspects of the health implications of air pollution in Richards Bay (located 200 km north of Durban), KwaZulu-Natal. The research explores community perceptions and complaints relating to human health impacts emanating from air pollution in Richards Bay. The research is informed by a multi-conceptual framework (political economy incorporating political ecology, place perspectives and environmental justice) which influenced the methods chosen in conducting the research. Standard quantitative and qualitative methods were employed in the study to generate data relating to the research objectives. The process of triangulation which is the use of multiple methods that cuts across the qualitative-quantitative divide was used. The various sources of information validate and clarify data by deepening and widening an understanding of the main issues under examination. The research was implemented in various communities in Richards Bay that reflect socio-economic differences, which contributes significantly to ascertain whether health impacts are differentially experienced by different socio-economic groups. Furthermore, the research cross-tabulated experiences, perceptions and coping strategies of different socio-economic groups in the area, especially in relation to upper, middle and lower income clusters. The spatial aspect of the research (mapping of key social and health variables) is a major contribution of this research, which draws from the field of medical geography. Information on the main residential areas was illicitied from documents providing background details on Richards Bay. A purposive sampling approach was adopted to identify the seven communities, namely, Alton, Aquadene/ Brackenham, Arboretum, Meer-en-See, Empangeni Rail, Nseleni and Umhlathuze. Simple random point sampling was used to identify the households within the communities. The number of households in each community was determined using proportionate sampling. Four hundred and seventy nine housholds (479) were interviewed which was deemed to be a statistically relevant sampling size at a 95% confidence level.

The study findings indicate that the lower income areas (Nseleni, Empangeni Rail and Umhlathuze) and the middle income areas (Aquadene/ Brackenham and Arboretum) have a more youthful population with a significant number being children, while the upper income areas (Alton and Meer en See) have a more elderly population. A similar trend was also found in relation to household size. There are clearly major variations in household income and employment types in Richards Bay, linked in part to the geographical location of communities based on economic and racial groups. Lower earning respondents were located mostly in the lower status areas which were classified as predominantly African populated areas as per the historical race classification and apartheid segregated areas. More than half of the respondents indicated that industrial smoke was the cause of their present health conditions. Other stated reasons were wide ranging and therefore there was no discernible pattern that emerged in relation to the causes for poor health experienced by the affected household member. However, the data did show that more respondents living in middle/ upper income areas identified causes. Reported health conditions include allergies (30.9%), coughing (29.8%), wheezing (25.5%), chest pains (18.4%) and asthmatic bronchitis/ asthma

(17.7%). With regards to health care, the findings from the study show that the economically better off communities (Alton, Aquadene/ Brackenham, Arboretum and Meer en See) used the private, more expensive health care sector while generally households in lower income areas tend to rely on public or traditional health care facilities. An interesting finding was that most respondents rate their general health status as either excellent, good (more respondents from the middle/ upper income areas than the lower income areas) or satisfactory (more respondents from Umhlathuze). A large majority of the respondents reported air pollution as the main problem that is associated with industries in Richards Bay while the health impacts of pollutants from the industries manufacturing processes was the second main cause. The areas deemed to be the most polluted were generally in or in close proximity to the industrial area or the port area. Lower income areas tendered to be most polluted, according to respondents residing in these areas or who lived in similar low income areas. The majority of respondents were found to be living in dwellings/ households made from dwellings constructed with brick and asbestos, brick and zinc, stone and other traditional materials which is indicative of housing in the poorer communities who live in informal dwellings/ households and may be a causal contributing factor of the poor health status of these communities. The participatory mapping exercise conducted during the focus group discussion revealed that participants identified the industrial areas (including the port and surrounds) as the most polluted areas. Areas outside Richards Bay were considered to be the least polluted areas.

The research findings indicate that there are a complex mix of socio-economic, environmental and spatial dynamics that influence air pollution and health impacts. Thus, health issues in the context of widespread air pollution concerns are linked to social, political and environmental aspects that require urgent attention. Air pollution and health impacts remain major concerns in many parts of the world, especially in areas of high levels of industrial development such as Richards Bay. The results of this research, therefore supports the findings of other researchers who reveal that communities/ neighborhoods of lower income status are most likely to bear the brunt of negative impacts and that air pollution from indoor uses of energy, behavioral factors such as cigarette smoking and industrial processes contribute to an individual’s/ community’s quality of life.

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ABBREVIATIONS AND ACRONYMS
LIST OF ABBREVIATIONS

AIDS	Acquired Immune Deficiency Syndrome
BRS	Building Related Syndrome
CO	Carbon Monoxide
CSIR	Council for Scientific and Industrial Research
DALYs	Disability Adjusted Life Years
DEAT	Department of Environmental Affairs and Tourism
EPA	Environmental Protection Agency
GGP	Gross Geographic Product
GIS	Geographical Information System
HAQI	Hamilton–Wentworth Air Quality Initiative
HC	Hydro Carbons
HEC	Homeside Environmental Committee
HIV	Human Immunodeficiency Virus
IPCC	Intergovernmental Panel on Climate Change
L FANS	Los Angelis Family and Neighborhood Survey
MDGs	Millennium Development Goals
NEMA	National Environment Management Act
NGOs	Non-Governmental Organizations
NIMBY	Not In My Back Yard
NO_2	Nitrogen Dioxide
NO_x	Nitric Oxide
O_3	Ozone
OECD	Organization for Economic Co-operation and Development
PM	Particulate Matter
RBCAA	Richards Bay Clean Air Association
RBCT	Richards bay Coal Terminal
RBIDZ	Richards Bay Industrial Development Zone
RBM	Richards Bay Minerals
SDCEA	South Durban Community Environmental Alliance
SO_2	Sulphur Dioxide
SPSS	Statistical Package for the Social Sciences
UNDP	United Nations Development Program
UNFCCC	United Nations Framework Convention on Climate Change
USA	United States of America
VOCs	Volatile Organic Compounds
WHO	World Health Organization

CHAPTER ONE
INTRODUCTION

1.1 Preamble

It is generally recognized that air pollution causes acute and chronic health problems (Chen and Goldberg, 2008; Chen and Goldberg, 2009; Logue *et al*., 2011; Spiric *et al*., 2011; Wright *et al.*, 2011). There is consensus that health issues are regarded by numerous organizations, the public sector and academics as a launch pad for effective planning, development and social change (Ashton, 1992; Baldwin-Ragaven *et al*, 1999; Ebrahim and Ranken, 1988; Lee and Mills, 1983; Moodley, 2002; World Health Organization - WHO, 2000; Zere, 2000). It is at the core of improving quality of life of residents and creating sustainable and liveable environments. According to the Environmental Protection Agency (EPA) (2012) and Moodley (2002), health issues provide an opportunity to promote justice and development. The 1978 Alma-Ata, which is the founding document to promote primary health care globally, outlined political will for implementation in developing countries as a key component of effective delivery and intervention (Alma-Ata Primary Health Care Report, 1978).

Population growth, increasing industrialization, and rising demands for energy and motor vehicles are factors considerably contributing to increasing levels of air pollution in developing country cities (Mishra, 2003). Similarly, Shankar and Ramarao (2002) suggest that health impacts in the developing world have been driven by population growth, industrialization and increased vehicle use that are directly associated with increasing air pollution levels. Current projections in Africa depict air pollution as a significant environmental problem mainly as a result of increasing emissions of industrialization (Stockholm Environment Institute (SEI), 1998). According to SEI (1998), urbanization and industrialization in Africa have increased regional environmental health concerns with regard to air pollution emissions, namely sulphur and nitrogen oxides. Furthermore, at the local level in South Africa, spatial and socio-economic inequalities are common features of both the pre-1994 and post-1994 era (Moodley, 2002; Reitzes, 2009). However, the nature and manifestations generating these inequalities differ considerably and are linked to inequalities in health care provision as well as locational factors including proximity to pollutants and other unhealthy environments.

The effects of air pollution in developing countries are now widespread and are an increasing concern among environmental health workers who are involved in the study of lung diseases (Pandey *et al*, 2005). Several studies indicate that the effects of air pollution on human health are wide ranging and can include irritation of the eyes and upper respiratory system, chronic respiratory disease, wheezing, asthma, lung cancer, heart disease, preterm birth, low birth weight and death (Abelsohn and Stieb, 2011; Clark *et al*. 2010; Gauderman *et al*. 2004; Karr *et al*. 2009; Laden *et al*. 2006; Wu *et al*. 2009; Salam, 2008). Mishra (2003) argues that the impacts of air pollution on human health are relatively dependent on the main type of pollutant, its concentration in the air, exposure duration, additional pollutants in the air, and individual resistance. Mishra (2003) further indicates that air pollution is also known to increase the frequency and severity of attacks of asthmatics, and to cause acute respiratory infections in children and chronic bronchitis in adults. Exposure duration is defined by Mestl (2006) as the human contact with pollutants of a certain concentration for a certain amount of time. Individuals and communities are affected by air pollution in different ways. Pandey *et al.* (2005) assert that there is increasingly growing evidence linking urban air pollution to acute and chronic illnesses amongst all age groups. In general, the people at risk are the poor, children, women and elderly people, and people with pre-existing respiratory disease and other ill health. According to the United Nations Children's Fund (UNICEF), respiratory infections from air pollution were the fourth largest cause of death in children under five years in South Africa with more than 6 000 deaths per year as recorded in 2000. Despite these studies, Arku *et al.* (2008) argue that although Sub-Saharan Africa has experienced the highest growth rate in urban populations than any other region in the world, there has been very limited systematic measurement and monitoring of urban environmental health risks such as air pollution.

Lee and Mannin (1995) state that most atmospheric pollutants are linked to industrial processes, for example smoke from factories, pollen from agricultural activities, dust from building constructions, asbestos from insulating material, and sulphur dioxide (SO_2) and Nitrogen oxide (NO_2) from power stations. According to Gore (1992), the direct effect on human health can be seen vividly in the hazy, smog choked skies and heard loudly in the hacking and coughing of the affected community. Gore (1992) asserts that many measures towards the control of local and regional air pollution help reduce the global pollution threat of industries, while many others actually increase that threat to global communities. McGranahan and Murray (2003) postulate that there is a marked difference in the spatial distribution and concentration of various air pollutants. Since most air pollutants are local in nature, the concentrations of pollutants at any particular location differ with local site geography, emission rate and meteorological dispersion factors.

In addition to the health impacts that are associated with industrial pollution, indoor air pollution is a significant public health problem predominantly for the poor populations in many developing countries. Begum *et al*. (2009), Mestle *et al*. (2007) and Smith and Mehta (2000) state that indoor air pollution from solid fuels (biomass and coal) is known to pose a major health risk, leading to such serious illnesses as acute lower respiratory infections in small children, and chronic obstructive pulmonary disease in adults. Indoor air pollution result from sources such as industrial processes, household level pollutants such as the burning of fuels for heating and cooking as well as insecticides and cleaning agents, smoking, solid fuels and traditional stoves or open fires for cooking and heating Begum *et al*. 2009; Perez-Padilla *et al.* 2010). The health effects of high levels of indoor air pollution, such as higher mortality rates and increased risks of respiratory illness, fall mainly on children and women (Larson and Rosen, 2002; Parikh, 2011), who spend a significant amount of time good inside cooking and tending fires.

Neidell (2004: 1209) argues that a primary objective of air quality policies around the world is to protect human health however, “many critics argue that air quality standards are set somewhat arbitrarily with inconclusive evidence of the specific health benefits and with inadequate considerations of the costs to producers”. Impacts on residents from a social science perspective, in particular remains limited. This is important since, as Neidell (2004) further argues, while numerous studies have focused on estimating a relationship between pollution and health, they have largely neglected to consider that pollution exposure is endogenously determined if individuals make choices to maximize their well-being. Williams (1999) states that social scientists have entered the debate over the environmental inequities facing the poor in general, and communities of color in particular. This trend remains and has been extended to developing contexts as well.

The health impacts on people have serious consequences in relation to quality of life, including livelihood options at the individual and household levels. Several studies have highlighted the impacts of ambient air pollutants on human health (for example, Brunekreef and Holgate, 2002; Grineski *et al.*, 2007; Hall, 1996; Kampa and Castanas, 2007; McGranahan and Murray, 2003; Mishra, 2003; Perez-Padilla, 2010; Shankar and Ramarao, 2002; Wang and Mauzerall, 2006; Zhang, 2005; Zhang *et al.*, 2007). Additionally, the literature on air pollution tends to be dominated by economic impact assessments at different scales, including economic evaluations of the impacts of air pollution (Brandt *et al*., 2012; Huang *et al*., 2012; Lamla, 2009; Larson and Rosen, 2002; Matus *et al*., 2012; Nicolas *et al*., 2005). Thus generally, research from the epidemiological/ biomedical and economic fields, tend to dominate the literature on air pollution and health. Furthermore, Goodman *et al*. (2011) have shown that mean air pollution is greater for areas and individuals with lower socio-economic position. There has been a dearth of literature that has focused on peoples' perceptions and concerns. Furthermore, social studies do not explore the spatial dimensions of peoples' perceptions and experiences in relation to health complaints. This includes coping strategies and mapping of the prevalence of diseases. Thus, this study contributes to medical geography in that it explores the socio-economic and spatial aspects of health issues in a polluted urban environment.

In terms of the spatial mapping, the actual mapping of emissions (air quality data, air dispersion modeling, and so forth) is difficult and extremely costly to acquire (Diab, 2008; Hounsome *et al*., 2000; Scott *et al*., 2004). There has been information on this aspect in the area compiled by the Richards Bay Clean Air Association (RBCAA) and information relevant to this study is used as a secondary data source. However, this study utilizes social mapping which is a growing field in Geographical Information Systems (GIS). It is also known as participatory GIS. According to Quan *et al.* (2001), a participatory GIS is the integration of local and indigenous knowledge as well as stakeholders' perspectives into the GIS tool. Harris and Weiner (1998) emphasize that the main goal of participatory GIS is to incorporate social data to provide a diversity of information. Quan *et al.* (2001) specifically argue that a GIS may facilitate ones understanding of spatial aspects of social and economic development by providing a tool which relates socio-economic variables to environmental issues. Additionally, according to Quan *et al.* (2001), a GIS can target interventions and monitor impacts over a variety of areas and scales. McCall (2003) suggests that a participatory GIS has strong potential to map indicators of poverty, exclusion and/ or discrimination within communities. Social maps also indicate distinct zones of deficiency by creating a visual representation of disempowerment and neglect (McCall, 2003). Similarly, Jerrett *et al*. (2001) illustrate how GIS can be used to undertake an environmental justice of particulate air pollution that reveals that populations with lower socio-economic status are more likely to be exposed to higher levels of pollution in Hamilton, Canada. GIS can be a powerful tool to communicate social and environmental problems to decision- and policy-makers. Thus, it is a very important tool when assessing the socio-economic dimensions of air pollution and health impacts.

In part, this study addresses a concern by Moodley (2002) that health care research and programs tend to be top-down without sufficient understanding of concerns and issues among the general populace. Furthermore, the complexities of the societal causes of poor health tend to be ignored. Demographic data together with information on diseases and perceptions of health concerns at the household level (derived from a household questionnaire survey) was used to create maps that spatially represent health perceptions, patterns and experiences. Thus, the study provides a detailed socio-economic and spatial analysis of health impacts focusing on community perspectives and concerns.

1.2 Motivation and Need for the Study

The study area (Richards Bay) is located approximately 200 km north of Durban in the KwaZulu-Natal province of South Africa. It comprises of a population of approximately 345 776 (uMhlathuze Municipal Area Statistics, 2009) and also incorporates Empangeni, Esikhawini, Ngwelezane, Nseleni, Felixton and Vulindlela as well as the rural areas under Amakhosi Dube, Mikhwanazi, Khoza, Mbuyazi and Zungu (Scott *et al.*, 2004). Richards Bay is rapidly becoming one of the leading industrial towns of South Africa (RBCAA, 2010; Groundwork South Africa, 2004). RBCAA (2010) also states that Richards Bay started out as a tourist town.

Groundwork South Africa (2004) and RBCAA (2010) assert that the area's location with respect to both local and international industrial regions, the availability of raw materials and the harbor make it an attractive location for heavy industry, reliant on import and export facilities and an electricity supply. According to RBCAA (2010), the main industrial plants that are located within and in close proximity to Richards Bay are India Ocean Fertilizers (Foskor which manufactures and exports fertilizers), Bay side and Hillside Aluminum (the leading industry being the Aluminum Smelting industry which is one of the leading producers of aluminum in the world), Mondi Kraft (a paper mill linked to the large timber plantations in the area), Richards Bay Coal Terminal (which is a coal exporting company), Bell Equipment (which deals with the manufacturing of heavy industrial and construction vehicles and equipment), Richards Bay Minerals (the extraction and refining of heavy minerals from sand deposits), and Central Timber Company and Silvacel (a wood chipping plant). Most of these industries release vast amounts airborne pollutants. Ambient air quality conditions in Richards Bay are currently monitored by the RBCAA (2002; 2010), a Section 21 company that includes a number of Richards Bay enterprises, provincial and local authorities and local interested and affected parties. The objective of RBCAA is to run a real time air pollution-monitoring network to understand the dynamics of air quality in Richards Bay, particularly SO_2. According to the Tata Steel Environmental Impact Assessment (EIA), CSIR Environmentek (2004), the major industries in the area are the primary sources of SO_2, NO_2, particulate matter, chromium, and green house gas emissions. McGranahan (2003) states that fuel combustion is the primary source of air pollutants, including particulate matter (PM2.5 and PM_{10}), sulphur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), ozone (O_3), volatile organic compounds (VOs) and lead.

In order to understand short and long–term adverse health impacts of pollutants that are associated with industrial processes, it is essential that the perceptions and concerns of individuals and communities of air pollution and the associated impacts on community health be thoroughly investigated and documented from communities situated at the closest point of ambient air pollution emission to communities that are located at great distance away from the source of pollution.

Richards Bay is a relevant case study since it is one of the leading industrial towns in South Africa. The residential areas are in close proximity to residential areas that traverse different socio-economic groups and the health impacts on residents are of grave concern (RBCAA, 2010). As indicated earlier, there is significant concern pertaining to the impacts of air pollution on the local populace. However, none of the current studies undertakes a comparative analysis of how socio-economic and spatial differences at the local level are likely to influence these impacts. This research, therefore maps socio-economic data (concerns and perceptions), in relation to health impacts (respiratory system) of inhaled air pollutants, particularly from industrial sources that emit sulphur dioxide, nitrogen oxide and particulate matter. It is important to also note, as indicated by Mestl (2006), that health impacts depend on more factors than the dose breathed. Impacts on health also include socio-economic factors such as income level, history of exposure and pollutant mix. Hence, the research takes into consideration such factors. The research contributes to the body of knowledge that focuses on industrial air pollution and health impacts. Specifically, the integration of GIS with social data (derived from questionnaire surveys) will provide often neglected information on how people perceive and interact with the environment they live in. The integration of quantitative and qualitative data in the form of triangulation (elaborated in the methodology section) also provides an important lens to examine air quality issues which tend to be examined either from a physical/ natural science or social science perspective. Hounsome *et al.* (2000) and Scott *et al.* (2004) underscore the need to undertake further research that specifically examines the social dimensions of industrial air pollution.

The above discussions clearly illustrate the social and economic health effects of air pollution. It is therefore critical to examine these aspects. While this study focuses primarily at community and household levels, it is important to note that socio-economic impacts are also felt regionally and nationally since health costs are partially borne by society at large. This aspect is further explored in the literature review using secondary data sources.

1.3 Aim and Objectives

1.3.1 Aim

The aim of this study is to undertake a socio-economic and spatial investigation into the health implications of air pollution in Richards Bay, KwaZulu-Natal. The main focus is on perceptions and complaints relating to human health impacts emanating from air pollution in Richards Bay.

1.3.2 Objectives of the research

To achieve the overall aim of this research, the following objectives informed the study:

- To generate detailed, locality specific information on the socio-economic demographics of selected households and communities in the study area that represent a range of socio-economic groups (lower, middle and upper income areas).

Given the continued impacts of the Group Areas Act imposed during apartheid, communities also tend to reflect historical racial groups, specifically Whites (generally located in the upper income areas), Coloreds (generally located in the middle and lower income areas) and Africans (generally located in the lower income areas). Census data will be used to ascertain community profiles in relation to socio-economic data of specific localities.

- To identify and assess the perceptions, issues and concerns relating to health of the sampled communities in Richards Bay.

A key focus area will be on respiratory health given its close association with air pollution impacts.

- To ascertain the extent to which and how indoor pollutants and housing conditions impact on health in the different communities under study.

The main consideration is to examine the extent of indoor pollution in the communities and linkages to health.

- To examine the coping strategies that households in the sampled communities use to deal with air pollution and health problems.

This includes examining whether households would like to (if able to) or plan to relocate to other areas that are deemed to be less polluted.

- To examine sampled community perceptions of the industries in the area, including perceived advantages and disadvantages.

This objective focuses on existing knowledge of the industries in the area, perceptions pertaining to which industries are perceived to be the main pollutants (and their location relative to household) as well as advantages and disadvantages.

- To ascertain the spatial distributions and patterns of specific health problems experienced by households.

This will include an examination of the prevalence of different illnesses relation to the sampled communities as well as disease mapping.

- To map perceptions regarding which industries are deemed to be the main and least air polluters in the area using participatory GIS.

The information gathered from the household survey in relation to perceptions is compared to actual industry pollution data derived from the RBCAA.

It is clearly outlined in the need for the study that air pollution impacts significantly on the health of individuals. Therefore, it can be presumed that individuals and communities in Richards Bay may be able to relate valuable insight with regards to their opinions, perceptions and concerns in relation to health impacts that are consequential of a complex mix of large scale industries and major transport networks. The primary concern for conducting this research is therefore based on an investigation into individual and communities socio-economic perceptions in relation to adverse impacts of air pollution on human health that are caused by the emissions of unacceptable levels of toxins, chemical waste and a large content of SO_2, NO_2 and PM, which are characteristic of industrial processes.

1.4 Overview of Conceptual/ Theoretical Framework

The study utilizes a multi-conceptual theoretical framework drawing on three main approaches/ perspectives: political economy (including political ecology), place perspective and environmental justice. The political economy perspective examines socio-economic and political aspects within historical contexts. Additionally, it underscores the importance of addressing inequalities and uneven development. The focus is on power dynamics and institutional issues are integrated. In relation to health and air pollution specifically, the political economy examines the distribution of people and pollution in relation to socio-economic and health impacts of development processes, including industrialization. The political economy approach also ensures that regional and global influences are considered when examining local dynamics, as this study does. Linked to the political perspective is political ecology which incorporates environmental considerations in relation to the issues discussed above. Finally, environmental justice is used to frame the study.

Place perspectives are directly linked to medical geography. It highlights that places and space is socially constructed, justifying the importance of perception studies in relation to examining health issues. Landscape ecology is an important approach that includes ecological landscapes, materialist landscapes, landscapes of consumption, landscapes of social control and therapeutic landscapes. This perspective focuses on people experience environmental hazards in specific places. Spatial aspects are highlighted and the role of mapping is deemed to be important.

Environmental justice is also linked to the political economy perspective and focuses specifically on socio-economic disparities and inequalities, focusing on who benefits and who loses from exposure to environmental hazards such as industrial air pollution. The spotlight is on poorer segments in society and vulnerabilities among specific groups. Environmental racism is also an important component that is relevant in the South African context.

The multi-conceptual framework is deemed to be appropriate since it unpacks the interrelated and multiple dimensions of a range of issues that relate to air pollution and health impacts. It provides an interdisciplinary lens that is important in the environmental and health fields, providing an integrated approach to guide the study conceptually, methodologically and analytically.

1.5 Research Methods and Data Sources

Standard quantitative and qualitative methods were employed in the study to generate data relating to the research objectives. Maxwell (1998) asserts that quantitative methods result in numeric data, which is usually machine-readable and can be analyzed by recognized statistical tests and models. Qualitative methods result in textual or narrative information that is either descriptive or subject to other forms of analysis (Meyers, 1997). The primary data sources used in the study includes the use of socio-economic questionnaire surveys and GIS mapping in terms of the quantitative approach and focus group discussions and key informant interviews in relation to the qualitative approach adopted. In terms of the latter, mental mapping, direct observation and ranking exercises were undertaken. This research includes a review of information acquired from reports, policies, and speeches; published works; as well as a review of articles and journals which are secondary sources.

The process of triangulation which, according to Olsen (2004), is the use of multiple methods which cuts across the qualitative-quantitative divide is therefore used. The various sources of information validate and clarify data by deepening and widening an understanding of the main issues under examination. Furthermore, triangulation supports interdisciplinary research.

1.6 Chapter Sequence

Chapter One provides an introduction to air pollution and the concomitant health impacts, the need for the study to be undertaken in Richards Bay, the aims and objectives for undertaking the research, an overview of the theoretical framework on which the research is based and the methodologies used. This chapter also includes a brief description of the study area. The conceptual/ theoretical framework is presented in Chapter Two. In Chapter Three, pre-existing literature on air pollution, air pollutants and the health impacts of air pollution levels is extensively reviewed. The socio-economic and spatial aspects are underscored. The literature review also assesses EIA reports that have been conducted in Richards Bay. Environmental justice issues pertinent to air pollution and health impacts are also integrated into the discussion. In Chapter Four a detailed description of the study area is provided and the research methodologies outlined. Chapter Five presents and analyzes the results of the qualitative and quantitative data collected during the research. The final chapter of the research consists of a summary of the main findings of the research. This chapter includes an attempt to provide valuable suggestions and recommendations based on the health impacts that are associated with industrial air pollution.

1.7 Conclusion

This research is embedded in various contexts which are interrelated. As indicated, the most key context is the spatial/ geographical. Additionally, there is the socio-economic context in which health and health care is examined. More specifically, air pollution is viewed as a socio-economic and spatial manifestation of development and entrenched inequalities in society. Furthermore, this study notes that what people think about their health and the environments in which they live impinge on everyday life. These different contexts are useful when examining the impacts of air pollution and health impacts at the community level.

This chapter highlights important aspects regarding air pollution and discusses the health implications on communities, that are directly or indirectly associated with air pollution from industries. The chapter also briefly introduces the need for and specific objectives for the study with particular reference being made to communities situated close to industries in Richards Bay. The underlying basis of any research is the study methodology. Therefore this chapter also highlights the various secondary and primary data sources that were used to undertake the study. The chapter also entails a chapter sequence, which is a breakdown of the subsequent chapters.

CHAPTER TWO
THEORETICAL FRAMEWORK

2.1 Introduction

Over the past two decades, researchers, policy-makers, and society have asserted that biases within environmental policy-making and regulatory processes, combined with discriminatory market forces, have created an unequal prevalence of hazardous pollution among poor communities around the globe (Bullard and Johnson, 2000; Morello-Frosch, 2002). Grineski *et al.* (2007) postulate that concerns over the societal distribution of environmental risks and hazards and their disproportionate distribution and the associated impacts on low-income groups, racial minorities, and other marginalized groups have been the focal point for environmental justice research. Buzzelli (2007: 4) states that disproportionate refers to "the hypothesis that disadvantaged communities 'consume' the disbenefits of economic growth and development but do not share equally (proportionately) in the benefits such as employment and rising living standards". Moodley (2002) states that with the growing realization of the complexity regarding health, there has been the development of numerous theories that are used when examining health-related issues. Noguera (2001) highlights that proper theoretical considerations encourage a dynamic relationship between relevant empirical and locality-based research as well as existing explanations and theories. Theory is an important component of social science research that contributes to examining phenomena and questions as well as assists in raising new questions that help to redefine current explanations.

The chapter reflects on three key theoretical perspectives that inform this study: political economy incorporating political ecology, place perspectives and environmental justice. Adopting a social science approach to the study of air pollution and health impacts demands an examination of interrelated aspects that permit an evaluation of historical, socio-economic, political, environmental, and policy dimensions.

Lester (2005: 460) aptly states that conceptual frameworks "not constructed of steel girders made of theoretical propositions of practical experiences; instead they are like scaffoldings of wooden planks that take the form of arguments about what is relevant to the study and why … at a particular point in time". This indicates that conceptual frameworks are important to justify the study, especially in relation to existing explanations and debates of key phenomena. This is further emphasized by Eyles (1997: 7) who states: "Theories are not about truth, they are about explanation and must be judged by their utility".

A conceptual framework, according to Lester (2005: 458), has four advantages:

- It provides a structure for conceptualizing and designing research studies. Particularly, a research framework guides the nature of the questions asked; the manner in which questions are formulated; the way the concepts, constructs, and processes of the research are defined; and the choice of acceptable research methods.
- It permits a researcher to make sense of a set of data.
- It allows researchers to transcend common sense and permits a deeper understanding of complex problems.
- It provides a basis for a deep understanding, not just 'for this' understanding. This is accomplished by providing a structure for designing research studies, interpreting data resulting from those studies, and drawing conclusions.

Thus, a conceptual framework informs every aspect of a research endeavor. In relation to information collected, a conceptual framework often forms the basis for data analysis to be undertaken that goes beyond description and also provides a basis for comparison in relation to what the data is revealing and what current explanations are.

White *et al.* (2009) stress the importance of utilizing an integrated conceptual framework. The approach, adopted in this study, is appropriate to understand air pollution and health issues which themselves draw from a range of disciplines and methodological orientations. Specifically, air pollution and health considerations include social, economic, environmental and epidemiological dimensions and as will be indicated in the literature review chapter discussed next, studies tend to be biased towards one aspect which is inadequate.

2.2 The Political Economy and Ecology of Health and Air Pollution

2.2.1 Political economy

In geography, Jones (2008) states the political economy is rooted within the spectrum of Marxist and poststructuralist approaches to human geography enquiry. Merchant (1992) asserts that political economy focuses on the patterns of uneven development within a capitalist system and their differential economic and social effects of a global market economy that has been emerging since the 16th century. Zafirovski (2000) asserts that the political economy perspective provides a theoretical framework for the consideration of economics within the ambit of social science which takes account of the various societal factors that impact and are impacted on by economics. Fæhn, and Bruvoll (2009), for example, state that a common result of economic growth in developed countries is that production patterns become less pollution intensive. They attribute this to economic growth strengthening domestic firms' international competitiveness in relatively clean, human capital and service intensive production. Additionally, it could be due to developed countries exporting less and importing more dirty products. Therefore, instead of achieving an overall emission reduction, emissions are displaced abroad (usually to developing countries), increasing pollution leakages which raise efficiency as well as ethical concerns (Fæhn, and Bruvoll, 2009).

Roberts *et al.* (2010) operationalize political economy in their study as referring to the conditions under which economic production is organized and metropolitan political economy to refer specifically to a set of economic circumstances at the metropolitan level that are closely tied to political decisions. Williams (2005) states that a key question raised by political economy is the way in which inequalities arise, resulting in the increasing disparity in the wealth of nations and among the different classes which creates an abstract formulation of welfare problems based in neo-classical economics, which has not been able to respond to this challenge. In relation to air pollution and health, critical issues become those related to what types of benefits and losses are generates, who benefits and who loses, do industries contribute to broad-based development or inequalities, etc. Thus, the political economy perspective raises different questions that go beyond economic considerations only.

Moodley (2002) states that political, social, economic and ecological marginality occurred as a result of capitalist and colonial expansion that led ultimately to the expropriation of land and resources as well as unequal service provision and access to facilities, including health care. Understanding the social relations of health and health care implies understanding power relations as well as struggles over access to health services and facilities (Moodley, 2002). From a community perspective, Scammel *et al.* (2009) describe power as the overall political and economic position of a community in relation to elected officials, business or corporate activity. Schoeni *et al.* (2008) asserts that political decisions are made at multiple levels (city/ local, provincial/ federal and national) with implications for health. In terms of health specifically, Donahue and McGuire (1995: 47) state that the "political economy in which a health system operated strongly influences people's perceptions of responsibility for their health, but may not structurally empower them to satisfy their health needs". Donahue and McGuire (1995: 47) cite Eric Wolf who identified four modes in relation to the exercise of power found within any political economy:

- Individual power refers to a person's ability or capacity to influence the play of power;
- Social or dyadic power is displayed in the attempts of one person to exert control over or influence another;
- Organization or tactical power applied when an actor in one field is able to restrain the activity of an actor in another setting; and
- Structural power (which is less visible but significantly influences the first three modes) is the ability to deploy and allocate labor in a social field in such a way as 'to render some kinds of behavior possible, while making others less possible or impossible'.

Additionally, Peterson (2000) identifies three dimensions of power:

- Overt power: this involves the direct manipulation of power through force, incentives, or intimidation to influence people's decisions and operates in the here and now because it requires mobilized people, and therefore by necessity, it occurs over brief periods at specific locations.
- Covert power: this type of power removes the opportunity for people to behave in specific ways by controlling what type of decisions can be made. It requires the manipulation of institutions, and this manipulation will usually occur over slower and larger institutional scales, including which issues are discussed and acted upon.
- Structural power: this is the slowest and broadest scale type of power and is the ability of the institutions of a society to restrict the set of issues about which people think they can make decisions. It involves manipulating culture, which is slow to change, and likely operates over a

broader area than an individual institution, because it determines what concepts are even considered, and therefore requires a group that is relatively insulated from external ideas.

These power dynamics remain relevant today and influence the allocation of responsibility for health and illness, as highlighted by Donahue and McGuire (1995). Gatrell (2002; 2005) shows that political economy approaches view disease in the broader context of social and economic conditions.

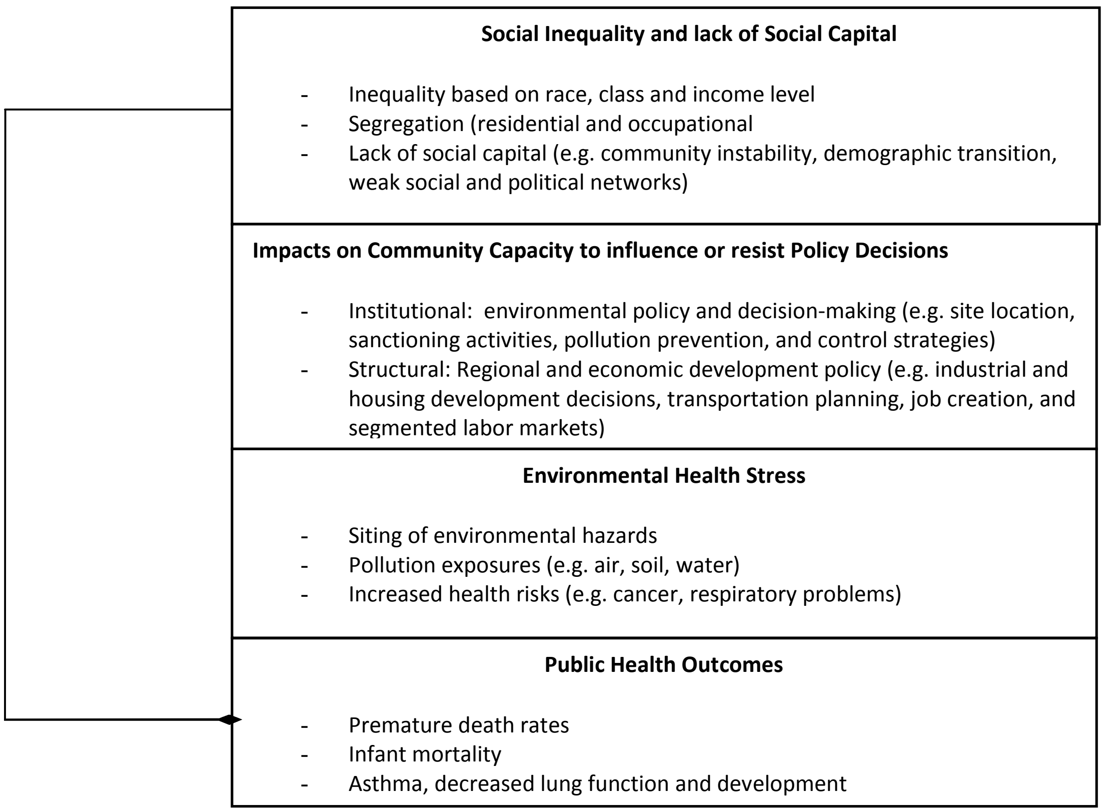
Hanchette (2008) states that analyzes from the Public Health Disparities Geocoding Project in the USA have made an important contribution in terms of understanding how socio-economic inequalities impact a wide range of health outcomes. The studies generate the following key findings (Hanchette (2008: 211):

- measures of economic deprivation were most sensitive to socio-economic gradients in health (as compared to measures that use education or occupation); and
- the single census variable ‘percentage of persons below poverty’ was a good predictor of adverse health outcomes.

In respect to the development, the implementation and enforcement of environmental laws, regulations and policies, environmental justice has been defined by the United States of America (USA), EPA (1998), as the equal treatment and meaningful involvement of all people regardless of their race, color, nationality, or income status. The equal treatment of all people maintains that no group of people, including racial, ethnic, or socio-economic groups should be subjected to a disproportionate share of the negative environmental impacts resulting from industrial, municipal and commercial operations (EPA, 1998 cited in Bullard and Johnson, 2000). In seeking to redress health disparities and inequalities in exposures to toxics, the environmental justice framework should focus on new insights into the junctures of political economy, social justice, discrimination, environmental degradation, and public health (Grineski *et al.*, 2007). Figure 2.1 illustrates the political economy of environmental inequality.

Morello-Frosch (2002) indicates that socio-economic and political forces unavoidably create a situation in which overlapping pollution plumes, emitted by various sources into our air, soil, food, and water pose a range of health risks to diverse surrounding communities. In this regard, the causes of environmental discrimination require an understanding of how a political economy shapes the pollution distributions, which in turn determines inequalities in community exposures and susceptibility to environmental hazards (Morello-Frosch, 2002). The political economy of the distribution of people and pollution and the concomitant impacts on environmental inequality are revealed by exploring the historical patterns of industrial development and radicalized labor markets; suburbanization and segregation; and economic restructuring. In South Africa specially, Ataguba and Alaba (2012) illustrate that the political economy perspective is useful in providing a framework to understand the historical, social and political contexts and power relations that have shaped inequalities in South Africa, especially why the poor suffer more from ill health than the rich.

Figure 2.1: The political economy of environmental inequality (Morello-Frosch, 2002: 6)



The global dimensions are also important to consider and have been the focus of significant research in relation to industrial development. As Cole and Fredrisson (2009) state, the assertion that countries with relatively weak environmental regulations will increasingly specialize in pollution-intensive production has become the subject of a rapidly growing body of literature in recent years.

Bullard and Johnson (2000) postulate that industries and governments have often exploited the economic vulnerability of poor communities for their unsound and hazardous operations. Traditionally, poor communities have been spatially bound and remain in close proximity to major production facilities as a result of limits imposed on them with regards to employment opportunities, working hours, income, and exclusionary and discriminatory housing development policies (Guhathakurta and Wichert, 1998). Conversely, the mobility and privilege of avoiding the toxic zones of industrial activity is enjoyed by the wealthier population (Pulido, 2000). Block and Whitehead (1999: 66) allude to the "double edged sword for the poor". They state that locating industry close to the poor reduces environmental amenities (and quality of life). They further argue that all other things equal, it increases job availability and that people make such tradeoffs for themselves. However, the environmental justice movement (discussed later in this chapter) has come a long way to centralize the importance of human rights in these debates and highlights that many people are forced to live in these environments and their choices are limited. Furthermore, industries can be 'cleaner' and environmental quality can be improved considerably given technology advancements.

As indicated in the previous Chapter, economic studies of air pollution tend to dominate the literature. Bernauer and Koubi (2009) assert that the economics literature has thus far concentrated primarily on the effects of economic variables on environmental quality, specifically the level of income, the scale and type of economic activity, and trade openness. Nicolas *et al*. (2005) state that within the political framework, the economic valuation of environmental impacts (for example, external costs in general) leads to two distinct practical applications: that such an impact can be taken into account in the economic assessment of public projects and that financial assessment also leads to the setting up of the polluter/ payer principle, through fiscal policies of environmental taxes and subventions. They state that by the end of the 1990s, half of the European countries financially evaluated the effects of air pollution and global warming in their official method of transport project assessments. Additionally, they indicate that all the Organization for Economic Co-operation and Development countries have installed taxes on road fuel, which adds up to two-thirds of their green taxes. It is important to note that these types of assessments are almost non-existent in developing contexts.

Binder and Neumayer (2005) state that the political economy literature suggests a strong role for environmental NGOs in determining environmental policy through their influence on policy-makers, who seek to maximize their own political welfare. This is often referred to as environmental lobbying. Canton (2008), for example, illustrates the roles that the eco-industry, polluting firms and environmentalists in terms of environmental taxation. She also indicates that importance of alliances between groups. This is also discernible in the South African context where Scott and Barnett (2009) highlight that the environmental movement in post-apartheid South Africa has involved the reframing of the environment as a 'brown' issue, articulating the discourse of social and environmental justice and a rights-based notion of democracy. They also argue that environmental movements have deployed science to pursue the strategic task of democratic opposition and have established networks of environmental knowledge and expertise, specifically strategically using civic science to place the issue of air pollution on the political agenda. They indicate that in the South Durban Basin in South Africa, civic science and lay knowledge (together referred to as a form of hybrid community knowledge) are used to further three purposes (Scott and Barnett, 2009: 381):

- They are combined in different contexts to reframe the problems in South Durban and to put pollution on the agenda as a 'brown issue'.
- They are combined to engage in the 'politics of shame', by exposing the state's neglect of community health and well-being and reframe environmental problems as the responsibility of multinational corporations. Science and lay knowledge are used as tools in activist strategies of opposition to critique and expose industry's practices of pollution, industrial accidents, emission levels that exceed regulations and use of 'dirty fuels' as well as exposing the health impacts of industrial emissions. Science and lay knowledge are also creatively disseminated to a range of publics to raise awareness and provide environmental education.
- They are used as a persuasive tool in deliberative policy processes and for the mobilization of communities to provide mandates for action. Since science is the authoritative discourse and basis for policy-making in the prevailing approach of ecological modernization, environmental movements have turned to producing their own civic science or commissioning research for their purposes.

Scammel *et al.* (2009: 145) also indicate that there is a public understanding of science which is a field of research that "examines public perceptions, understanding and attitudes toward science and technology, with a particular focus on how lay people translate or understand scientific information". Sparks (2006) also examines the role of civil society in the South Durban Basin, in relation to the Wentworth Oil Refinery specifically. Sparks (2006), states that the South Durban represents an important test case for post-apartheid South Africa since it juxtaposes major multinational petrochemical industries and residential neighborhoods with histories of forced removals during apartheid. Leonard and Pelling (2010: 149) examine the role of civil society in Durban more generally and conclude:

> …the balance between bonding, bridging and linking ties when understood in relation to the socio-economic and political positioning of individuals or organizations can help understand social actor response to engage in social capital for mobilization and protests.

2.2.2 Political ecology

Linked to the political economy of health is the political ecology of heath which focuses on environmental aspects. Offen, (2004) states that political ecology represents a multidisciplinary research approach to society-nature relations that seeks to understand how local resource use and perceptions are mediated by a combination of biophysical characteristics and processes as well as manifestations. Blaike and Brookfield (1987) argue that the political ecology approach is oriented towards political economy and human ecology to assess the uneven power relations between actors as regards distribution and access to environmental resources between the exploited poor in a given locality and the normally distant exploiters. Forsyth (2008: 757) indicates that political ecology has drawn from Marxian or structuralist analysis of environmental and social changes to "integrate more locally-determined, discursive and participatory approaches to environmental crisis and social vulnerability". Furthermore, Adams and Hutton (2007) assert that political ecology is a field of study that embraces the interactions between the way nature is understood and the politics and impacts of environmental action. Additionally, Schubert (2005) underscores that political ecology deals with how both nature and societal structures influence each other and shape access to natural resource and the connections between the access to, and control over, resources and environmental change.

Moodley (2002) states that several changes to connect the environment and health have taken place since the work of Park (1936) and his classical ecology. The key construct today is the ecosystem which is deemed to be selective systems, which are fragile and need protection as well as human intervention. Muldavin (2008: 687) asserts that political ecology is a critical approach to the human-environment dialectic which “provides unique theoretical, methodological, and practical insights for unraveling the complexities of this contentious nexus” and is experiencing a renaissance which is similar to the rediscovering of the importance of place in geography. Moffat and Finnis (2005) argue that political ecology recognizes and analyzes the relationships between material, natural and social resources. Forsyth (2008) argues that political ecology primarily focuses on two questions: How do we understand environmental crisis and how do we identify social vulnerability? In this study the environmental crisis is air pollution and the social vulnerability is linked to the health impacts of air pollution on specific communities.

In political ecology, the focus shifts to ecosystem health and ecosystem stress, with concerns about environmental health emphasizing human health and well-being. The overarching intention is to bring together human health and ecosystem issues. It may be achieved quantitatively and critically by researching the human costs of environmental actions and the environmental costs of human actions. Hanchette (2008) states that political ecology is one of the frameworks that has been used to understand disease processes within a political, social, and economic context. Furthermore, Hanchette (2008) states that political ecology differs from political economy in its inclusion of ecological concepts and its greater focus on the environment—natural, cultural, and/ or political domains. Mayer (1996) specifically states that political ecology focuses on the examination of a problem within a broad social and economic context with an initial analysis at a local scale with later links to national and global processes. Mayer (1996) further states that political ecology highlights the importance of adopting a historical analysis approach in examining human–environment relations as well as socio-political processes. In addition, Rocheleau (2008: 716) highlights that “political ecology is rooted in a combination of critical perspectives and the hard won insights distilled from fieldwork”. Thus, the importance of locality-based research is emphasized. Mauro (2009: 123) states that because “political ecology offers more context-situated approaches of scale, for example, its production or construction and greater sensitivity with respect to micro-scale society environment relations, it can improve spatio-temporal resolution, reducing analytical losses of detail of explanatory importance, such as may occur through a world-systems paradigm”. However, Brown and Purcell (2005) warn about the ‘local trap’ which often results from political ecologists assuming that organizations, policies and actions at the local scale are inherently more likely to have desired social and ecological effects than activities organized at other scales.

Richmond *et al.* (2005), state that the political ecology framework provided by Mayer (1996) provides an effective theoretical merger of population health and political ecology. Hanchette (2008) indicates that political ecology has its limitations which include the fact that the effort involved in understanding historical and economic processes is time consuming and sometimes involves archival research as well as the fact that public health practitioners might not recognize the need to understand historical and economic processes that have contributed to adverse health outcomes. Additionally, Peterson (2000: 324) underscores the importance of considering both the political and ecological since "political ecology research that does not address these ecological dynamics may be political, but it is not ecology" and "while politics cannot ignore ecology, ecological approaches need to consider political dynamics in their explanations of human action".

2.3 Place Perspectives

The importance of place in relation to understanding health issues in relation to environmental/ spatial dimensions are rooted in the sub-field of medical geography. Rosenberg and Wilson (2005) assert that medical geography consists of two strands: the first investigates the various dimensions of health and illness while the second analyzes the aspects that are related to medical care. They further indicate that medical geography consists of conventional approaches to space and place that are characterized by spatial and locational analysis. Medical geography examines space as a container of things (represent the platform upon which social relations take place) and an attribute of characteristics. Thus, from this perspective space is seen as independent from the social phenomena which it contains, a dominant view of spatial analytical approaches (Rosenberg and Wilson, 2005). Research that has examined the relationship between place and health has defined place in relation to the social and/ or physical characteristics of different geographical scales (such as communities, cities or regions) and through co-ordinates on a map. In this context, according to Moodley (2002), health is closely defined in terms of specific medical conditions that are removed from the socio-economic and political aspects in which people live.

Key issues in relation to medical geography are the 'geography of disease' and the 'geography of medical care', focusing on the spatial patterns of disease and illness. Rosenberg and Wilson (2005) assert that some of this research focuses on disease particularly, whilst others focus on morbidity and mortality in general. They further indicate that studies on morbidity and mortality in general include the examination of the variations in morbidity or mortality rates across urban areas while research that are disease specific examine the disparity in incidence rates over either small (urban/ rural divides) or large (county/ political levels) geographic areas. Additionally, Rosenberg and Wilson (2005) state that medical geography has also conducted research on spatial analyzes and place-specific examinations of the geographic allocation of medical care facilities and professionals, as well as the access and utilization of these medical care services. Furthermore, they aver that medical geography also studies the characteristic of medical care in certain locations as well as across larger geographic units, and in doing so pays close attention to health policy, medical insurance, and medical coverage across space and over time. The spatial issues in relation to the availability, access and affordability of health care facilities are important because they reveal distributional inequalities that contribute to vulnerability and area that require redress and program intervention.

Curtis (2004 cited in Day, 2007: 250) identifies five theoretical perspectives linked to landscape ecology and health impacts: ecological landscapes, materialist landscapes, landscapes of consumption, landscapes of social control and therapeutic landscapes. These perspectives are important since, according to Day (2007), they provide conceptual clarity/ signposts to examine the ways in which place may be important in experiencing environmental hazards. Specifically, the following aspects in relation to the different perspectives are relevant (Day, 2007):

- Ecological landscapes refer to the conceptualization of place as the spatial distribution of physical environmental factors, and/ or the distribution of biological risk factors in populations such as the distribution of air pollution and certain medical conditions such as asthma;
- Materialist landscape is a perspective where place is perceived as containing and expressing a collection of socio-economic relationships, constraints and opportunities. They include the relationship between housing and health outcomes;
- Landscapes of consumption relate to how places and products are used and transacted, including infrastructure and services linked to health care;
- Landscapes of social control relate to how power is distributed and who makes decisions; and
- Therapeutic landscapes relate to the role places play in contributing to healing, well-being and leisure.

The perspective above encourage examining place and health impacts in a multi-dimensional way which correlates with the multi-conceptual approach adopted in this study. It also links to environmental health concerns discussed in greater detail in the next Chapter. It is worth noting, however, that, according to Eyles (1997), several theories provide the basic for environmental health research and include symbolic interactionism which focuses on the production of meanings and perceptions and ecologism which is concerned with ecosystems and their relations to human health and well-being. Furthermore, the interactions are not static but change in different circumstances, which result in orientating individuals for action. Symbolic interactionism also provides an understanding of how people construct risks through events, interactions and meanings with a focus on how perceptions of risk concerning, for example, health and security can lead to anxiety and uncertainty (Eyles, 1997). Ecologism is significant when examining the relationship between the environment and the health of its occupants, for example, the physiological and the psychological effects of exposure to toxic events (such as air pollution) are examined and the effects, outcomes and relationships are then quantified (Moodley, 2002).

The focus on place also highlights the importance of perception studies which is a component of this research endeavor. Brody *et al.* (2004), state that this approach results in public risk perceptions playing an increasingly important role in shaping environmental policy and management response systems. Bickerstaff and Walker (2001) highlight that having a detailed knowledge of an individual's/ community's perception is important for participation in future policies/ programs in order to develop to a shift in personal behavior. Bickerstaff (2004) also indicates that the commonly observed differences between the lay publics' perceptions of environmental and technological risks and that of scientific and policy experts has resulted in a range of concerns and discomfort among those that are responsible for the management of these risks, particularly in relation to how social and cultural factors influence the way in which people understand and make sense of a certain risk. Bickerstaff and Walker (2004: 50) highlight:

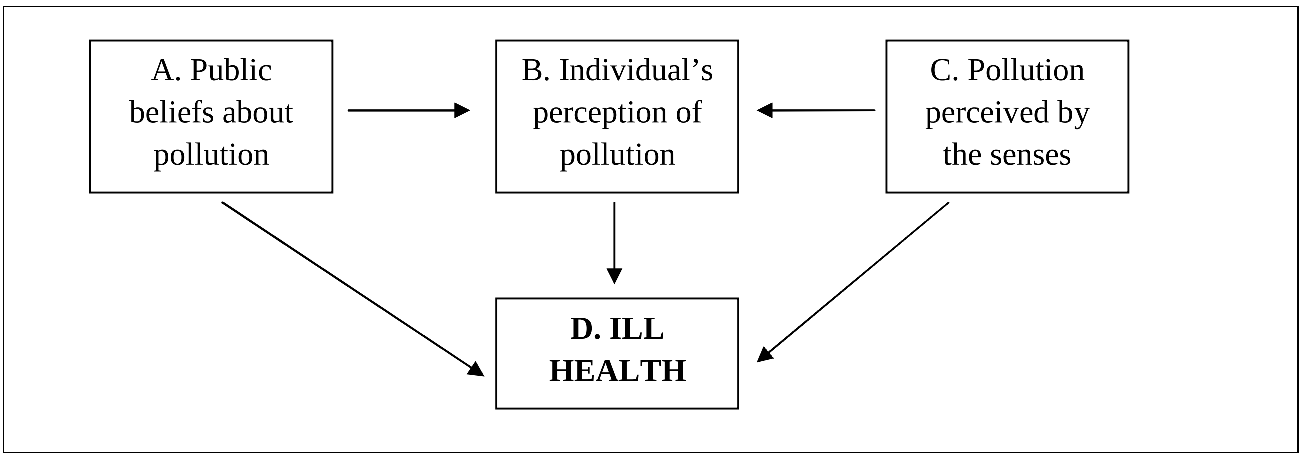
> All of the studies undertaken in geographical situations associated with urban and industrial air pollution problems stress the role of practical everyday experience in how people come to know air pollution. These studies show how understandings of polluted air are embedded in daily life through the senses and the body.

They cite a study done pertaining to the public understanding of air pollution in a major urban area which showed that a wide range of non-human aspects were involved in influencing peoples' perceptions which included include the physical concentration of perceived sources of pollution such as a cluster of industries, and the visual effects that are observed on the environment, especially vegetation, such as its color and growth (Bickerstaff and Walker, 2003).

Hunter *et al*. (2003) provide a useful model to understand how perceptions influence reporting of illness (Figure 2.2). An individual's perception of pollution (B) is influenced by beliefs about pollution (A) derived from several sources as well as personal experiences (pollution perceived by the senses: C). Thus, personal reports on illnesses are not factual/ medical but influenced by social factors and personal experience. Hunter *et al.* (2003 illustrate that many illnesses, especially respiratory illnesses, have their root causes totally or in part in psychological factors that include beliefs about illness, however, few studies have sought to link illness to personal perceptions of environmental pollution. Specifically, Hunter *et al.* (2003: 228) state:

> Much of the research effort that has been done especially recently has been focused on trying to improve measures of exposure. However, it is suggested that this focus on the measurement of specific pollutants, though important, has the risk of missing out on an important aspect of disease causes and origins, that of personal and community belief about the quality of their environment and the risks this may pose to their health.

Figure 2.2: Model of the relationship between air pollution and self-reported illness (adapted from Hunter *et al*., 2003: 235)



The importance of place is emphasized by Gatrell *et al*. (2004: 11):

> Mapping the survey respondents in social spaces reveals a social landscape that is complex and heterogeneous, in that members of relatively deprived areas and neighborhoods [sometimes] find themselves 'neighbors' of those drawn from more affluent areas, and vice versa. This is an important finding; mere co-location in geographical space does not mean that individuals have near-identical stocks of social and material capital.

In terms of the spatial aspects, Bickerstaff (2004) states that the presence of an industry can produce a stigma effect in the case where a community lives adjacent to industries which influences negative public perceptions. Bickerstaff and Walker (2001) state that changes in socio-cultural systems play an integral role in perception formation. They indicate that people who were satisfied with the physical appearance of the neighborhood would not rate air pollution as a problem, while those who were dissatisfied are more likely to rate air pollution as a problem.

Bickerstaff and Walker (2001:139) identified three features in relation to the social constructions of perceptions. Firstly, they state that perceptions could be viewed as the rational outcome of logical human cognitive processes based upon the source, physical environment and spatial attributes of the local area. Secondly, they identify the role of financial empowerment, for example, economic routes that are open for an individual that will alleviate poor air quality such as moving out of the area. Thirdly, public reluctance to recognize negative environmental conditions within the immediate location was deemed to be important. They argue that if these three explanations are connected, this implies that lower socio-economic status is associated with lowered air quality and lack of group or individual empowerment to secure change.

Hunter *et al.* (2003) state that the role of place in understanding the concept of risk perception involves the aspects of stigma and place identity in forming perceptions associated with air pollution. They argue that research needs to focus on the contextual characteristics of place and show how local knowledge (for example, daily experience of highly visible and odorous air pollution) plays an important role in the belief that illness is caused by air pollution and how people feel about their immediate environment. Mix and Shriver (2007) state that resident's perceptions of government and corporate culpability varies widely. They assert that depending on the severity of the environmental hazard, residents' perceptions of environmental hazards involve a combination of psychological, physical, scientific, and attitudinal factors that have been shaped by previous apartheid policies in the South African context. Buzzelli (2009) states that equity and social justice are foundational to the particular question of the distribution of environmental health hazards, especially as these occur across space. This is the key focus of environmental justice which is discussed next.

2.4 Environmental Justice

Linked to the political economy approach articulated above is the environmental justice theoretical framework that highlights socio-economic disparities in relation to who benefits from and who loses from industrial air pollution. As Swyngedouw and Heynen (2003: 910) assert, "uneven socio-ecological conditions are produced through the particular capitalist forms of social organization of nature's metabolism". Furthermore, Fisher *et al*. (2006) state specifically that environmental inequality addresses structural questions that focus on social inequality of power, resources and environmental burdens.

Williams (1999) states that since the early 1980s the environmental justice movement has argued forcefully that environmentalism is not simply about protecting nature from the ravages of industrial society but is also about poorer people in general, and people of color in particular, who tend to face the greatest risks from their proximity to hazardous facilities and waste sites. Issues of ethics, equity and fairness, human and ecological rights, identity and representation, scale and notions of sustainability have emerged as key concepts in environmental justice discourses (Agyeman *et al.*, 2003; Swyngedouw *et al*., 2004; Williams and Mawdsley, 2006). Williams and Mawdsley (2006) further state that a key feature of debates around environmental justice has been a strong focus on the industrialized countries, specifically the experiences of the USA, UK and Australia. They state that earlier environmental justice struggles were often directed against locally-unwanted land uses, and tended not to connect up to wider discourses (such as capitalist exploitation of labor and the environment), what Davis Harvey (1996 cited in Williams and Mawdsley, 2006: 660) called "militant particularisms". They also state that NIMBYism (NIMBY referring to 'not in my backyard') remains an important feature of some environmental justice struggles.

Williams and Mawdsley (2006: 660-661) assert that environmental justice has broadened move in terms of focus and scale (to include developing contexts):

> There has also been a widening of activists' recognition of scale, environmental sustainability, and plural 'communities of interest'—captured in the slogan 'not here, not anywhere'—and in the multi-ethnic and class alliances within and between grassroots organizations.

Furthermore, Reed and George (2011: 835) state that in recent years scholars have noted that the field of environmental justice has broadened both geographically and conceptually to include global issues that "expand beyond the spatial distributions of environmental 'goods' and 'bads' to include other dimensions including recognition, participation, and capabilities".

Todd and Zografos (2005: 484) define environmental justice as ''a concept that promotes the equitable treatment of people of all races, incomes and cultures with respect to environmental laws, regulations, policies and decisions". Buzzelli (2007) states that environmental justice research is based on the notion that as socio-economic position increases, exposure to environmental health hazards among individuals and neighborhoods decreases. Namdeo and Stringer (2008) state that the concept of environmental justice has gained greater recognition in recent years, as social goals (for example, equity, fairness, and justice) have gained greater prominence through almost universal efforts to promote sustainable development. Pellow (2000) asserts that while environmental injustice mean different things to different people and groups, it occurs when a particular social group is disproportionately burdened with environmental hazards. The environmental justice movement started in the USA and while its initial focus was on the transportation sector, Bullard (2004) and Chakraborty (2006) assert that the scope has expanded significantly over the years to a wide range of environmental issues. Chakraborty (2006) specifically states that the importance of measuring environmental justice has been recognized by a large number of studies that have examined the differential distribution of environmental risk on people and places.

The first part of this section provides a generic overview if environmental justice as a lens to examine the health impacts of air pollution, specifically in relation to residents. The second part discusses environmental justice issues on South Africa, especially in relation to air pollution issues.

2.4.1 Environmental justice and air pollution

Environmental justice has been defined by the EPA (1998) as the equal treatment and participation in decision-making of all people regardless of their race, color, nationality or income status. Wilkinson (1998) states that draws environmental justice focuses attention on the questions of whether certain socio-economic groups, including the economically and politically disadvantaged, bear a disproportionate burden of environmental externalities, and whether policy and practice are equitable and fair. Sze and London (2008) indicate that environmental injustice can be explained in terms of two inter-related linked aspects:

- Distributive environmental injustice occurs when vulnerable groups are disproportionately affected by environmental hazards; and
- Procedural injustice explains the inequitable distribution of hazards in terms of underlying socio-cultural and political factors, including the burden of risk imposed on socially disadvantaged groups, and lack of public participation in decision-making processes.

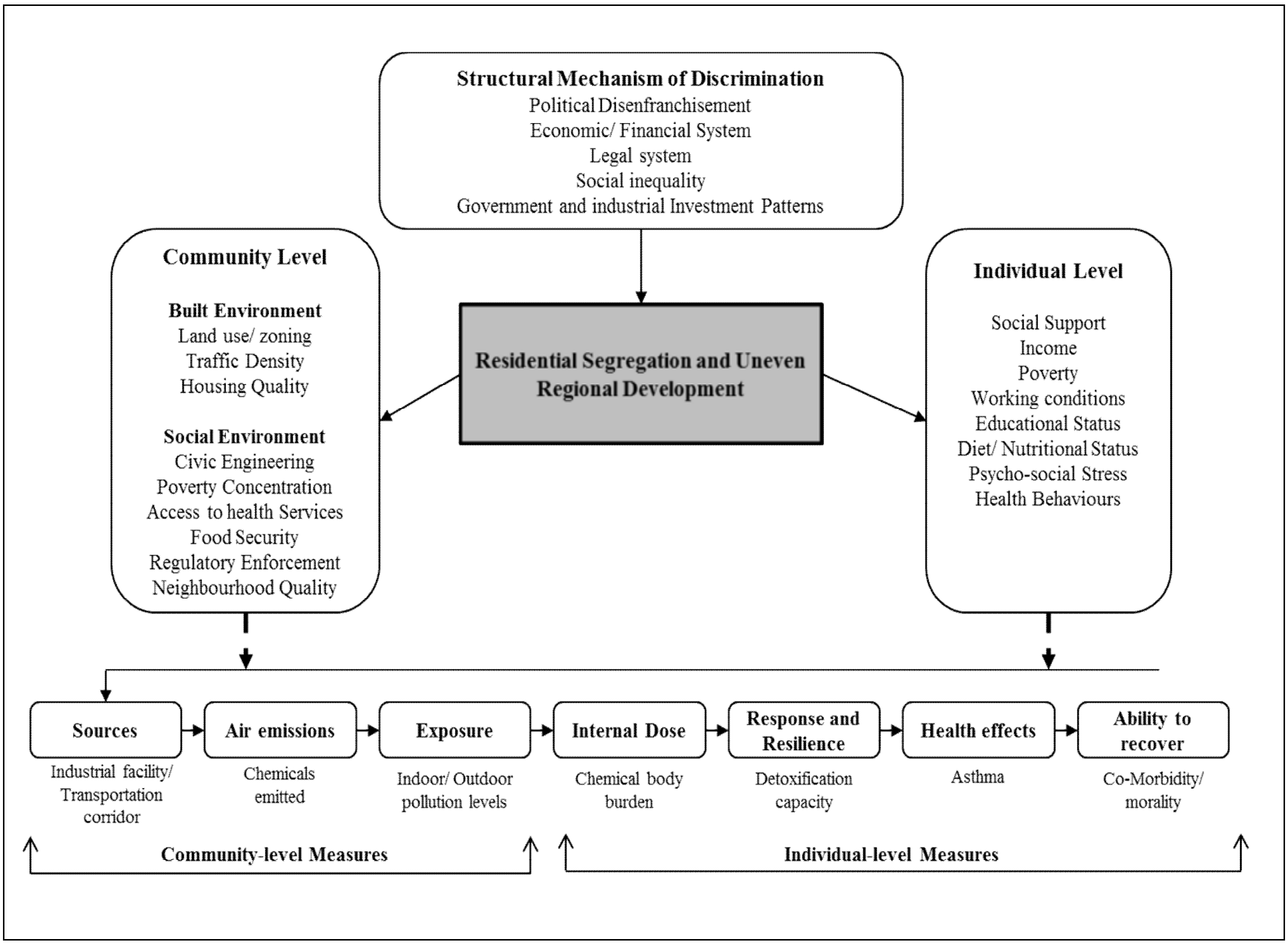
Morello-Frosch and Lopez (2006) specifically state that environmental health researchers, sociologists, policy-makers, and activists concerned about environmental justice argue that communities of color who are segregated in neighborhoods with high levels of poverty and material deprivation are also disproportionately exposed to physical environments that adversely affect their health and well-being.

Environmental justice is a strong component of environmental and public health policy in many parts of the world. Jerrett *et al.* (2001) illustrate this in North America, especially in the USA and Canada. They specifically indicate that in the US in 1994 the then President Clinton issued an executive order mandating federal agencies to consider the environmental justice consequences of their decisions in relation to whether poor or minority groups bear disproportionately high exposure to environmental contaminants and potential health risks. Several authors have shown that varied wide-ranging and complex political, socio-economic, and discriminatory practices together with patterns of industrialization, disinvestment, and development have segregated people of color, particularly African Americans and other minorities, into neighborhoods with some of the highest indices of urban poverty and deprivation in the USA (Morello-Frosch, 2002; Morello-Frosch and Lopez, 2006; Schultz *et al*., 2002). Morello-Frosch and Lopez (2006: 181-182) argue that several authors show:

> ….uneven industrial development, the movement of economic opportunities away from inner cities, real-estate speculation, discrimination in government and private financing, and exclusionary zoning have led to systemic racial segregation among diverse communities with important implications for community health and individual well-being.

Figure 2.3 indicates the framework developed by Morello-Frosch and Lopez (2006: 184) to understand the relationships between racial residential segregation and various indicators of environmental health inequalities. They state that this eco-social or biosocial framework connects a spatial form of social inequality, specifically racial segregation, to community-level conditions that disproportionately expose communities of color to environmental hazards and stressors which potentially amplify individual level vulnerability to the toxic effects of pollution. They argue that this dynamic may partially explain persistent racial and class-based health disparities that are environmentally mediated. The top of the Figure denotes structural mechanisms of discrimination which reinforce racial disparities in socio-economic status which influences the distribution of wealth, resources and opportunities in society. The bottom of the Figure shows how the individual and community-level factors influence the exposure-health outcome continuum by increasing exposures to environmental hazards. This in turn worsens the probability of adverse health effects as well as the ability to cope or recover. This framework stresses the importance of examining both individual and community-level factors. Morello-Frosch and Lopez (2006) further argue that discriminatory forces leading to segregation drive community-level disparities in the quality of the built environment (for example, traffic density and housing quality) and the social environment (for example, poverty concentration, access to health services, food security and regulation). Furthermore, community-level stressors (for example, poor housing conditions, food insecurity and poor neighborhood quality) can influence individual living conditions and health behaviors (for example, household crowding, diet/ nutritional status and smoking) (Morello-Frosch and Lopez, 2006).

Figure 2.3: Segregation and Environmental Framework (Morello-Frosch and Lopez, 2006: 184)



Kingham *et al.* (2007) reveal that areas where car ownership levels are highest tend to have relatively low levels of pollution exposure. They argue that this suggests that there are social injustices in exposure to traffic-related air pollution across neighborhoods within the urban area of Christchurch, New Zealand. Marschall (2008), states that understanding exposure variations (and responses) among sub-populations is important for risk management, epidemiology, and environmental justice. A distributive justice framework in the context of air pollution exposures is used that is valuable in understanding components from an environmental justice perspective.

These are (Marschall, 2008: 5502):

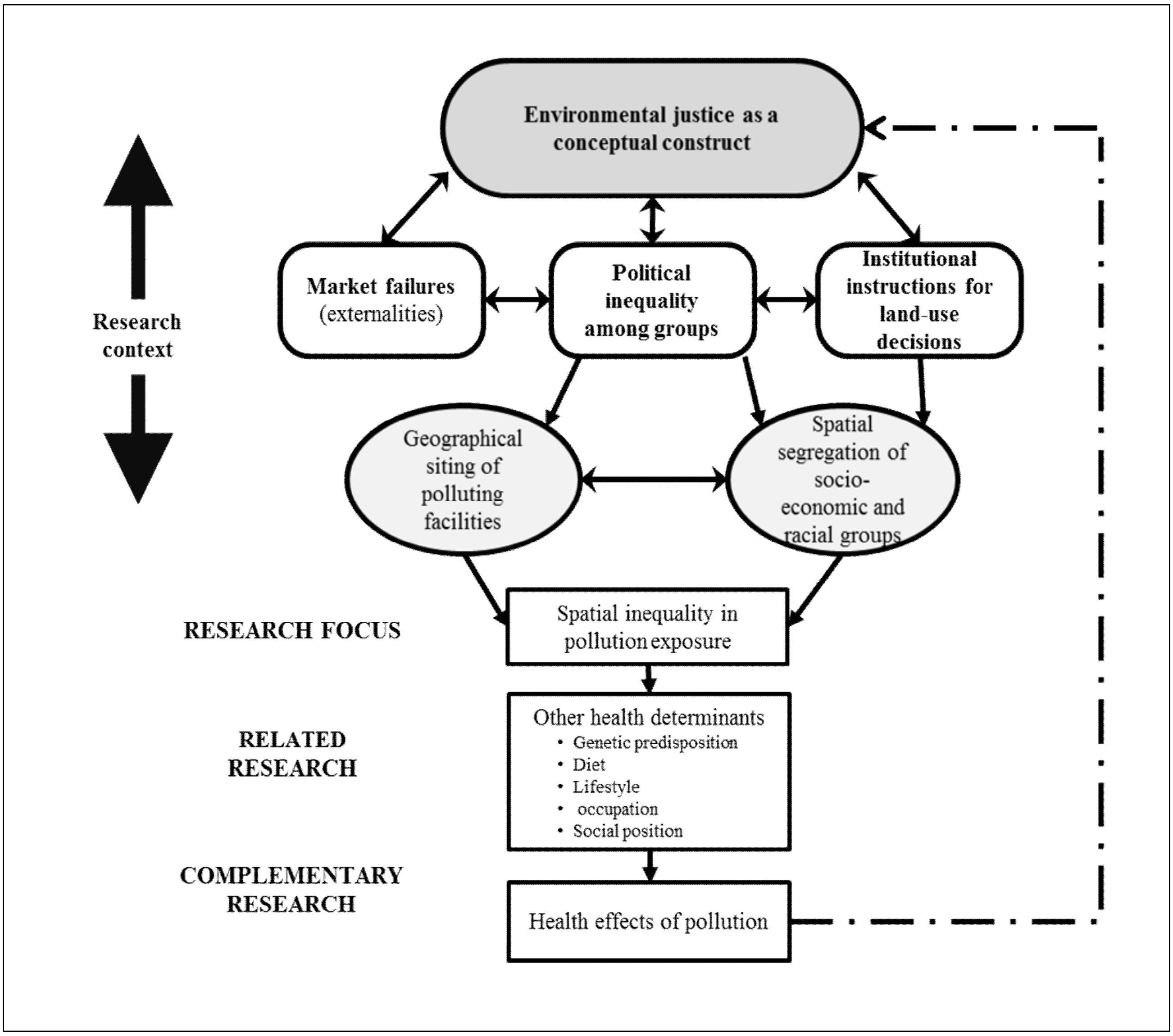
- Equality of outcome: Exposures should be equal for all individuals. Central tendencies (for example, mean values) for important sub-populations should be equal;

- Equality of health impact: Environmental health impacts (risks; disease rates) should be equal for all individuals. Central tendencies for important sub-populations should be equal;
- Welfare-maximizing: The distribution of exposures should be such that the population burden-of-disease is minimized;
- Equality of opportunity: Individuals and subpopulations should have equal opportunity to reduce or avoid exposures;
- Fairness: Inequality should yield the greatest benefit for the worst off. Here, this would imply lower exposures for more susceptible individuals. Susceptibility to air pollution may derive from attributes such as age, socioeconomic position, pre-existing disease, and genetics;
- History: If individuals and groups with lower exposures obtained that position fairly, then the distribution is just. If other individuals have higher exposures, this fact is largely irrelevant;
- Minimum standard: The worst-off should not fall below a certain standard. The standard can be relative (e.g., the difference between best- and worst-off) or absolute (for example, a health-based concentration standard); and
- Cost–benefit matching: Environmental health impacts (costs) of a technology should be proportional to the benefits derived from that technology (for example, for motor vehicles: personal mobility and access to shipped goods; for power plants: use of electricity consuming products and services).

Maschall (2008) argues that the goal for environmental policy is to identify and eliminate environmental injustice; an important step towards achieving this goal is generating useful metrics to aid in evaluating policy options, comparing among pollutants and locations, and tracking progress over time. Marschall (2008) further asserts that environmental managers will be better able to improve environmental justice conditions when they can measure their own progress and when stakeholders can hold them accountable for firm, systematic improvements. Scholsberg (2004) states that in particular environmental justice advocates for policies that institutionalize public participation and recognize the legitimacy of community or lay persons' knowledge concerning ecosystem and human health. Furthermore, Lambert *et al.* (2006: 472) call for a "science of environmental justice". Wing (2005) asserts that a science of environmental justice is a science for people, applied research that addresses issues of concern to communities experiencing environmental injustice, poor public health conditions and lack of political power.

Perrolle (1993) and Jerrett *et al.* (2001) show how environmental justice can be used an interpretive frame or conceptual construct for understanding environmental problems, inclusive of environmental equity, equality, and racism. They further highlight that authors have shown that adopting an environmental justice approach reveals the influence of several, interrelated factors such as economic externalities, unequal power relationships between and among different groups, and the ability of those in power to shape and use institutions for their own benefit. The environmental justice framework is schematically represented by Jerrett *et al*. (2001), as shown in Figure 2.4., from a research perspective.

Figure 2.4: The environmental justice framework (Jerrett *et al.*, 2001: 957)



The above framework informs the conceptualization and focus of this research endeavor. Specifically, while the focus is on locality specific air pollution (that is, a case study of Richards Bay), the political aspects in relation to issues discussed in the previous section as well as apartheid spatial planning impacts (discussed in greater detail next) are centralized. Vulnerability and inequality between and among groups are also examined. The methodological approach adopted utilizes a spatial framework that permits and examination of differential conditions of exposure, living circumstances and experiences. A contribution of this study is that the spatial focus also permits an investigation of intra-group dynamics.

The locations of residents in relation to the polluting industries are a key focus of the study. Thus, socio-economic and spatial variables are integrated that provide the basis for examining which groups are more vulnerable to industrial pollution in a specific locality. Additionally, as illustrated in Jerrett *et al*.'s (2001) framework, various health determinants are also included such as socio-economic position, access to health care facilities, living conditions (for example, type of energy used) and demographic profiles which are deemed to be relevant in the South African context. Thus, the environmental justice framework as proposed by Jerrett *et al*. (2001) is useful in investigating the health effects of pollution at a local level. The framework indicates that issues pertaining to environmental justice influence where industries and specific groups of residents are located.

In terms of the location of resident groups, race and socio-economic status appear to be key factors. Grineski *et al*. (2007) state that the distribution of environmental risks and hazards and their disproportionate distribution and impacts on low-income groups, racial minorities, and other marginalized groups have been the focal point for environmental justice research in recent years. Bullard and Johnson (2000) assert that the equal treatment of all people maintains that no group of people, including racial, ethnic or socio-economic groups should be subjected to a disproportionate share of the negative environmental impacts resulting from industrial, municipal and commercial operations.

The above discussion and environmental injustice research more generally identify a range of vulnerable groups (Braveman, 2006; Brulle and Pellow, 2006; Higginbotham *et al.*, 2010; Sze and London, 2008):

- Racial or ethnic minorities;

- Low paid and unemployed workers;
- Isolated communities;
- Women and children; and
- Residents living close to polluting industries.

It is important to note that many of the vulnerable groups fall into most if not all of these categories simultaneously.

The above discussion illustrates that notions of environmental justice are strongly linked to sustainable development imperatives. Newman and Kenworthy (1999) state that sustainability has emerged to address key challenges facing the world which remain currently:

- the need for economic development to overcome poverty;
- the need for environmental protection of air, water, soil, and biodiversity, upon which we all ultimately depend; and
- the need for social justice and cultural diversity to enable local communities to express their values in solving these issues.

Fenger (2009: 22) asserts:

> The present human impact on nature and artifacts has so far by no means reached that level, but the acidification, the eutrophication, and last, but not least, the greenhouse warming are nearing global proportions. In principle the problem with air pollution used to be simple. Everybody could smell the odorous activities and see the black smoke from low chimneys, and their number was so small, that they apparently only posed local problems, although it is surprising how long time it took to start seriously to solve them.

Devuyst (2000) asserts that sustainability assessment can be determined as a formal process of identifying, predicting and evaluating the potential impacts of a wide range of relevant initiatives which include policies, plans, programs, legislation and regulations; as well as their alternatives on the sustainable development of society. Higgs and Langford (2009) state that here has been a notable increase in the use of GIS in studies of environmental (in)justice in the last two decades.

It is worth recounting the key indicators presented by the Federal Highway Administration (2000 cited in Chakraborty, 2006: 317) in the USA that stipulates the following principles that are applicable to meeting environmental justice objectives generally:

- To avoid, minimize, or mitigate disproportionately high and adverse human health and environmental effects, including social and economic effects, on minority populations and low-income populations;
- To ensure the full and fair participation by all potentially affected communities in the transportation decision-making process; and
- To prevent the denial of, reduction in, or significant delay in the receipt of benefits by minority and low income populations.

Williams and Mawdsley (2006: 661) caution that "the language of environmental justice environmental justice has also been taken up by governments and hegemonic institutions, although here understandings of the term have tended to be set *within* rather than against market structures and standard definitions of property rights". They argue that while this progressive to the extent of these institutions have recognized that particular groups and communities should not be persistently discriminated against in the distribution of environmental goods and bads, there is no critique of the underlying relations of production that produce such social inequities and environmental damage. McAfee (2004) states that in these neoliberal contexts, market mechanisms, voluntary codes of conduct from the corporate sector, and private property rights are seen as the major appropriate mechanisms for change.

2.4.2 Environmental justice in South Africa

Environmental justice struggles in South Africa emerged in light of the longstanding legacy of apartheid politics and spatial planning discourse and practice (Durning, 1990). It is advanced by Durning (1990) that apartheid, despite being an example of political injustice, was also the most comprehensible example of environmental injustice. Apartheid's zoning policies and its racialized separate development philosophy forced black South Africans to be placed in overcrowded Bantustans/ Homelands and townships that were located downwind or downstream from industrial complexes (Kalan, undated). As a result, communities of color in South Africa are unequally exposed to industrial pollution and socioeconomic deprivation, since many individuals are forced to live and work in hazardous industries due to their poverty status. McDonald (2002) advocates the importance of conceptualizing environmental justice and the environment more generally holistically, inclusive of leisure, home and work.

The South African Constitution (Section 24) states that all people irrespective of their race, color or ethnic differences have the right to an environment that is not harmful to their health or well-being and to have the environment protected not only for the benefit of the present generation but also for future generations, which can be achieved through reasonable legislative and other measures that help prevent pollution and ecological degradation, promote conservation, and secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development (Department of Environmental Affairs and Tourism - DEAT**,** 2005). However, these rights have been ignored by most industries, if not all, and pollution continues to infringe on the environmental rights of the poor populations. Lopez (2002) suggests that environmental factors should be included in research on race disparities in health, since the bulk of segregated Blacks are generally situated in close proximity to hazardous industries.

The flagship environmental statute of South Africa is the National Environmental Management Act No. 107 of 1998 (NEMA). NEMA's primary objective is to provide for co-operative environmental governance by establishing principles for decision-making on all matters affecting the environment (Classen and Kalima, 2007). NEMA makes provision for sustainable development and 'the polluter pays' principle, which provides that those responsible for damaging the environment be responsible for the costs of remedying pollution, environmental degradation and any consequent adverse health effects and for the prevention, controlling or minimizing of further pollution.

Classen and Kalima (2007) assert that the Atmospheric Pollution Prevention Act, No. 45 of 1965 has been considered as having inadequate compliance and enforcement mechanisms necessary to implement its provisions effectively. The Act does not take into consideration the cumulative impacts of air pollution in areas where the concentration of emissions of harmful substances into the atmosphere is considerable. However, according to the Department of Environmental Affairs (DEAT, 2005), the Air Quality Act, No. 39 of 2004, replaces the outdated and ineffective Atmospheric Pollution Prevention Act, No. 45 of 1965, and provides for a comprehensive decision-making and management framework for air pollution control. The Air Quality Act, No.

39 of 2004 states that many areas of South Africa do not provide a healthy environment in which its people can reside in, that it is mostly the poor that is placed with the burden of ill health associated with polluted ambient air, that the high social, economic, and environmental cost that is associated with air pollution is rarely endured by the polluter, and that the emissions of harmful substances and gases cause irreparable damage to the environment (DEAT, 2005).

The environmental justice framework has emerged as being critical in informing air pollution studies. However, Buzzelli (2007) and Krieger (2003) have highlighted problems. A key problem is data limitation which Buzzelli (2007) argues results in exposure misclassification and aggregate/ scale effects. Furthermore, Buzzelli (2007) states that the absence of real environmental monitoring data has resulted in a proliferation of exposure surrogates such as buffering and proximity techniques which have resulted in health outcomes only being assumed rather than tested directly. The challenges stress the importance of more empirically-based studies to support assertions embedded in adopting an environmental justice approach. It is hoped that this research contributes to this as it adopts undertakes comparative, spatially-based survey research at the local level to examine differences and explore factors that influence these differences.

2.5 Conclusion

By undertaking a health study in various communities that reflect socio-economic differences, this research will contribute significantly to ascertain whether health impacts are differentially experienced by different socio-economic groups. The study cross-tabulates experiences, perceptions and coping strategies of different socio-economic groups in the area, especially in relation to upper, middle and lower income clusters. Furthermore, the spatial aspect (that is, mapping of key variables as highlighted in the research questions and objectives) is a major contribution and draws from the field of medical geography. Social mapping, as indicated earlier, is a relatively new field. It is extremely useful in terms of collecting and representing social data. The multi-conceptual perspective used in this study provides a framework to examine a range of pertinent issues pertaining to air pollution and health as well as guides the methodological approach adopted as discussed in Chapter four.

CHAPTER THREE
LITERATURE REVIEW

3.1 Introduction

This research endeavor deals with community perceptions on the health impacts that are associated with air pollution from indoor, chemical and manufacturing industries. There is increasing recognition of the links between air pollution and human health. Evidence from epidemiological studies have shown that there are numerous air pollutants that are associated with indoors energy use and with the production processes of industries, and most represent some sort of health implication. However, in-depth and fundamental knowledge of the health impact relationship of most pollutants is limited. Therefore the literature reviewed in this chapter contributes significantly to the knowledge and understanding of health impacts that are directly or indirectly associated with emissions of air pollutants from industrial processes.

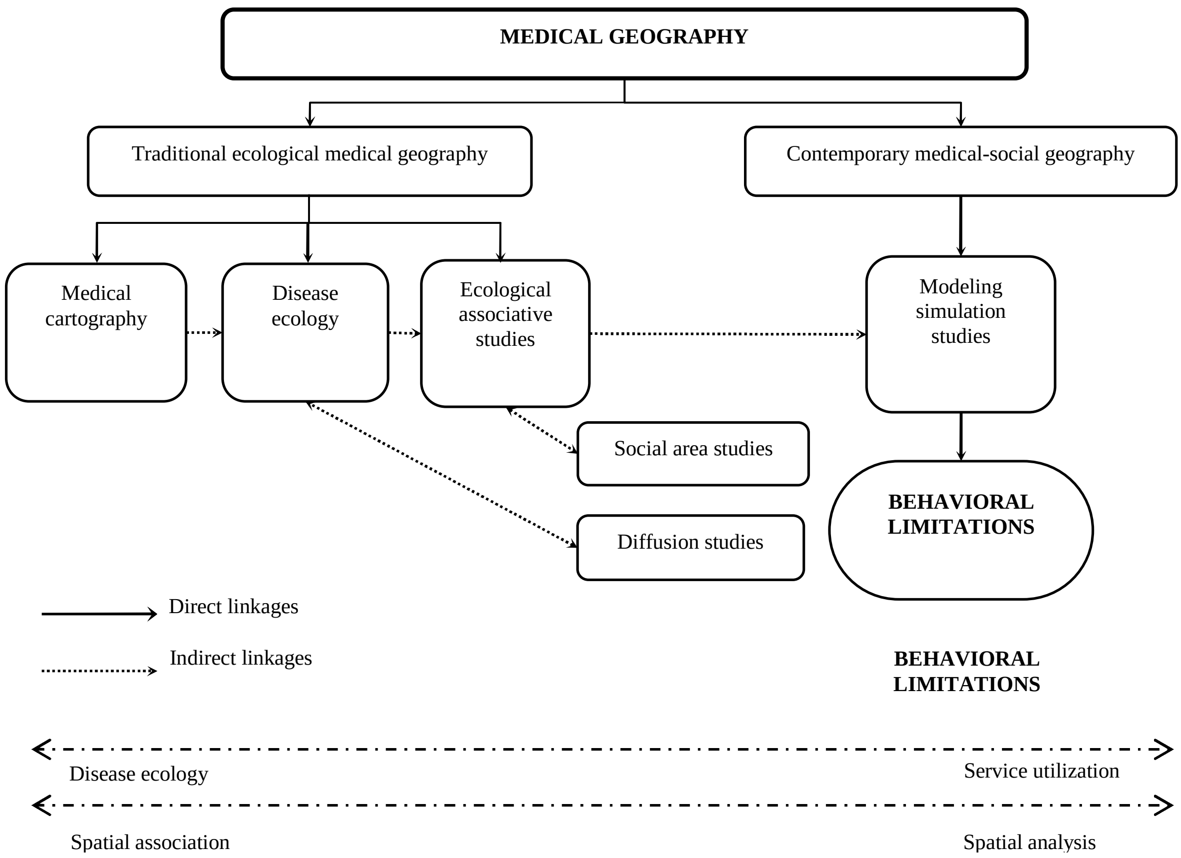
The literature review entails an examination of the following thematic aspects:

- The geography of health
- Environmental racism
- Environmental health aspects
- Neighborhood/ place and health
- Health and development
- Air pollution (examining both outdoor and indoor sources)
- Air pollution and health
- Air pollution, health and socio-economic aspects
- Responses to air pollution

3.2 The Geography of Health

Any geography requires a contextual approach and the geography of health and health care provides such a framework (Eyles, 1986). Moodley (2002) states that the questioning of the direction, purpose and content of current health research from a geographical perspective highlights the need to take space and place seriously, especially with regard to health and health care issues and investigate the relationship between health and health care and people and place in South Africa. This approach broadens the scope of health geographies and re-orients its concerns using innovative research strategies and social theory which adds to the existing knowledge base pertaining to health issues in developing countries. According to Barrett (1986), the importance of medical geography (or the geography of health) as a sub-discipline is characterized by the notion of locational factors and the environment's influence on health which is related to the understanding that the primary cause of disease is not found in the host itself, but the cause of disease is found in the environment. This is linked to the discipline of geography as a whole that focuses on the relationships between people and the environment. Foster (1992) states that geographers also examine marked similarities or differences between a disease pattern and a suspected geographical causal variable. Figure 3.1 below summarizes the main areas of interest in relation to medical geography that informs the rest of the discussion in this section. The social and environmental aspects, and their interconnectedness, are foregrounded. Additionally, health service provision has been a major part of the contribution of medical geography.

Figure 3.1: Spatial approaches to the study of health issues (adapted from Akhtar and Hunter, 1991: 13)



The WHO (2003: 1) defines health as being “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity”. Thus, health includes non-physical aspects in combination to aspects pertaining to the prevalence of disease. Linked to this definition is the recognition of health as a fundamental human right regardless of social or economic conditions, religion, race or political affiliation (WHO, 1983). The importance of this definition is that health is conceptualized as a social phenomenon as opposed to the object or outcome of medical care. Thus, this broadened definition focuses not only on the absence of disease but also includes non-physical aspects of the quality of life. Kronenfeld (1993) states that it includes a tripartite conceptualization of the ability of a person to function in an environment, that is, the mental, physical and social dimensions of health.

Schlenger (1976) formulated a two-dimensional model which looks at the absence of disease and the effective or feeling aspect of health. The integration of social dimensions resulted in an increase in population and community surveys which were adopted to avoid sole reliance on medical data or avoid bias of interviewing those people who attend health care facilities (Moodley, 2002). This approach has become the norm today and most research uses multi-dimensional survey data which include simple questions asking persons to rate health; doctor-based assessments of health status which are linked to the presence or absence of major chronic illnesses; aggregate population measures such as infant mortality rate; and average life expectancy or disability rates in a population (Kronenfeld, 1993).

Pautrel (2009) states that the detrimental influence of pollution on health and life expectancy is one of the well-documented phenomena in the field and one of the most striking features of the negative impact of pollution on individuals. Additionally, Luechinger (2010) highlights the importance of life satisfaction more broadly that is increasingly being used to value public goods including air quality. Luechinger (2010) and Welsch (2006) found that air pollution negatively affects life satisfaction in a statistically significant way. This is similar to MacKerron and Mourato’s (2009) findings reveal that non-income aspects influence individuals’ life conditions. They affirm that environmental quality, in particular perceived and measured air pollution levels, influence life satisfaction. Day (2007) indicates that individuals' perceptions of air pollution are positively related to objective pollution measures, as well as to broader evaluations of their local environment. They also state that since health is invariably found to be a major determinant of life satisfaction levels, improving health is often associated with significant life satisfaction gains.

The WHO, established under article 57 of the Charter of the United Nations in 1948, is the global organization mandated to ensure “the attainment by all people of the highest possible level of health” (Varney and Kriebs *et al*., 2004: 70). This is guided by the following tactical directions outlined in its General Program of Work (Varney and Kriebs *et al.*, 2004: 71): reduce excess mortality, morbidity and disability, especially in poor and marginalized populations; promote healthy lifestyles and reduce risk factors to human health that arise from environmental, economic, social and behavioral causes; develop health systems that equitably improve health outcomes, respond to peoples legitimate demands, and are financially fair; and frame an enabling policy, create an institutional environment for the health sector, and promote an effective health dimension to social, economic, environmental and development policy.

Linked to the above, the South African Constitution also centralizes the importance of human rights in relation to health. Specifically, the South African constitution provides for the right to health and health care under section 27: Health care, food, water and social security (South African Constitution, 1996 cited in Kidd, 2008: 68):

> Everyone has the right to have access to health care services, including reproductive health care; sufficient food and water; and social security, including, if they are unable to support themselves and their dependents, appropriate social assistance. The state must take reasonable legislative and other measures, within its available resources, to achieve the progressive realization of each of these rights. No one may be refused emergency medical treatment.

Despite this laudable position articulated in the South African Constitution, there are significant disparities in relation to health provision and exposure to unhealthy environments in South Africa.

Geography as a discipline, as indicated in earlier Chapters, has also contributed to an understanding of air pollution and health impacts. Oudinet *et al*. (2006) state, for example, that use of GIS is a relevant geographical tool that has assisted in establishing the spatio-temporal dispersion of air pollutants as it takes account of the complex involvement of climatic, meteorological and urban topographic parameters. Furthermore, their study incorporates anthropogenic uses of urban areas. As this study will show, GIS is also well-suited to integrate socio-economic perceptions in relation to a range of variables. Elliot and Wartenberg (2004) argue that the introduction of GIS has provided new tools that examines the dispersion of air pollutants in specific locations as well as shows spatial links between different types of information. Diem and Comrie (2002) highlight the predictive mapping of air pollution involving sparse spatial observation that is using spatial interpolation which is to discern the spatial patterns of a phenomenon by estimating/ predicting values at un-sampled locations based on measurements at sample points. They specifically develop a surface map of air pollution concentrations in Tucson, Arizona in the USA. Maantay (2007) also indicates the importance of using GIS to examine asthma and air pollution in the Bronx, New York. Bevc *et al*. (2007) use GIS to examine environmental justice and toxic exposure in a low income, African –American community in Fort Lauderdale, Florida. They found that there existed a significant relationship between physical health and psychological well-being.

3.3 Environmental Racism

Guhathakurta and Wichert (1998) and Mix and Shriver (2007) argue that race is seen as an important variable that shapes residents' perceptions of environmental hazards. Specifically, Lopez (2002) asserts that the result of racial segregation can be attributed to the disproportionate risk of exposure to environmental stressors endured by Blacks. Morrice and Colagiuri (2012) and Morello-Frosch (2002) specifically highlight that socio-economic and political forces unavoidably create a situation in which overlapping pollution plumes, emitted by various sources into our air, soil, food and water pose a range of health risks to diverse surrounding communities, where the poorest are the most vulnerable. Their study together with others (Bell *et al*., 2005; Brown, 1995; Brulle and Pellow, 2006; Marschall, 2008) have documented higher outdoor air pollution in regions with a greater portion of non-white and low-income groups in California's South Coast Air Basin Industries and governments have often exploited the economic vulnerability of Black communities for their unsound and hazardous operations (Bullard and Johnson, 2000).

As highlighted previously, environmental struggles in South Africa can be attributed to apartheid policies which forced Black South Africans to be placed in overcrowded areas that were downwind or downstream from industries. Jaggernath (2010) states that this has resulted in communities of color in South Africa being unequally exposed to industrial pollution and socio-economic deprivation, since many individuals are forced to live and work in hazardous industries due to their poverty status. Sparks (2006) argues that environmental racism and its unjust effects in South Durban did not simply arise out of official and corporate indifference, but was in fact a by-product of the power of a white civic culture itself concerned with the polluting effects of oil refining in the area which illustrates the negative consequences of South Africa's legacy of a racialized civil society. van de Merwe (2004) indicates that in a global context, governments have been criticized for failing to effectively regulate and control the activities of environmentally hazardous industries in racially segregated areas.

In relation to health care, the adequate provision and quality of health care in South Africa remains largely unequal despite the demise of apartheid in 1994 which reflects environmental racism. As Moodley (2002) and Stuckler *et al*. (2011) state, during apartheid, a diversity of health care systems co-existed uneasily and inequitably. They further indicate that health care structures for Whites, both private and public, flourished under widespread support from the existing government while the Black health care sector, both state and traditional, was neglected and became increasingly impoverished. This fundamental inequality together with conditions of vulnerability created the basis for high rates of health problems among the Black populace (Moodley, 2002).

Moodley (2002: 4) specifically states:

> Due to the varying degrees of health care systems and institutions in South Africa, ranging from State services to western private medical care as well as traditional practices, coupled with various social dimensions (gender, location, class, religion, ethnicity) that affects access to health care services, there is definitely a need for the transformation of apartheid geographies and landscapes linked to health and health care provision in South Africa.

Bullard (2001) argues that environmental racism in relation to health reinforces the stratification of people (race, ethnicity, status, power), place (central cities, suburbs, rural areas, unincorporated areas and homelands), and work (office workers afforded greater protection than farm workers). Furthermore, the following characteristics are noticeable (Bullard, 2001):

- Institutionalizing of unequal enforcement;
- Trading of human health for profit;
- Placing of the burden of proof on the 'victims' and not the polluting industry;
- Legitimizing human exposure to harmful chemicals, pesticides, and hazardous substances;

- Promoting 'risky' technologies;
- Exploiting the vulnerability of economically and politically disenfranchised communities;
- Subsidizing ecological destruction;
- Creating an industry around risk assessment;
- Delaying cleanup actions; and
- Failing to develop pollution prevention and precaution as the overarching and dominant strategy.

Bullard (2001) further states that environmental racism is also evident at the global level. He provides the example of the shipping of hazardous wastes from rich communities to poor communities which is not regarded as a solution to the growing global waste problem. Specifically, he shows that the transboundary shipments of banned pesticides, hazardous wastes, toxic products, and export of 'risky technologies' from the USA, where regulations and laws are more stringent, to nations with weaker infrastructure, regulations and laws smacks of a double standard. He claims that unequal interests and power arrangements have allowed the poisons of the rich to be offered as short-term remedies for poverty of the poor. This situation, Bullard (2001) argues, plays out at the national level (as in the USA where non-White and low-income communities are disproportionately impacted by waste facilities and 'dirty' industries) and internationally (where hazardous wastes move from developed countries to developing/ underdeveloped countries). Bullard (2001) also indicates that people of Color globally (in both industrialized countries of the North and in developing countries of the South) are threatened by industrial polluters.

Jones (1984) states that equity refers to who gets how much of what is available. The main focus is on who gets what, where and how. Furthermore, Humphreys (1988: 323) states that “equity is a procedural concept which requires implementing rules to the allocation and distribution of scarce resources.” Issues of equity in relation to health care relate to ensuring that the following are attained (Leahy, 1996):

- Financial and geographical equality: it is important to note that allocating money on the basis that each individual is the same is not equitable. People have differing needs and concerns related to issues such as age, sex and the social environmental conditions;
- Equality in relation to health status: implies equality of health status for all. While this is desirable, it is not a suitable short or long-term objective. Furthermore, there are many

factors outside the health system that affect health, for example, housing and pollution. However, government should try to achieve this objective by pursuing the effective delivery of services in areas that will have an equal impact on the health of the population;

- Equality of service use: however, it is important to note that it is impossible for the authorities to force people to use services even if every effort is made for people to use services appropriately;
- Equality of treatment: patients with the same illness will complete their treatment in the same condition as each other (equal outcome). However, patients are different and it is difficult to predict factors that will affect the uptake of treatment and recovery; and
- Equality of access: there should be a move towards providing everyone with equal access to basic health services which should be monitored and disadvantaged groups can be targeted.

The focus of attention is on the distributional aspects of resource provision to ensure that unmet needs were fulfilled and inequalities minimized or overcome in relation to health (Asher, 2004; Graycar, 1979; Smith, 1977). Furthermore, Humphreys (1988) and Smith (1977) state that equity is a term closely related to notions of equality, justice and fairness. It is only one of several distributional principles, which guides the process of resource allocation.

In relation to health care provision, Moodley (2002) states that there are significant disparities in health status which can be linked to individuals' unequal access to quality health care on the basis of race, ethnicity and gender. The denial of health care does not occur only as overt racism, but also as a result of institutional racism which grows because of the disparate impacts of practices and public policies, inadequate laws and regulations, ineffective enforcement of existing laws and regulations, cultural incompetence of health care providers and institutions, and socio-economic inequities that are disproportionately distributed along racial lines (Randall, 2001).

Racial barriers to quality health care may manifest themselves in a number of ways in different countries (Bullard, 2001; Cohen *et al.*, 2002; Randall, 2001):

- Racially discriminatory policies and practices;
- Lack of economic access to health care;
- Racial disparities in medical treatment;
- Racial prejudice of physicians and other health care providers;

- Racial barriers of entry to hospitals and health care institutions;
- Disparate impact of the intersection of race and gender;
- Lack of language and cultural sensitivity;
- Inadequate inclusion of disadvantaged groups in health care research;
- Lack of data and standardized collection methods; and
- Racialized conduct of scientists, professionals and other public figures on matters relating to scientific experiments, clinical trials, industrial products and safety standards.

Effective monitoring and regulation of racial discrimination in health care requires that governments and other stakeholders such as non-governmental organizations (NGOs) take a proactive role in identifying where institutional racism exists and ensuring that mechanisms are put into place to eliminate these practices. Randall (2001) states that among the actions that need to be considered include the routine and systematic collection of health status and health care data based on race, gender and socio-economic status. Furthermore, such data should not be limited to census and vital statistics, but should include data on access and quality; particularly service delivery, diagnosis and treatment, facility availability, provider availability and other related health activities and services (Randall, 2001).

Together with the focus on equity concerns, there has also been a shift from medical to heath concerns in society. As Kearns (1997: 271) states more than a decade ago:

> As citizens and geographers we are both participants in, and observers of, turbulent times. In the health sector, we witness people disillusioned with a commercial re-orientation, which sees patients re-cast as customers. In modest ways, we witness a striving to reclaim health as a quality rather than a commodity - something less medicalized and more connected to everyday experiences.

Thus, the importance of integrating peoples' experiences and concerns in addressing health concerns are centralized.

3.4 Environmental Health

Environmental health has been a focus of medical geography as outlined in the conceptual framework. Eyles' (1997) definition proposed more than a decade ago remains relevant today. He states that environmental health refers to the health and well-being of human populations taking into consideration social, physical and societal contexts which are interrelated and multi-dimensional, implying that the condition of the environment can affect human health and issues pertaining to human health and well-being can also affect the environment. According to Eyles (1997), early ideas of environmental health emanated from the work of Winslow in 1920 and focused on the following: the science and art of preventing disease; prolonged life; promoting health and well-being through organized community effort for the sanitation of the environment; control of communicable infections; organization of medical and nursing services for the early diagnosis and prevention of disease; education of individuals in personal health; and the development of social machinery to assure everyone a standard of living adequate for the maintenance or improvement of health. For example, Bickerstaff and Walker (2001) state that the negative social and physical conditions (greenery and visual pollution) of the environment generate a propensity to dislike the neighborhood and attach a range of negative attributes to the local area.

Last (1987: 131) defines environmental health as an "aspect of public health concerned with all the factors, circumstances and conditions in the environment or surroundings of humans that can exert an influence on human health and well-being". Moodley (2002: 46) states that environmental health is about the deterrence of disease and the endorsement of health in environments or geographically defined populations and focuses on the "preservation, restoration and promotion of what society sees as important to promote health" and "includes not only disease prevention and health promotion, but also monitoring environments for adverse human effects and outcomes". It is clear that environmental health is about the prevention of disease as well as promotion of healthy environments. Specifically, Eyles (1997) states that the focus is not only on disease prevention and health promotion, but also the monitoring of particular environments for adverse human health effects and outcomes.

Several authors assert that the empirical literature that examines the determinants of environmental outcomes (especially in relation to health issues) focuses on economic status, social vulnerability, decision-making democracy, literacy levels and income inequality (Barrett and Graddy, 2000; Binder and Neumayer, 2005; Briggs *et al*., 2008; Goodman, 2011; Jerrett, 2004; Laurent, 2007; Makri and Stilianakia, 2008; Neumayer, 2002; Neumayer *et al*., 2002, O'Neill, 2003; Tonne, 2008). These factors also influence the distribution of power in society and, as discussed earlier, they are also linked to environmental racism. Boyce (2003) asserts that that power inequality is a cause of environmental degradation because the more powerful people are likely to benefit from environmental degradation. Policy choices and government decisions have significant environmental outcomes which is clearly discernible in the South Durban Basin area (Jaggernath, 2010; Leonard, 2011; Vissers, 2010) and land degradation in the former homelands in the South African context.

The link between environmental issues, air pollution and health is well established in the literature (Bickerstaff and Walker, 2001; Hunter *et al*., 2003; Richmond *et al.*, 2005). The increase in environmental health issues in the South African context is, as stated by Bickerstaff and Walker (2001), as coinciding with the social and political transformations that characterized the 1980s and 1990s. They further argue that this heightened environmental awareness resulted in the concern of how to manage these risks and the role of stakeholders (particularly the public) in influencing policy formulation for the management of air pollution, especially in and around residential areas. Richmond *et al.* (2005) illustrate that in Namgis First Nation, Canada, there are strong links between reduced access to environmental resources, marginal participation in the economy, and declining community health and well-being. Pendleton *et al.* (1999) state that in addition a person's socio-economic status, cultural ties and past experiences influence how environmental quality is perceived, as well as reaction behavior in order to change the quality of the natural environment.

The importance of place and health is based on the premise that human-beings require certain needs to be met to live a healthy life, irrespective of the socio-economic and locational background. Maslow's hierarchy of needs (Table 3.1 below) provides a useful framework for understanding how place affects human health. The Table illustrates that several environmental resources are needed to meet a range of human needs and the quality of the resources are critical for human well-being and quality of life. A number of factors influence one's ability to meet these needs including socio-economic (especially wealth) status, access to technological and medical advancements, power dynamics at the household and community levels, etc. The aspect of access to resources, services and opportunities become central to meeting the range of needs outlined in Table 3.1. In relation to health specifically, of concern is how health-related services and resources in a given society are geographically distributed and provided. Thus, examining the influence of place on health becomes central since health-related resources and services have a spatial footprint. When environmental health issues related to the quality aspects are included, it is clear that place matters when examining health issues. Macintyre *et al*. (2002) state that from an environmental health perspective it is also important to examine the regulations put in place in a specific area to control air and water quality. The United Nations World Water Development Report (2009) indicates that water quality is declining from mass pollution, particularly as a result of the processes of industrialization which include industrial agricultural processes in rural areas.

Table 3.1: Maslow's hierarchy of needs as outlined by Macintyre *et al*. (2002: 133)

Needs	Health Services
Air	Unpolluted
Water	Clean water for drinking and cooking
Food	Adequate supplies of nutritious and non-poisonous food
Shelter	Protection form wind, cold, rain
Security	Protection from threats to person or property
Hygiene	Protection form infectious or contagious disease and from toxins and pollutants
Education	Socialization in the skills and information needed in a given society
Healing	Care and treatment for sick and infirm
House keeping	Resources for food storage and preparation, cleaning (of people, cloths and homes) and waste disposal
Work	Gainful labor
Transport	Private and public transport, roads, railways, etc.
Personal relationships	Family life, intimate relationships, acquaintance and friendship networks
Religious	Spiritual or ritual practices
Involvement in group activities	Participation in political, social or economic activities
Play	Social, cultural, and physical recreation

The focus on place and health is based on the premise that the locations in which people live and/ or work directly or indirectly influences their health status. Five features of places or localities in particular, as outlined by Macintyre *et al*. (2002: 131), influence health outcomes:

- The physical features of the environment shared by all residents in a locality: this includes, for example, water, air and climate that is usually shared by neighborhoods across a wide ranging area;
- The availability of healthy environments at home, work and play: examines how areas differ in their provision of decent housing, safe areas for children to play and secure and safe employment opportunities. These environments do not necessarily affect everyone

within that environment in the same way that water and air quality would, instead they may affect families with children more than elderly people without children, or the employed more than the unemployed;

- The services provided, publicly or privately to support people in their daily lives: includes for example transport, education, policing and health and welfare services of the area. These features influence people differently, as how they affect people depends on their personal situation, for example, public transport may mean less to a person who owns a car, than to a person who does not;
- The social-cultural features of a neighborhood: these aspects influence the health of people, which includes the economic, political, religious and ethnic history of the community. This in turn includes the level of community integration, their norms and values, crime levels and any other threat to the safety of individuals, and the existence of networks of community support; and
- The reputation of an area: focuses on how places or areas are perceived by residents, by service planners and providers, as well as by investors. This influences the morality and self-confidence of residents in the area, the infrastructure of the area and who moves in and out of that area.

It is important to note that the first three aspects referring to infrastructural or material resources which are also known as opportunity structures. These are generally socially constructed and socially patterned features of the physical and social environments which may promote or damage health either directly or indirectly through the possibilities they provide for people to live healthy lives (Macintyre *et al*., 2002). The last two features relate to the collective social functioning and practices, for example, perceived local cohesion.

The infrastructural and service environments of neighborhoods influence the health of its residents. Cubbin *et al*. (2008) state that neighborhoods determine ones access to and quality of services and opportunities, such as schools, health care services, employment opportunities, transportation, and employment opportunities which directly and indirectly influences health. The provision of health care facilities and services influences health directly. However, social aspects such as education and employment opportunities affect accessibility, including the ability to afford health care. As Cubbin *et al*. (2008) indicate, the differences in education and employment opportunities in different neighborhoods often create and reinforce social disadvantage which then results in worse health due to the creation of disparities among (and within) different neighborhoods.

3.5 Neighborhood/ Place and Health

The conceptual framework presented in the previous chapter highlights the importance of neighborhood/ place in understanding health issues. As Bickerstaff and Walker (2003: 53) state:

> An emphasis on the role of industry as a key source of pollution has been shown to reflect not only local spatiality mediated through sensory scopes but also temporal/ historical geographies. The local experience of industry was important in the construction of ideas about air pollution.

Furthermore, Scammel *et al*. (2009) assert that a "neighborhood includes the social, physical, biologic and chemical environment; where we live, what we live in, and the social structures, institutions and people with whom we live". They further argue that rootedness in or experience of a particular place has the power to shape individual perceptions of health studies, and conceivably health.

Hanchette (2008) states that an understanding of place and the collective experiences of people, in that place, should remain an important focus of medical geography. Bush *et al*. (2001) examine how the presence of a hazardous industry may affect the identity of a place and the people who live there. Drawing on qualitative research undertaken in Teeside in North East England (a heavily industrialized area), they conclude that place stigma associated with air pollution is a complex, multiple and reinforcing concept. They identify four reinforcing types or sources of stigmas: technological stigma; air pollution (or `dirt') stigma; health stigma and social stigma. They argue that "the presence of technologies, air pollution, poor health and social exclusion may be used as `discrediting' characteristics, to stigmatize one place, whilst confirming the usualness of another: (Bush *et al*., 2001: 47). These stigmatized places (also referred to as 'contaminated communities' or 'faulty environments') are associated with high perceptions of risk. Gregory *et al*. (1995: 220) also refer to the "geographic stigma" associated with places located in close proximity to a "novel technology" (for example, a nuclear power or chemical plant) as a result of public perceptions which brand that technology as "unduly dangerous". This is also linked to economic blight which is associated with repressed/ lower property prices. Yusuf and Resosudarmo (2009) specifically found in Jakarta, Indonesia that air pollutants have a negative association with property value. Walker *et al.* (1998), highlight that these areas are also associated with social stigmas which are linked to high levels of poverty, deprivation, unemployment and crime. Bush *et al.* (2001) present reasons for a spoiled place identity:

- Visibility: while historically air pollution and heavy industry were symbols of economic success, polluted places are now seen as marginalized places;
- Distancing and dis-association: air pollution and poor health are used as discrediting characteristics to stigmatize an `Other' place as dirty and unhealthy (linked to the discourse on inclusion and exclusion); and
- Virtual identity: how quality of air in a specific location is expected to be based on stereotypical associations with industry and the actual identity, that is, real levels of air quality based on monitoring

Neighborhood and health dimensions are also important to consider. Davidson *et al*. (2006) assert that because health is a key component as well as the outcome of attitude, identity and behavior of people, it means that 'place' plays a role in constructing health. They further indicate that the relationship between health and place can be demonstrated by the relationship between neighborhoods/ place and health which take numerous forms. Neighborhoods can influence health in many ways. Cubbin *et al*. (2008), state that people who live in neighborhoods that provide resources for exercise, such as parks and other recreational spaces, tend to be more physically active and therefore healthier. They further aver that the social environments of neighborhoods embedded in the social relationships among residents (including the connectedness and mutual trust among neighbors) also play a role in shaping the health of its residents. Wen *et al*. (2009: 452) define neighborhood social cohesion as the "social relational resources of a physically bound area characterized by some degree of homogeneity, typically manifested in community solidarity and norms of reciprocity". The importance of social cohesion is also supported by Kawachi and Berkman (2003) who highlight that in closely knit neighborhoods, residents are more probable to work together in order to achieve common goals, maintain informal social controls, and to exchange information which subsequently directly or indirectly influences health. They further argue that in these types of neighborhoods, children are likely to receive guidance from many adults, other than their parents, and as a result less likely to participate in health threatening activities such as smoking, drinking and drug use. Wen *et al*. (2009) assert this social cohesion enhances health because it increases a community member's social contact, support and ultimately their psychological well-being.

Hanchette (2008) states that aggregate data can obscure more localized spatial patterns. In terms of the importance of neighborhood conditions on health, Poortinga *et al.* (2008) indicates that several researchers have debated the extent to which neighborhoods influence health, specifically in relation to whether the association between neighborhood conditions and health is due to the socio-economic status of individuals living in the neighborhood. Poortinga *et al.* (2008) states that in response to this concern, there is an increasing focus to consider the individual socio-economic position of residents when attempting to determine the association between neighborhood deprivation and health. This study includes household surveys to unpack individual household dynamics as well as examine community level concerns such as access to services. The latter is included because, as Cubbin *et al.* (2008) state, most research on neighborhood and health has found associations between deprived neighborhoods and health even after taking into account the individual socio-economic characteristics. Furthermore, several studies show that that poor individual and household health is more prevalent in poorer, more vulnerable neighborhoods (Goodman *et al*., 2011; Gouveia *et al.*, 2004; 1996; Jerrett *et al.*, 2001; Jerrett *et al*., 2004; Pearce and Kingham; 2008; Perlin *et al.*, 2001; Wright *et al.*, 2011).

It is important to note that neighborhoods and communities are not homogenous units. As Meer (1997) indicates, the assumption of homogeneity in communities is partly as a result of policy-makers trying to simplify reality in their attempts to offer legalistic, technicist or economistic solutions. This is driven by the desire to develop 'one-size-fits-all' approaches to address complex problems. This is a problematic approach to conceptualizing communities and households which has partly contributed to ineffective interventions. The diversity among and within households and communities must be recognized, especially in relation to health care issues. Impacts can differ considerably over space and time.

The physical characteristics of the features of neighborhoods including buildings, streets, open spaces and lighting which make up the physical environment affect health and well-being. Wen *et al*. (2009) specifically state that physical characteristics of neighborhoods can have positive impacts on health such as in the case of accessibility to amenities (gyms or parks) that often results in greater levels of physical activity and mental health. On the other hand, Kawachi and

Berkman (2003) indicate that health can be affected by poor air and water quality or by the close proximity to industries that produce hazardous substances, by having a lack of access to nutritious foods and places that are safe to exercise, and by adverse traffic conditions and neighborhood noise.

Poortinga *et al*. (2008) indicate that there remains a key debate in relation to neighborhood and health in terms of whether the association between neighborhood conditions and health is due to the socio-economic status of individuals living in the neighborhood. The key aspect is the extent to which the individual socio-economic status of residents establishes the relationships between neighborhoods and health. This position centralizes the individual socio-economic status of residents in a particular location. Poortinga *et al*. (2008), states that as a result of this concern, it is common to consider the individual socio-economic position of residents when examining the relationships between neighborhood deprivation and health aspects. Cubbin *et al.* (2008) argue that research based on approach questions whether people who live in wealthier neighborhoods tend to be healthier due to the fact that they themselves are better-off economically or because of the characteristics of the neighborhoods that they live in. Despite these debates, Poortinga *et al*. (2008) assert that there is generally a consensus in the literature that both the individual socio-economic status and the characteristics of neighborhoods influence the health of its residents, and therefore both should be taken into consideration when conducting research.

Cubbin *et al.* (2008) provide an illustrative example in their study which shows that when comparing heart disease amongst people who live in different neighborhoods, individuals who lived in the most deprived or socio-economic disadvantaged neighborhoods had a greater chance to develop heart disease than similar individuals who lived in socio-economic advantaged neighborhoods. They further highlighted that the physical features, social relationships, opportunities and services that are accessible in neighborhoods either positively or negatively influence individual choices that improve their health and well-being. Thus, they conclude that the characteristics of neighborhoods as well as individual socio-economic status influences health, suggesting that both place and people are influential in terms of health impacts.

Linked to the characteristics of neighborhoods are housing conditions which influence health impacts. Health conditions within a household are central to its socio-economic stability.

Macintyre *et al*. (2002) identify the following functions that in relation to housing that promote health and well-being:

- Shelter: assumes that housing should be accessible and affordable, well-suited to the physical health and mental well-being of its residents, and should provide shelter and protection from weather and pests;
- Housekeeping or house maintenance: these costs must be affordable and reasonable, and includes aspects such as food preparation, waste disposal and household maintenance;
- Accommodation: includes the size, arrangement, and division of space and amenities which should be appropriate for the wide range of household activities;
- Suitable links to other households and places of service and employment, including tenancy which promotes co-operation rather than friction amongst other households;
- Meaning: relates to the appearance, character and conditions of the households which should mirror the values of the owner of the house and create a sense of belonging and security; and
- Recreation: housing should provide the persons living within a household with opportunities and spaces to rest and relax.

Linked to housing conditions is the issue of spatial crowding which is the number of persons per a square meter in a housing unit. However, it is important to note that crowding includes not only the concentration of people in residential space but also their concentration with respect to the use of limited environmental resources and services (Moodley, 2002). As indicated by Aldridge (1993), Smith *et al.* (2011) and Surjadi (1993), research reveals that crowding facilitates the spread of respiratory infection. Exposure to cooking smoke, for example, increases susceptibility to infections and is likely to compound the effects of crowding (Perez-Padilla *et al*., 2010; Smith *et al*., 2011). Chen (1990), Ellegard and Egneus (1992) and Smith *et al.* (2011) indicate that the extent and nature of exposure depends on where the cooking (proximity to living quarters exacerbates health side effects) is done and what type of fuel source (paraffin/ kerosene, gas and certain wood types give off toxic fumes) is used. Thomas *et al.*'s (1999) research shows that people in the lower wealth quintiles are exposed to risks in their homes related to the building methods and materials. They specifically indicate that the majority of homes in Port Elizabeth, South Africa are constructed of brick, however the majority of people in the city in the lower two wealth quintiles live in informal housing where wood and corrugated iron sheeting are the main building materials for homes in the lowest wealth quintile (76%) and the lower-middle wealth quintile (54%). They state that the problems experienced in the household environment by residents in the lower two wealth quintiles include damp, thermal inefficiency, overcrowding, poor ventilation rates, risks associated with paraffin (the main cooking fuel used) and the location of informal housing in poor locations. Their study showed that 80% of households using paraffin had soot on the walls and ceilings, with the focus groups reporting negative health impacts of using paraffin. They also note that the negative health effects of paraffin combustion products required further examination.

According to Howel *et al*. (2003), people who live the closest to industries feel that air pollution is a problem that affects their neighborhood, while communities that are situated further away from industries do not tend to regard air pollution as a problem. Howel *et al*. (2003) underscore the importance of considering the geographical proximity to polluting industries. Their findings show that self-reported respiratory symptoms, plus the belief that emissions from industry affected ones' own health, and knowing of people who suffer from ill health increased in residential communities that were situated closer to an industry. The study by Howel *et al*. (2003) concluded that the presence of an industry in close proximity to residents frames or influences their view and perceptions about the associations between air pollution and health. Similarily, Bush *et al.*'s (2001) study revealed that two communities living at a distance from the source of pollution did not associate themselves with air pollution. They showed that these communities linked air pollution to the 'poorer' (the "distant others") who lived close to industries due to industrial development and socio-economic deprivation:

> In communities located at a distance from industry, air pollution and poor health were largely seen as `belonging' to socially and geographically distant `Others'. However, air pollution as a problem was also `Othered' by those living in the community closest to industry.
>
> (Bush *et al.*, 2001: 54)

Bickerstaff's (2004) research showed that the spatial reach of air pollution exerts an influence over a person's agency to act in a meaningful way. In a study on perceptions of various groups of residents living next to heavy trafficked roads, Bickerstaff (2004) established that people who had the strongest opinions about air pollution had little interest to act against it which showed the relationship between power, inequality and the meanings people attach to risk in communities that are or have been marginalized by means of geographic, economic, social or ethnic isolation. Furthermore, Bickerstaff (2004) indicates that people who feel that they have no control over their geographical circumstances and no political or economic routes of escape expressed the strongest concerns about being trapped in a polluted environment. Bickerstaff (2004) summed up the main findings from the study that people who are the most economically and socially disadvantaged show greater suspicion than other groups towards industry and government. This was found to be most widespread among unemployed men which they attributed to the alienation from decision-making processes and their economic marginalization. Bickerstaff (2004) states that middle class people on the other hand accept that authority figures (generally experts and managers) have competence and they also feel that they are in a position to challenge authorities.

Research thus reveals that the air pollution issues (which can be extended to environmental pollution more generally) are influenced by people's sense of power over specific places and attachment. Furthermore, as stated by Bickerstaff and Walker (2001:137), there appears to be a strong relationship between affluence and the way in which people living in poverty is perceived. They showed that affluent individuals tend to perceive that areas of low environmental quality were restricted to deprived society members which causes physical deterioration and social apathy. This also reinforces socio-economic and spatial inequalities in society. As Bickerstaff (2004: 833) indicates: "What is then evident in these studies is the relationship between power, inequality and the meanings people attach to risk in communities which have been marginalized by positions of economic, geographic, social or ethnic isolation".

Arku *et al.* (2008) state that a number of studies have examined spatial patterns of air pollution, with many such as Buzzelli and Jerrett (2004), Levy *et al.* (2002) and Loh *et al.* (2002) focusing on air quality and air pollution sources in marginalized neighborhoods and populations. Schikowski *et al*. (2008) showed that a higher prevalence of respiratory disorders, including impaired lung functions was found in participants of a lower educational level. Educational levels have also been shown in other studies (Finkelstein *et al*., 2003; Miller *et al*., 2007) to modify the effect of exposure to particulate matter on mortality, with higher risks among people of lower educational level. A study in Europe and North America by Samoli *et al.* (2008) found that a high percentage of unemployment was associated with a greater particulate matter health effect. In England, the study by Wheeler *et al*. (2006) found that low social class and poor air quality were associated with decreased lung functions. Thus social and environmental factors are important considerations when examining the impacts of air pollution on the development of pulmonary disorders.

A study was conducted by Elliott *et al*. (1999) in the region of Hamilton-Wentworth in Canada. This area faced significant air quality problems for several years linked to the region's local economy relying primarily on steel and correlated manufacturing. The authors indicate that this problem was worsened because the area was the recipient of a significant amount of cross-border long-range transport of air pollutants. A multi-stakeholder process spearheaded by the NGO Hamilton-Wentworth Air Quality Initiative (HAQI) was conducted to estimate the health, odor, economic and aesthetic impacts of the air quality. The HAQI put together environmental scientists from government and academia to synthesize existing data and information on air quality in an attempt to establish an inclusive management policy and research agenda for the region. While the multi-stakeholder process initially was based on priority pollutants identified by the scientific experts, after conducting consultations with community partners, black particulate fallout which was a health concern of the public was also included in the study. This indicates the importance of community consultation.

The region under study was socio-economically differentiated with the north end of Hamilton being an area of low socio-economic status as compared to other areas within the region. This community was characterized by higher proportions of the population employed in unskilled/ manual professions with lower household incomes and lower levels of education. Additionally, it was regarded as an environmentally disadvantaged neighborhood due to the residential areas being located nearby (known) polluting industries as well as due to the documented distributions of total suspended particulate in the area.

The results from the primary research conducted in a specific locality within the area known as Hamilton Beach or Beach Strip revealed that residents of the area were aware of the environmental hazards in their neighborhood resulting primarily from unfavorable air quality due to its close proximity to the major industrial activities. Furthermore, the main reasons for living in the area were the strong social networks and affordable home ownership in the area. Additionally, only those very strongly affected by the adverse air quality were most likely to either move elsewhere or take about actions to reduce the impact. The authors concluded that for most residents the economic and social benefits gained by living within the area outweighed the environmental costs. While there was a general desire to remain in the area, the status quo was challenged to improve the quality of life in the area with numerous grassroots community groups such as the Homeside Environmental Committee (HEC) being active.

The HEC attempted to influence the environmental management process by carrying out their own health study in 1994 which documented a considerable amount of uneasiness with air pollution in the area, and found cases of asthma and cancer. This concern for air pollution and health within the community resulted in the formation of an interdisciplinary, intersectional working group tasked with responding to the concerns of the community. In 1995 the Health and Public Project provided funds needed to establish links between the Regional Department of Public Health Services, university-based health researchers and community organizations to design and develop the North Hamilton Survey which was implemented in 1997/1998. The main aim of the community health survey was to determine the level of health concerns associated with the perceptions of the community of the variety of air pollution types (for example, black fallout and asthma) and determine how these perceptions impact the daily lives of members of the community. The survey also focused on the attitudes of the respondents towards the neighborhood as well as health concerns associated with pollution within the neighborhood. The socio-demographic profile of the community in relation to sex, age, marital status, income, employment status and education level was also established. Furthermore, the health status of the respondents specifically in relation to respiratory illnesses, use of medication for the respiratory illness and whether or not any of the respondents smoke was also included in the survey. Questions were also used to determine the knowledge of respondents regarding air pollution, the source of information about air pollution provided to them, the source/s of the air pollution and any form of action taken to in response to the concerns for air pollution.

The main survey results showed that about half of the respondents have lived within the area for more than 15 years and what they liked most about the area was the ease of access to amenities and the sense of community within the area. The main negative feature of the area was industrial pollution, with a quarter of the respondents stating that there was nothing wrong with the area. Air pollution provided the greatest concern by the community, specifically black fallout. Lifestyle disruptions were identified in relation to air pollution and included health impacts as well as having to keep windows closed and odor. The results also showed that respondents recognized a link between air pollution and respiratory health effects.

In the South African context, the most researched locality in relation to air pollution and health impacts is the South Durban Basin area in the eThekwini, Municipality, KwaZulu-Natal. Several studies underscore air pollution concerns and deteriorating health in several neighborhoods and communities within the South Durban Basin (Brooks, 2010; Kistanasamy, 2008; Vissers, 2010). Vissers' (2010) study examined perceptions of air pollution in relation to specific illnesses in the South Durban Basin, generally dealing with negative health impacts. Additionally, the focus is on attitudes towards responses to combat air pollution in the area. The study looked specifically at the influence of demographic variables on community perceptions. The research revealed that variables such as race and level of education had little impact on the results. A key finding which echoes with results from other research (Jaggernath, 2010: 143-145) is that there is a high neighborhood satisfaction and place attachment in the South Durban Basin despite strong perceptions that air pollution has negative health impacts. Furthermore, the negative attitudes towards industries in the area and conflicts as highlighted by Jaggernath (2010), persists.

A locally-based NGO, the South Durban Community Environmental Alliance (SDCEA, 2007: 6) states:

> Industries in South Durban constantly relay the blame between each other. None of the industries have taken responsibility for the health issues of South Durban, yet they are to blame. Chemicals released by these industries cause heart, kidney and liver damage. ENGEN refinery has never done anything to help these community residents afflicted with these ailments directly linked to the chemicals used in their process and which are released over homes 24/7. Their close proximity to residents makes them our No 1 in regard to detrimental health in South Durban.

Vissers' (2010) study emphasizes the importance of perception studies in understanding air pollution and health impacts. Furthermore, she asserts that this approach advocates that policy-makers cannot rely on scientific information alone to drive a public decision-making process, but must also consider location-based factors, the specific make-up of the population, and the avenues through which this population receives information on environmental conditions. Other studies have focused on health risk prevalence in the South Durban Basin and epidemiological aspects (Howel *et al*., 2003). Robins (2002) states that these studies, together with the environmental awareness programs implemented by several NGOs and civil society organizations, has raised the communities' consciousness of air quality level regulations and their adequacy in protecting their health in the area.

From the above discussion, it is clear that the determinants of health are multi-factorial and are linked to a range of political, social, cultural and economic as well as biophysical aspects. Bowling (1997) and Hunter (1974) argue that like most complex phenomena involving human beings, health problems defy compartmentalized thinking and segmented solutions, since they are products of myriad interactions within the total environment. Thus, there is a need for a comprehensive and holistic approach that takes into account the different factors that influence health.

Pearce and Kingham (2008) state that researchers in the neighborhoods and health fields have considered whether features of the residential environment exercise an influence upon a range of health outcomes independently of the individual characteristics of residents. They further indicate that there is a general consensus that neighborhoods are important in explaining individual health outcomes, although further research is required to ascertain exactly which features of neighborhoods affect health and how these should be measured.

In researching health issues in specific neighborhoods, the concept of a community is important to unpack. The nature and dimensions of what constitutes a community is highly debated although there is generally reference to geographical location/boundaries, cultural coherence and a sense of belonging. Williams (1999) state that community is generally framed as a geographical unit of analysis in environmental justice research (and health research more generally) as belonging to one or a combination of the following categories: a neighborhood (a place of cultural identity); part of a political jurisdiction (county, city, suburb, etc.); and as approximated by data constructs (like zip code areas and census tracts). Williams (1999: 324) extends these units of analyzes to include:

- the nature of the environmental burdens investigated (discrimination, health, etc.);
- the type of inequity to be examined (whether outcome or process inequity);
- the means by which to evaluate disproportionate burdens (whether via a risk or a proximity orientation); and
- the data, and their observational units, that constitute the independent and dependent variables.

This study utilizes this frame as a broader understanding of the case study under investigation.

3.6 Health and Development

Recent studies indicate that changes in the health status can dramatically impact on people's quality of life including their ability to participate in and benefit from development activities and processes (Bond, 1999; Dorrington, 2000; Gray, 2000; Osman *et al.*, 2001; Wilson *et al*., 2012). Novick (1990: 5) states:

> All constituents of the environment of our planet - rainforests, troposphere, seas and biological environment - ultimately exert influence on human health and well-being. However, the environment, which exerts the greatest and most immediate influence on the lives of people, their health and well-being, is the intimate environment of their home and neighborhood. A health-promoting home and urban environment embody the fundamental aspirations of the majority of people, where the quality of their lives depends on having a clean, decent, safe home in which to live and raise a family.

Furthemore, Namdeo and Stringer (2008: 586) assert:

> Relationships between air pollution and health and deprivation, potentially result in the most cost to both the public and the government in terms of increased mortality and morbidity, hence establishing causal links between them is very important and can be justified.

Pick *et al*. (2000) state that experience of developing countries indicate that weakening of economic opportunities and income flows, especially intra-family income flows, is often accompanied by a weakening of the health status of individuals and families as well as a growth in poverty more generally. Thus, one's ability to access resources and socio-economic position influences one's health status. Studies show that the loss of income and the related impact on household food security dramatically impacts the health status of households (Baum, 1993; Bob, 2002; Gill, 2010; Goss, 1996; Jayne, 2004; Nanama *et al.*, 2012; Yamano and Jane, 2004). It is particularly devastating at the household level when the main income earner becomes too ill to work. Bullard (2001), shows that the poorest households lose the most workdays and incomes due to injury and poor health, and incapacitated earners are also more likely to have severely undernourished children. Bullard (2001) further states that direct medical and social service costs do not take into account the costs arising from the loss of productivity, absenteeism from work, nor the costs to train and replace skilled individuals succumbing to various ailments and diseases, especially Human Immunodeficiency Virus/ Acquired Immune Deficiency Syndrome (HIV/ AIDS). These losses represent significant socio-economic costs and impacts in terms of human resources and development goals.

Johnson (2002) showed how socio-economic aspects influence health risk perceptions in the USA. Johnson (2002) specifically indicated that economically and socially marginalized people (including women, the politically marginalized, the less affluent and the elderly) rated health risks from hazardous chemical waste sites and from global warming higher than white men. Men from minority groups in the USA were more likely to report not understanding air pollution information and had more concerns about health risk relating to these air quality information reports. Furthermore, outdoor air quality was rated a high health risk by women and by other politically and/ or socially marginalized groups such as African Americans, Asians and Hispanics. Johnson (2002) attributes these findings to the possibility of the shared sense of vulnerability to negative effects. These results were also supported by Brody *et al.* (2004) who asserted that minority groups, especially those that are socio-economically marginalized due to politics, are often located closer to air pollution sources and therefore were more vulnerable to associated health risks.

In urban areas, the key environmental risk factors that impact negatively on health are strongly linked to standard poverty indicators identified by Stephens and Harpham (1991):

- Poor sanitation facilities and open defecation in the neighborhood;
- Fly infestations;
- Inadequate access to a clean water supply;
- Questionable water storage practices; and
- High levels of food insecurity linked to unbalanced nutrition.

As can be seen from the above, the initial focus was on household level aspects, mainly in relation to water quality and availability. However, increasingly air pollution has been included as will be discussed later.

Poverty and poor health affect people from different backgrounds and are greatly influenced by a range of variables which include location, race, gender, age, sexual orientation, location and ethnic differences. Moodley (2002) asserts that the extent and the nature of poverty and disparity between and among these groups differ considerably. In South Africa specifically, numerous studies (Aliber, 2001; Bond, 1999; Bradshaw, 1997; Hindson, 2003; Klasen, 1997; WHO, 2000) highlight that Africans are disproportionately impacted by poor health and poverty more generally. Additionally, research reveals that experiences of poverty and development (including the provision of and access to health care) are highly gendered (Barnard and Turner, 2011; Moodley, 2002). Gwatkin and Guillot (2000) state that most people are not aware of the need nor do they have the means to interrupt disease and they are not encouraged to participate in collective activity. They also assert that health care systems (and interests) tend to be dominated by the State, the medical profession and business interests.

Health problems are rooted in the socio-economic conditions of a society and Ashton (1992) states that this attributed mainly to two important measures, that is, improved nutrition and better environmental hygiene where the latter comprises of improved water supplies and sanitation to reduce fecally transmitted disease. Environmental improvements demonstrate the relationships between health promotion, political processes and development. Degefie and Aseffa (2001) state that the complex link between health and nutrition has long been recognized and is exemplified by the clinical outcome of malnutrition, which in turn may be linked to inadequate food intake or of disease (usually infectious) or a combination of the two.

Brody *et al.* (2004) in their study indicated a relationship between perceptions of air pollution, age and the history of the area where people stay. They found that on average non-white older community members in the Houston area of Dallas, Texas in the USA believed that the air they breathe was less polluted than what the white population believed. This was different from Howel *et al.*'s (2003) findings in the UK which illustrated that older residents were more likely to rate local air quality as low which they attributed to them having past memories of bad pollution incidents. Additionally, Howel *et al*. (2003) found that the perception that air pollution causing asthma and lung cancer declined with age, however, bronchitis being affected by air pollution increased with age.

3.6.1 Women and health

According to Moodley (2002), the triple impact of racism, sexism and classism that many Black women experience contributes significantly to making them less healthy and also deprives them of access to adequate health care. Several studies (Aldridge and Rodgers-Rose, 1993; Bowser and Hill, 2010; Butegwa and Awori, 2010; Dowse and Frohmader, 2001; Moodley and Zama, 1997; Randall, 2001; Steenkamp and Sidzumo, 1996) pertaining to African women in particular describe the inhumane treatment, for example, forced sterilization and experimentation, violence and abuse, while others deal with the unavailability of health care of any kind. The main issues for consideration emanating from these studies are reproductive health issues, women and violence and malnutrition. The focus tends to be on both women and children as vulnerable groups.

Bevc *et al.* (2007) found that women exhibited higher levels of stress avoidance than men in contexts of high levels of contamination. Marschall (2004) argues that women, compared to men, generally have heightened perceptions of risk since they tend to be are more concerned about the health and safety of both family and community. Bevc *et al.* (2007) state that stress avoidance becomes a coping mechanism among women.

3.7 Air Pollution

Air pollution levels are strongly linked with pollution demand. Cole *et al.* (2008: 397-399) identify the following potentially significant determinants of environmental demand in the Chinese context which can be generalized in developing contexts:

- Energy use: especially the high energy-consuming industries that generate the majority of the industrial air pollution. The level of dependency upon production from heavy industry which tends to require high levels of raw material and energy inputs is also important to consider. Energy use is deemed to be a strong positive determinant of industrial air pollution; the more energy intensive production, the greater an industry's demand for pollution;
- Factor intensities: The pollution level of an industry may be influenced by its factor intensities where factor intensities refer to physical and human capital intensity. Sectors that face the largest abatement costs per unit of value added also have the greatest physical capital requirements. Generally, physical capital intensive industries are also the most

energy intensive. High technology, human capital-intensive sectors are likely to be more efficient and less energy intensive and therefore relatively clean compared to lower skilled sectors. On the other hand relatively low skilled, labor-intensive sectors could be fairly clean whilst those industries which typically generate greater volumes of pollution are more likely to be based on complex industrial processes that require higher levels of human capital (skilled labor) to maintain them;

- Size: Size is measured by the value added per firm in an industry. Pollution intensity is expected to diminish as output increases. However, larger firms may be more visible targets for regulatory authorities which may offset these economies of scale in abatement;
- Efficiency: an industry that is more productive is expected to be more resource efficient and better managed and hence to be less energy intensive per unit of output. Furthermore, highly productive industries should also be better placed to respond relatively quickly to any change in pollution control incentives;
- Vintage: Vintage is defined as the use of modern production processes. It is generally expected that a newer plant or one that uses modern production processes will be cleaner. As environmental regulations have become increasingly stringent, modern production processes have become more resource efficient and therefore produce less waste per unit of output;
- Innovation: Innovation within firms, as measured by research and development expenditure, will often result in improvements to the firm's production processes, often resulting in the need for fewer inputs per unit of output. Thus, it is expected that innovation expenditure will reduce a firm's demand for pollution; and
- Pollution supply: The 'environmental supply schedule' is determined by environmental regulations. Environmental regulations ensure that the greater the use of environmental services (that is, the larger the emission of pollution) the higher the costs imposed on any firm or industry.

The main sources of air pollution in urban areas identified in the literature and discussed in more detail in this section are (Abelsohn and Stieb, 2011; Arku *et al.* 2008):

- Transportation
- Industrial pollution
- Non-combustion sources

However, Arku *et al.* (2008), Bailis *et al*. (2005), Barnes *et al*. (2005) and Smith *et al*. (2004) note that in Sub-Saharan African cities (especially in poorer communities often known as townships and informal settlements) the sources of air pollution in African cities include biomass fuels used at the household level for cooking and heating. They assert that more than three quarters of the region's population, including a large fraction of the urban population, use biomass fuels for cooking.

Nicolas *et al*. (2005) state that the three key factors continue to keep the problem of air pollution on the political agenda in developed countries despite a decline in air pollution levels: there are still uncertainties on the evolution of the background ozone and on finer particles (that is, the nature, extent and consequences of air pollutants; there are growing expectations of urban populations faced with environmental and public health questions; and epidemiological research has increasingly confirmed that air pollution has a significant long-term impact on human health. These issues are even more acute in developing contexts where pollution levels remain unabated (and in many instances are increasing) and socio-economic inequalities have resulted in dire consequences for poorer and more vulnerable segments of society. WHO (2004) define vulnerable population groups based on innate factors, acquired environmental, social or behavioral factors, and unusually high exposures to pollution. Specific sub-populations deemed to be vulnerable to air pollution include young children, fetuses, the elderly, persons with certain underlying diseases, those exposed to other toxicants that add to or interact with air pollutants, and the socio-economically deprived. Makri and Stilianalis (2008) state that vulnerability encompasses susceptibility, exposure and social coping where exposure relates to factors that modulate human exposure and dose, rather than physical attributes of environmental pollutant concentrations, and social coping specifically refers to how conditions in the social environment affect susceptibility, exposure, and the capacity to manage risks and potential health outcomes.

3.7.1 Industrial/ outdoor air pollution

With the growing need for manufactured goods and services and thus the expansion of industries, society has developed a greater reliance on a broad range of chemicals and chemical by-products in major manufacturing sectors. Examples of outdoor air pollution include emissions from motor vehicles, power generations and industries (Mishra, 2003). Industries produce waste streams that are typical of the industry, for example, mining, textile, pulp and paper, leather tanning and plating wastes (Santoleri *et al.*, 2000). The following Table sections briefly presents the manufacturing processes of industries/ outdoor pollution the source pollutants and their associated health implications.

Table 3.2 summarizes the main sources of industrial/ outdoor air pollution. According to Mishra (2003), the primary source of outdoor air pollution is the combustion of fossil fuels which releases health threatening air pollutants such as sulphur dioxide (SO_2), particulate matter ($PM_{2.5}$ and PM_{10}), ozone (0_3), nitrogen oxides (NO_x), volatile organic compounds (VOCs) and atmospheric lead.

Table 3.2: Common sources of industrial pollution and the associated health impacts

Category	Production Source and Pollutant released	References
Pulp and paper industry	Large plants usually produce both pulp and paper; therefore the wastes are considered together. The common feature of these wastes is the inevitable presence of cellulose fibers. Most air pollution problems, specific for the pulp and paper industry, are associated with the production of Kraft pulp and sulphite pulp. During Kraft pulping woodships, cooked with a solution of sodium hydroxide and sodium sulfide, produce volatile constituents; inert and water vapor. Separate streams of turpentine, condensate, and non condensables are obtained after these vapors are passed through a condensing and decanting system. Black liquor washed out of the pulp, passes through a multi effect evaporator and is sprayed into a recovery furnace. Flue gases from the recovery furnace, flow through the evaporator, dust collecting equipment and then to the stack. Molten salts which are withdrawn from the bottom of the recovery furnace are dissolved in a smelt tank. Vapors and entrainment arise from the boiling solution.	Koziorowski and Kucharsk (1972) Lund (1971)
Mining and quarrying	Air pollution associated with the mining industry, specifically coal mines, and result mainly from the emissions of particulate matter and gases such as methane (CH4), sulfur dioxide (SO_2) and nitrogen oxide (NOx). Explosives used in the mines releases carbon monoxide (CO), which poses a health risk for mine workers. Dust and coal particles stirred up during the mining process, as well as the soot released during coal transport, can cause severe and potentially deadly respiratory problems. Major sources of air pollution in the mining industry are from operations like drilling, blasting, movement of the heavy earth moving machinery on haul roads, transportation and handling of coal, screening, sizing and segregation units and underground mine fiber. Pollutants such as suspended particulate matter, sulphur dioxide, oxides of nitrogen, carbon monoxide, volatile organic compounds, sulphur trioxide, lead are released with the mining and quarrying processes.	Ghose and Majee (2000) Sharma (2008)

Oil Refinery	Oil refineries convert crude oil, coal, or natural gases into fuel (including petrol, diesel, paraffin, kerosene). There are various processes involved which include heating and chemical reactions. Rrefineries cause smog, and emit about 100 chemicals which include metals like lead, very small dust particles called PM_{10}. Refineries also emit many gases like sulphur dioxide (SO_2), nitrogen oxide (NO_2), carbon dioxide, carbon monoxide, methane, dioxins, hydrogen fluoride, chlorine, benzene and others. Crude oil and coal both contain relatively high quantities of sulphur. Crude oil or coalt that is heated at a refinery to produce fuel converts the sulphur into a sulphur dioxide. Exposure to very high concentrations of sulphur dioxide from accidental leaks at refineries can result in irritation of the eyes, nose, mouth and throat, difficulty in breathing, nausea, vomiting, headaches and even death. Sulphur dioxide causes tight chests, worsening of asthma and lung disease, and narrowing of air passages in the throat and chest, exposure can provoke asthma attacks.	**Groundwork (n.d)**
Power Plants	Power plants are large emitters of sulfur dioxide (SO_2) and nitrogen oxides (NOx). The most hazardous contribution of these gaseous emissions is through the formation of secondary fine particulate matter. Adverse human health effects, ranging from premature death, hospital admissions and asthma attacks to chronic bronchitis.	Deck et al. (2002)
Transportation	Vehicles have become the most important source of urban air pollution. The transport sector emits the most numerous atmospheric pollutants. Increasing traffic not only pollutes, it is also noisy, and it causes accidents and congestion. Combustion engines release suspended particulate matter, sulphur dioxide, oxides of nitrogen, carbon monoxide, volatile organic compounds, lead.	Fenger (2009) Nicolas *et al.* (2005)

Linked to industrial and domestic activities is pollution related to transportation. Colvile *et al.* (2001) state that there is widespread recognition that the transport sector is an increasing source of outdoor air pollution globally (see Table 3.3). With the expansion of industries, the need for more transportation vehicles is increasing. The literature that follows describes the air pollutant sources resulting from increased transportation and vehicle components. According to Colvile *et al.* (2001), concern is increasing around the exhaust emissions from urban traffic and air quality on human health and tropospheric ozone production. Motor vehicles are major emission sources for NO_X, carbon monoxide (CO), particulate matter (PM), and hydrocarbons (HCs) (Krzyzanowski *et al.*, 2005). The transportation sector is necessary to a nation's economy and personal mobility; however, it is also a significant source of greenhouse gas emissions (Krzyzanowski *et al.*, 2005). According to Ken *et al*. (2004), internal combustion engines are responsible for almost 50% of global CO, HCs, and NO_x emissions from fossil fuel combustion. The contribution of the transport sector to total CO_2 emissions in developed nations is forecast to increase from 20% in 1997 to 30% in 2020.

According to Bateebe (2012), the composition of the emissions released from transport is affected by the quality of fuel used in vehicle engines due to several properties in the fuel used which can affect the level of vehicular emissions. The quality of fuel used has a direct effect on the exhaust emissions. Significant changes in emissions can be induced by certain engine design parameters. Vehicle non-engine components such as the tyres used, air-conditioning, lighting, road and traffic characteristics also affect emission levels (Bateebe, 2012).

Diesel fuel contains sulphur which contributes to the formation of PM in the vehicle engine. The functionality of the vehicle emissions control equipment is also affected by sulphur which, as a result, has indirect effects on emissions of CO, hydrocarbons and NO_X (Colvile, 2001). The proximity to diesel exhaust causes or exacerbates a variety of respiratory and cardiovascular problems (Dockery *et al*., 1993; Houston *et al*., 2004; Pope *et al*., 2002). The damaging health effects of particulate matter, both large (10–2.5 mm diameter [PM_{10}]) and small (2.5 mm and smaller in diameter [PM2.5]), from diesel exhausts have been documented by Donaldson *et al*. (2000) and Hesterberg *et al*. (2006). While the large particles are visible, the small particles may result in more damaging effects due to a larger surface area and because they are more easily absorbed into the blood stream.

According to Krzyzanowski *et al*. (2005), four main components can be distinguished from road transport:

- exhaust emissions under engine operation using heat (hot emissions);
- exhaust emissions after engine start-up (cold-start emissions);
- emissions released from fuel evaporation; and
- non-exhaust emissions from the vehicle components and traffic and road characteristics.

Table 3.3: Pollutants from fuel type and non-engine components (Colvile, 2001; Krzyzanowski *et al*., 2005)

Fuel type and non-engine components	Pollutant
Petrol	CO, HC emissions and increased VOC emissions. Nitrogen oxide emissions influenced by sulphur, PAHs, olefins, low levels of hydrocarbons, hydrated sulphuric acid and salts, carbon monoxide, benzene,
Diesel	Particulate matter and Nitrogen oxides, sulphur, PAHs, hydrocarbons and carbon monoxide
Non-engine components Vehicle break and tyres	Various particles such as styrene butadiene rubber, natural rubber and polybutadiene, organic zinc, metals (such as iron, copper and lead), organic materials and silicone materials

Meena (2003) states that there is growing evidence that the emissions of pollutants from transport operations have negative impacts on local populations, particularly on the poor in developing countries. Air pollution from transport or increased traffic is associated with numerous adverse health effects that include mortality, cardiovascular illnesses, lung cancer, respiratory illnesses in children and asthma (Finkelstein *et al*., 2004; Gauderman *et al*., 2007; Hoek *et al*., 2002; Krewski *et al*., 2000; Miller *et al*., 2007; Morgenstern *et al*., 2007; Nyberg *et al*., 2000; Peters *et al*., 2004; Pope *et al*., 1995; Pope *et al*., 2002; Tonne *et al*., 2007). According to Kryzanowski *et al.* (2005), the health effects of vehicle emissions can result in both short and long term health problems. Short-term effects, for example, from HCs and NO_X which form ozone gas range from chest pain, decreased lung function, and increased susceptibility to respiratory infection and may lead to long-term health conditions such as premature lung aging and chronic respiratory illnesses (Krzyzanowski *et al*., 2005). Furthermore, several cohort studies have shown the link between air pollution and the incidence of asthma in relation to transport (Colvile, 2001; Gehring *et al*., 2009; Jacquemin *et al*., 2009; Kunzli *et al*., 2009; Modig *et al*., 2009). Most recently, Ekpenyong *et al*. (2012) provided additional evidence on the adverse respiratory health effect of ambient air pollution from their study to assess the respiratory health effect of city ambient air pollutants on transit and non-transit workers and compare such effects by transportation mode, occupational exposure and socio-demographic characteristics of participants. Their study found that that the prevalence of respiratory functions impairment was higher among transit than non-transit workers.

3.7.2 Indoor air pollution

Mestle *et al*. (2007) and Smith and Mehta (2000) state that indoor air pollution from solid fuels (biomass and coal) is known to pose a major health risk, leading to such serious illnesses as acute lower respiratory infections in small children, and chronic obstructive pulmonary disease in adults. Person-made sources of air pollution include industrial pollutants as well as household level pollutants such as the burning of fuels for heating and cooking as well as insecticides and cleaning agents (Table 3.4) which are known to release chemical pollutants (Mestl, 2006; Mestle *et al*., 2007). They also include smoking. Larson and Rosen (2002) indicates that more than 2 billion people rely on solid fuels and traditional stoves or open fires for cooking, lighting, and/ or heating. These include wood, charcoal, dung, crop residues and coal. They argue that exposure to emissions caused by burning these fuels are believed to be responsible for a significant share of the global burden of disease. They state that solid fuels, although they provide direct energy benefits to households, impose a series of costs which arises from the very high levels of air pollution they generate. Additionally, Larson and Rosen (2002) highlight that the health effects of high levels of indoor air pollution, such as higher mortality rates and increased risks of respiratory illness, fall mainly on children and women (Parikh, 2011), who spend a significant amount of time good inside cooking and tending fires.

Table 3.4: Indoor sources of pollution and pollutants (Zhang and Smith, 2003 cited in HEI International Scientific Oversight Committee, 2010: 49)

Source	Pollutant
Household use of solid fuels	PM2.5, CO, PAHs, NOx, VOCs, semi-VOCs
Burning of Coal	PM2.5, NOx, sulfur oxides, arsenic, fluorine
Tobacco smoke	PM2.5, CO, PAHs, VOCs, semi-VOCs
Cooking in the home	PM2.5, PAHs, NOx, VOCs, semi-VOCs, aldehydes
Cleaning products	PM2.5
Incense and Mosquito coils	PM2.5
Consumer products	VOCs, semi-VOCs, pesticides
Construction materials used in remodeling or demolition	VOCs, semi-VOCs, aldehydes, or asbestos, lead, radon
Building - moisture, ventilation, and furnishings.	Biologic pollutants (fungal spores, mites, cockroaches, endotoxins, glucans)
Soil, rock, and water - Radon sources under building	Radon
Indoor chemical processes	Free radicals and other short- lived, highly reactive compounds

Kasimbazi (2009) states that the majority of Uganda's rural communities depend on forest resources to meet their subsistence, energy and related needs since electricity supply and distribution is still very limited and tariffs are generally beyond the reach of most rural people. Specifically, Kasimbazi (2007: 199) notes that biomass (that is, firewood, charcoal and crop residues) accounts for over 90% of Uganda's total energy consumption. The reliance on forest-based resources for energy consumption at the local level is therefore noticeable and is reflective of most rural communities in sub-Saharan Africa, including South Africa.

Larson and Rosen (2002: 573) state that fuel use affects household welfare through five different paths:

- by providing energy for the production of prepared foods, which then affect utility directly;
- by providing energy for the production of prepared foods, which affect health and then utility;
- by generating indoor air pollution, which affects health and then utility;
- by providing energy for services, such as warmth and light, that are directly valued by the household; and
- by generating emissions that might negatively affect household utility in ways not related to health.

The lack of access to safe and clean energy has resulted in a range of costs and consequences identified by Sagar (2005: 1) for the poor who rely on non-renewable and unhealthy energy options:

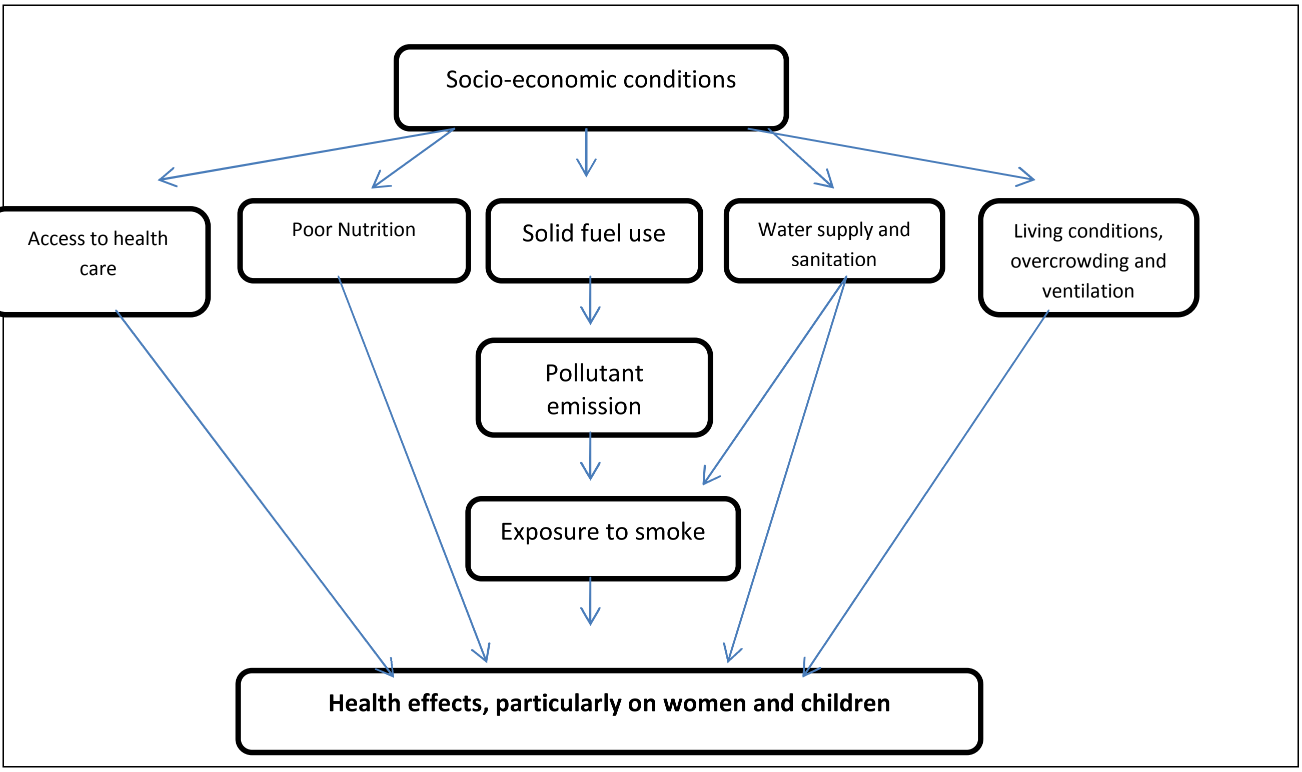
- Significant time and effort spent on the procurement of firewood and other biomass sources which particularly affects women, for example, in rural areas of sub-Saharan Africa African women carry on average 20 kg of firewood approximately 5 km per day.
- The possibly high price per unit of energy services since subsidies often increase as one moves up the energy ladder.
- The inefficient combustion of fuelwood and other biomass traditional sources results in severe health impacts. Indoor pollution and smoke inhalation is the cause of many deaths, especially among women and children.

Karekezi and Kithyoma (2002) indicate a link between biomass combustion and respiratory illnesses in women and children in Kenya. They found that women were exposed to twice the amount of particulate emission than males, and were therefore more likely to endure respiratory problems. They further argue that while the links between rural household energy and its effect on women and children are particularly pervasive, they are generally ignored. Ferrer-Martı´ *et al*. (2012) indicate that the burning of energy sources such as kerosene lamps and candles has harmful effects on lungs and eyesight.

Larson and Rosen (2002) assert that to achieve widespread health improvements, interventions that reduce exposures to indoor air pollution will need to be adopted and consistently used by large numbers of households in the developing world. However, Munien and Ahmed (2012) highlight that given the persistence of socio-economic deprivation and energy poverty in developing countries it is unlikely that households will switch to alternative energy sources. They argue that it is imperative that renewable and affordable alternative energy sources are provided in these contexts. Their study also highlights that the lack of these sources of energy undermine the achievement of several of the Millennium Development Goals (MDGs) including growth and income poverty reduction, hunger, education, gender equality, health environmental sustainability and water and sanitation (Modi *et al.*, 2006). Larson and Rosen (2002) state that what is also required is a better understanding of household demand for interventions designed (in part at least) to reduce indoor air pollution, especially given that interventions need to be adopted by large numbers of households in developing countries. They develop a household framework that identifies the determinants of household demand for indoor air pollution interventions based on willingness to pay and show that three aspects are important: the direct consumption effect, the child health effect and the adult health effect.

Saksena and Smith (2003) analyze the potential impact of indoor air pollution on health in developing countries with a particular emphasis on exposure to particulates. Jin *et al.* (2006) argues that the magnitude of the health risk associated with exposure to indoor smoke and its concentration among the marginalized socio-economic and demographic groups (women and children in poor households and the rural population) have motivated efforts towards interventions in international development and public health arenas (Figure 3.2).

Figure 3.2: The interactions between poverty, exposure to solid fuel smoke and ill health indoors (Perez-Padilla *et al*., 2010: 1081)



Mestle *et al*. (2007) highlight the health benefits from reducing indoor air pollution from household solid fuel use in China. They state that according to WHO, indoor air pollution from the use of solid fuels in households in the developing world is responsible for more than 1.6 million premature deaths each year, whereof 0.42 million occur in China alone. Jin *et al.* (2006) also examine exposure to indoor air pollution from household energy use in rural China. They state that indoor air pollution from household use of biomass and coal is a leading environmental health risk in many developing nations. They examine the linkages among technology, user knowledge and behavior, and access and infrastructure in exposure to IAP from household energy use.

Jin *et al.* (2006) found that that broad health risk education is insufficient for successful risk mitigation when exposure behaviors are closely linked to day-to-day activities of households such as cooking and heating, or have other welfare implications, and hence cannot be simply stopped. They assert that emphasis should be placed on the economic and infrastructure determinants of access to technology, as well as the details of behaviors that affect exposure. Furthermore, they indicate that a better understanding of technology–behavior interface would also allow designing technological interventions that account for, and are robust to, behavioral factors or to provide individuals and households with alternative behaviors. Mestle *et al*. (2007) advocate that improvements to the outdoor air quality in addition to a complete fuel switch to clean fuels in households, particularly in urban areas. However, Jin *et al*. (2006) warn that household energy choices and energy use behaviors are likely to have complex linkages to household economics and energy infrastructure, as well as knowledge of health hazards and risk perceptions. They highlight that characterizing these determinants is important for designing and delivering interventions in diverse environmental and socio-cultural conditions. The main sources of indoor air pollution are the use of biomass (including fuelwood) and coal for cooking, heating and food drying and storage.

3.8 Air Pollution and Health

Delucchi *et al.* (2002) state that air pollution from motor vehicles, electricity-generating plants, industry, and other sources can harm human health, injure crops and forests, damage building materials, and impair visibility. Air pollution is a worldwide problem and Totlandsdal *et al.* (2007) state that health effects occur at low pollution levels, even when air quality standards have been met. Fenger (2009) states that air pollution in the industrialized world has in the last 50 years undergone drastic changes with prior to World War II the most important urban compound was sulphur dioxide combined with soot from the use of fossil fuels in heat and power production. Fenger (2009) states that this problem was partly solved by cleaner fuels, higher stacks and flue gas cleaning in urban areas, the growing traffic gave rise to nitrogen oxides and volatile organic compounds and in some areas photochemical air pollution, which may be abated by catalytic converters. Lately the interest has centered on small particles and more exotic organic compounds that can be detected with new sophisticated analytical techniques. However, in the developing context including South Africa industrial and fossil based fuels remain key polluting agents.

Air pollution and health may be contextualized simply as the presence of substances in the air at concentrations, duration and frequencies that adversely affect human health and the environment (Mukhopadhyay and Forssell, 2005; McGranahan and Murray, 2003). Currie *et al.* (2009) argue that the primary goal of pollution abatement is to protect human health. The cause of air pollution can be both from natural or person-made sources. Natural sources include wind-blown dust and soot, atmospheric oxidation of ammonia, forest fires, volcanoes and vegetative matter (Buzea *et* *al*., 2007). Person-made sources include both industrial and outdoor pollutants as well as indoor household pollutants which are discussed next. Several studies from across the world have focused on the health impacts of air pollution (Afroz *et al.*, 2003; Currie *et al*., 2009; Evans and Smith, 2005; Namdeo and Stringer, 2008; Sarnat *et al*., 2012; Sheffield *et al*., 2011).

Several studies focus on childhood health issues. Currie (2008) states that this is because there is increasing evidence of long-term effects of poor infant health on future outcomes; for example, low birth weight has been linked to future health problems and lower educational attainment. Furthermore, Currie *et al*. (2009) argues that studying infants also overcomes several empirical challenges because, unlike adult diseases that may reflect pollution exposure that occurred many years ago, the link between cause and effect is more immediate.

3.8.1 Air pollution and health impacts

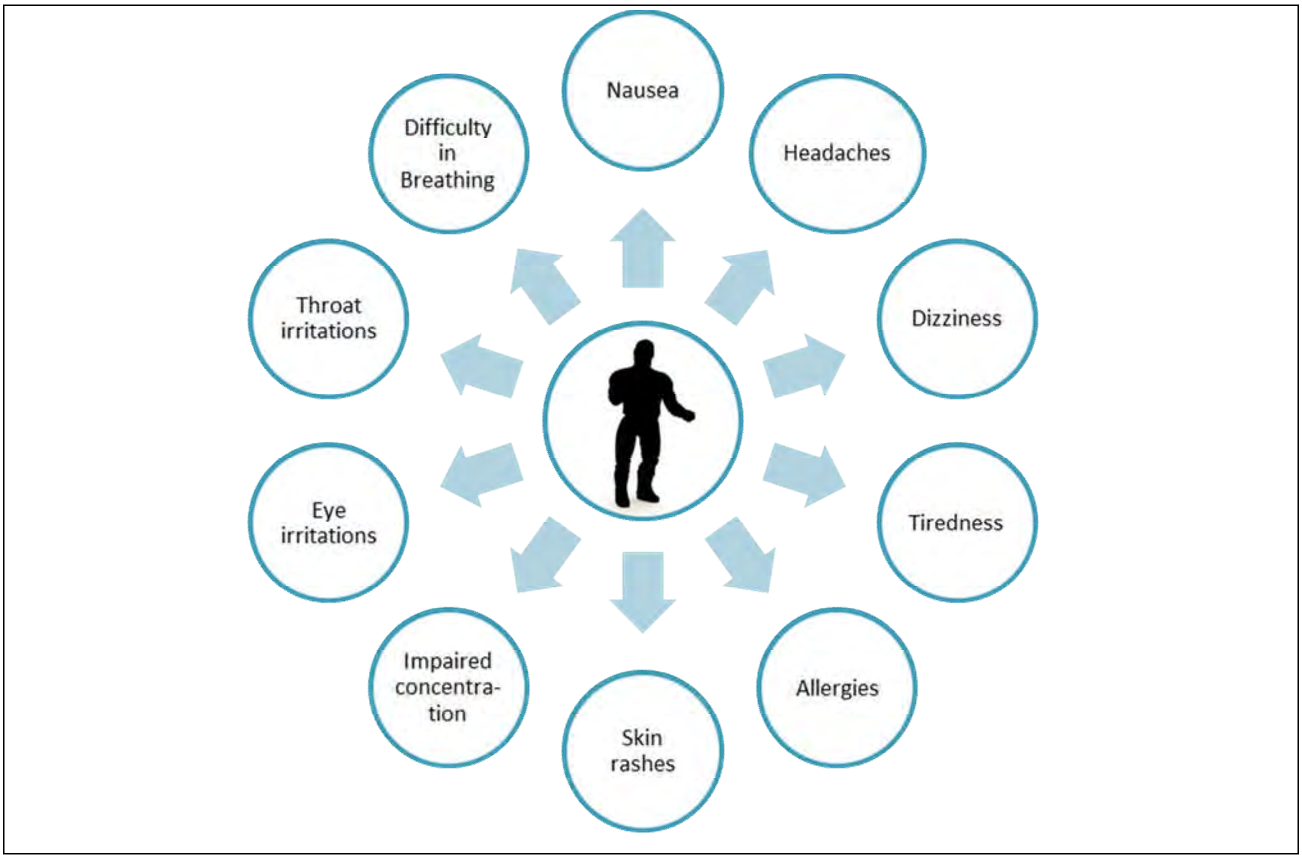
As indicated in the previous chapters and indicated by Abelsohn and Stieb (2011), Clark *et al*. (2010), Gauderman *et al*. (2004), Mishra (2003) and other studies, air pollution is known to have both acute and chronic effects on human health, ranging from the minor irritation of the eyes and upper respiratory system to chronic respiratory disease, lung cancer, heart disease and even death. The health impacts of indoor and industrial air pollution are discussed in the following sub-sections.

3.8.1.1 Health impacts from indoor air pollution

There are several health impacts of indoor air pollutants (Figure 3.3). Indoor air pollution is a major contributor to the global burden of disease and is the second largest environmental contributor to poor health worldwide (WHO, 2002). According to Begum *et al*. (2009), a significant public health problem predominantly for poor populations in many developing countries is indoor air pollution from the combustion of traditional biomass fuels (wood, cow dung, and crop wastes). A significant public health hazard is created by by-products that are released from the combustion of biomass fuels, which affect poor rural and urban population in many developing countries (Smith *et al*., 2004). According to Perez-Padilla *et al*. (2010), 50% of the world’s population, specifically in developing countries, is exposed to high concentrations of solid fuel smoke (biomass and coal). Women are mostly prone to the effects since they are primarily responsible for food preparation and cooking (Figure 3.2). The effects are also felt by infants and young children who spend time around their mothers near the cooking area Begum *et al*. (2009). As stated by Franklin (2007), indoor air pollution is an important environmental health issue in developing countries and is a major contributor to mortality and morbidity from acute lower respiratory illness in children.

The term Building Related Syndrome (BRS) is used to describe the reaction of humans to environmental hazards that are restricted to industrial, commercial or residential buildings (Zhang, 2005). Symptoms related to indoor pollution is shown in Figure 3.3.

Figure 3.3: BRS symptoms (indoor air polution) (Adapted from Zhang, 2005: 4)



Indoor pollutants can emanate from a range of sources. The health impacts from indoor exposure to combustion products from heating, cooking, smoking of tobacco, building materials, household products and biological pollutants such as dust mites and fungal spores are discussed in Table 3.5. The table also highlights symptoms and health implications that are associated with pollutants emitted from indoor sources (Perez-Padilla *et al*., 2010).

Table 3.5: Sources and characteristics of indoor air pollutants and the associated health effects (adapted from the EPA, 1994)

Pollutant	Sources and descriptions	Health Impact
Solid fuels	Combustion of solid fuels. Main pollutants released are Particulate matter, sulphur dioxide, nitrogen oxide, carbon monoxide, different hydrocarbons Aldehydes and ketones, PAHs (such as butadiene; benzene; styrene, and formaldehyde)	Cause irritation and oxidative stress producing lung and airway inflammation, hyper responsiveness, and in long-term exposures airway remodeling and emphysema Reduced mucociliary clearance and macrophage response Carcinogenic. Carbon monoxide binds to hemoglobin interfering with transport of oxygen Headache, nausea, dizziness, low birth weight, increase in perinatal deaths. Feto-toxicant, has been associated with poor fetal growth Nitrogen oxides irritates the mucosa of eyes, nose, throat, and respiratory tract Increased bronchial reactivity, longer-term exposure increases susceptibility to infections Sulphur dioxide Irritant, affecting the mucosa of eyes, nose, throat, and respiratory tract. Increased bronchial reactivity, bronchoconstriction. Hydrocarbons, aldehydes and ketones cause adverse effects are varied, including eye and upper and lower respiratory irritation, systemic effects. Cacogenic to human health.
Tobacco Smoke	A complex mixture of >4000 chemicals found in both vapor and particle phases, many of which are known toxic/ carcogenic agents. Non-smoker exposure to ETS-related toxic and carcinogenic substances occurs indoors, where there is smoking.	Exposure to second hand smoke causes disease and even premature death in children and in adults. Sudden infant death syndrome (SIDS), acute respiratory infections (including bronchitis, bronchiolitis and pneumonia), tuberculosis, and more severe asthma, varied respiratory symptoms, delayed lung growth, increased middle ear effusion, reduced lung function, and reduced lung growth. Lung cancer, impaired breathing, aggravation of existing respiratory and cardiovascular disease, lowers the defence system against infections, exacerbation of allergic responses.
Biological Pollutants	Fungal spores, dust mites, molds, fungus, bacteria, pets, pests (cockroaches, mice, rats) enhanced by damp conditions. Microbial products such as endotoxins, microbial fragments, peptidoglycans and varied allergens.	Allergic reactions, which range from rhinitis or conjunctivitis to severe asthma. Indoor allergens are important causes and triggers of asthma: dust mite, cats, cockroaches, dogs, and indoor molds and fungus. Possible infections, hypersensitivity pneumonitis, and toxic reactions.
Volatile Organic Compounds	VOCs include formaldehyde, benzene, and perchloroethylene. The semi-	Eye and upper and lower respiratory irritation, rhinitis, nasal congestion, rash, pruritus, headache,

VOCs)	VOCs category includes compounds such as phthalates. Sources include common products used daily, personal care products, household products such as finishes, rug and oven cleaners, paints and lacquers, paint strippers and thinners, pesticides, building materials, and home furnishings.	nausea, vomiting, dyspnea, and epistaxis. Symptoms may include headache, dizziness, muscular weakness, and nausea. Possible cancer from pesticides considered carcinogens.
Radon	A natural radioactive gas which occurs underground resulting from the decay of radium. It is a decay product of uranium. Radon can be attached to airborne particles, which are may be inhaled.	Human carcinogen - cause of lung cancer.
Asbestos	Asbestos is mainly found in insulation for heating systems, and mixed with cement. The product is used for roofs and water deposits. Fibers may be dispersed into the air when asbestos containing material is damaged.	Human carcinogen: lung cancer or mesothelioma, with synergic effects with tobacco smoking.

As seen in Table 3.5, exposure to indoor pollutants can be a major cause of health damages, including acute respiratory infections, chronic obstructive pulmonary disorder, cancers, cataracts, and low birth weight. Several studies have been conducted which relate to the impacts of air pollution on human health. For example, particulate matter emanating from indoor pollution sources has been found to be associated with increased respiratory symptoms, bronchitis and asthmatic symptoms (Simoni *et al.,* 2002). Ormstad (2000) conducted a study on suspended particulate matter in indoor air which showed that indoor suspended particulate matter contained a large amount of potential allergen carriers (soot particles <1 mm). Smith and Mehta (2000) found that children living in households that use solid biomass fuels are 2–3 times more likely to suffer from acute respiratory infections than children in households that use other fuels and women who have cooked over biomass fires for 15 years are 2–4 times more likely to develop chronic obstructive pulmonary disorder. Other studies on the impacts of indoor pollution children which were related to lung function (Kostas *et al.,* 2007; Lui and Zhang, 2009), found that factors such as children's age, sex, factors related the growth and development, family economic status, smoking family members, household fuels, central heating, kind of stove used for cooking and other social economic factors relate to the decline of children’s lung function.

Numerous studies that have been conducted worldwide have reported an association between dampness or mold and adverse health effects (Bush *et al*., 2006; Portnoy *et al.,* 2005). With regards to low birth weight, an association between exposure to indoor air pollution during pregnancy and low birth weight was found by Boy *et al*. (2002) and Mishra *et al*. (2004). A study conducted by Mishra *et al*. (2004) in Zimbabwe found that babies born to mothers cooking with wood, dung or straw were 175 g lighter, on average, than those born to mothers using liquid petroleum gas, natural gas, or electricity. In addition to these studies Ormstad (2000) and Leung *et al*. (2002) state that a pro-inflammatory effect which leads to the exacerbation of asthma and other allergic diseases may be exerted by the presence of organic pollutants together with allergens or endotoxin. It is also worth noting that a study on the use of central air conditioning in homes in the USA was associated with a 15-fold increased risk (95% confidence interval 1.3 to 166) of a near fatal asthma attack (Turner *et al*., 2005).

8.1.1.2 Health impacts from industrial air pollution

Evidence from epidemiological studies indicates that chemical compounds emitted from industrial processes have numerous adverse impacts on the respiratory system (Godish, 2004). Sulphur dioxides primary effect (Figure 3.4) is upon the respiratory system and on asthmatics, thereby increasing the effort required to breathe. Mucus secretion is also stimulated by the exposure to sulphur dioxide contaminated air (Manahan, 1997). Table 3.6 presents a range of industrial pollutants and the associated health impacts. Table 3.6 illustrates the main types of air pollution-related health impacts associated with industries.

Figure 3.4: Shows the risk to human health resulting from SO_2 emissions (Pickering and Owen, 1997: 187)

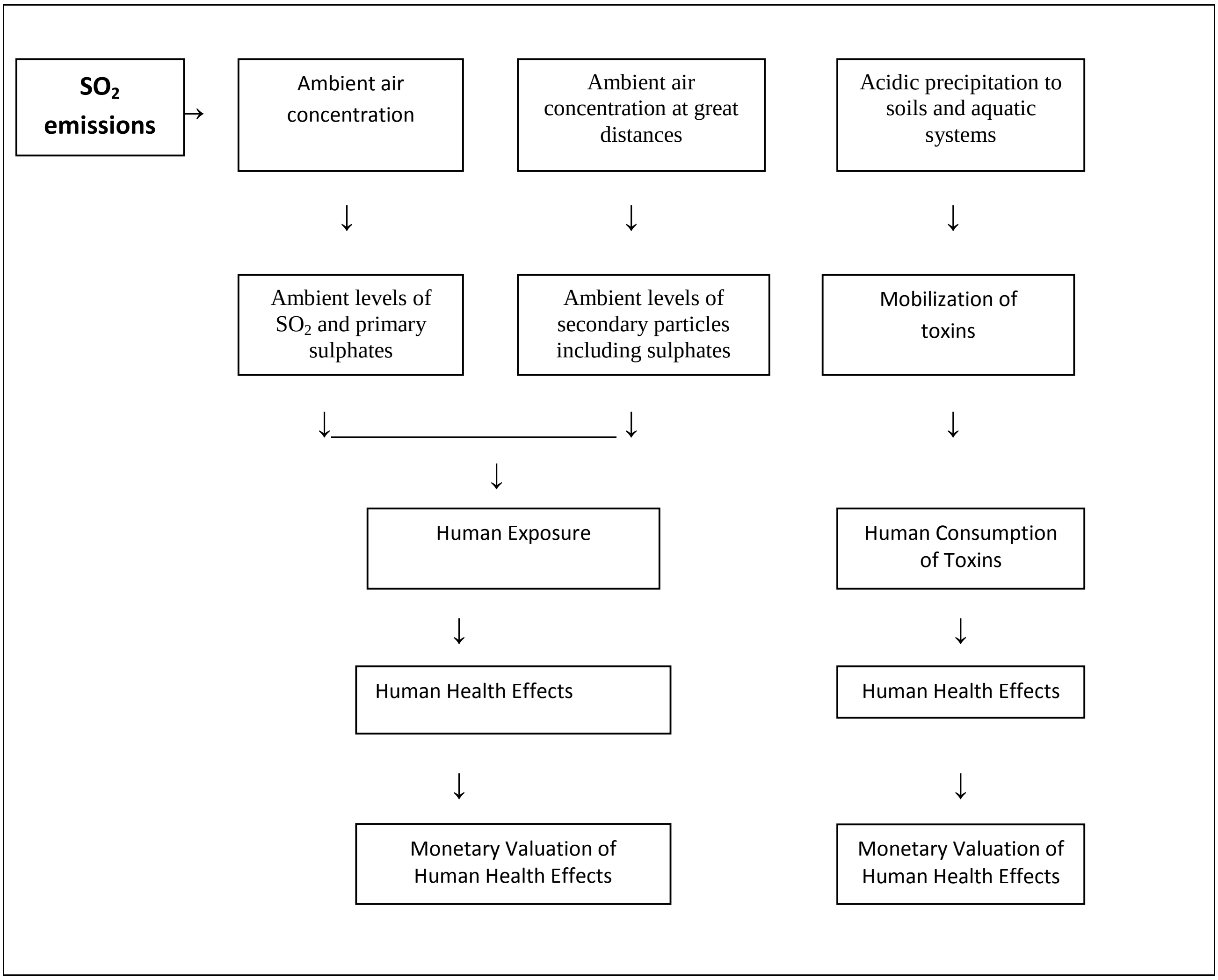


Table 3.6: Common air pollutants from industrial processes and their associated health impacts

Air Pollutant	Description	Health Impact	References
Particulates			
Particulate matter	A mixture of solid particles and liquid droplets which toxicity vary in size and composition. Particles of 0.1 um – 1 um size cause interference because they are about the same dimensions as the wavelengths of visible light.	Respiratory diseases such as chronic bronchitis, acute bronchitis, asthma, pneumonia, lower respiratory systems, upper respiratory symptoms and the reduction and distortion of visibility, cardiovascular and heart disease. Particles inhaled through the respiratory tract may damage health. Very small particles, which are likely to reach the lungs. A strong correlation has been found between increases in the daily mortality rate and acute episodes of air pollution. The respiratory system may be damaged directly by particulate matter. Inhaled particles may enter the blood or lymph system in the alveoli of the lungs and be carried throughout the body as systemic poison and be retained by them. Inflammation and destruction of lung cells. Mortality has been reported with long term exposure.	Li *et al*. (2008) Lockwood *et al*. (2009) Manahan (1997) Pope *et al*. (2002) Schwarz (1993) Abbey *et al*. (1995) Lambert *et al*. (1998) Seaton *et al*. (1995) Abelsohn and Stieb (2011)
Photochemical smog	Characterized by oxidants, irritating vapours and visibility - obscuring particles that occur in urban areas, where the combination of industrial pollution - forming emissions and atmospheric conditions are ideal for its formation.		Manahan (1997)
Smog	Is the combination of smoke and fog compounded by sulphur dioxide,	Highly detrimental to health	Manahan (1997)
Gaseous Emissions			
Carbon Monoxide	Carbon monoxide (CO) is a tasteless, odorless, and colorless gas produced by the incomplete combustion of carbon-based fuels. Carbon monoxide is released from vehicle exhausts, fossil fuel combustion, industrial processes. Exposure to carbon monoxide interferes with absorption of oxygen from hemoglobin in the red blood cells	Binds to hemoglobin and interferes with systemic delivery of oxygen to tissues. Headache and fatigue especially in people with weak cardiovascular health. Prolonged exposure may impair perception and thinking. Exposure can also slow reflexes, causes drowsiness and can cause unconsciousness and death. A combined exposure of carbon monoxide and other pollutants, promotes morbidity in people with	Hagberg *et al*. (1985) Hampson and Norkool (1992) Tao *et al*. (2011) Badman and Jaffe (1996) Abelsohn and Stieb (2011)

		circulatory problems.	Perez-Padilla *et al*. (2010)
Sulphur dioxides (SO_2)	Gas sulfur dioxide (SO_2) comes primarily from the combustion of fossil fuels such as coal, oil, and diesel fuel. Sulfur in fossil fuel is converted to sulfur dioxide. A small amount is also converted to sulfuric acid. In the atmosphere, gaseous sulfur dioxide is also converted to sulfuric acid and sulfate-containing particles. Atmospheric concentrations of sulfur dioxide are associated with acidic particles, sulfuric acid particles and sulfate particle concentrations.	Watery-gasey emission which can be absorbed by the upper respiratory tract. Can penetrate into the airways can provoke important health effects, primarily in individuals with asthma, causing difficulty in breathing and asthma attacks.	Lockwood *et al*. (2009) Kleinman (2000) Abelsohn and Stieb (2011)
Nitrogen oxides (NO_2)	produced during most combustion processes About 80% of nitrogen oxide is released in the form of nitric oxide (NO). Small amounts of nitrous oxide (N_2O) are also produced. Nitrous oxide is a "greenhouse" gas which reacts with oxygen in the air to produce nitrogen dioxide (NO_2). Oxidation during the day causes the nitrogen dioxide to form nitric acid and nitrate particles. Nitrogen dioxide reacts with ozone in the dark to form a reactive free radical which then may react with organic compounds in the air to form nitrogenated organic compounds, which have shown to be mutagenic or carcinogenic.	Can cause significant lung irritation and inflammation, suppresses the immune system, acute pulmonary function responses, pulmonary disease, acute respiratory infectious disease and chronic lung disease. Children exposed to high levels of ambient nitrogen dioxide may be at increased risk of respiratory infections, greater incidences of lung-related illness. Those with asthma may have reduced lung function and symptoms of respiratory irritation, such as cough and sore throat, when outdoor average nitrogen dioxide concentrations exceed about 0.02 ppm. Ambient exposure to nitrogen dioxide might increase susceptibility to respiratory infections and increased severity of responses to inhaled allergens Nitrogen oxide also causes shortness of breath and chest pains.	Kleinman (2000) Hodgkins *et al*. (2010) McKee and Rodriguez (1993) Abelsohn and Stieb (2011) Perez-Padilla *et al*. (2010)
Hydrogen Chloride and Hydrogen Sulphide	Hydrogen sulphide is produced as a by-product of wood pulping from geothermal steam, and from a number of natural and anthropogenic sources. Most atmospheric hydrogen sulphide is converted to SO2 and to sulphates, and has particularly unpleasing colors.	Incidents reported that hydrogen sulphide emissions have resulted in damage to human health and fatalities. For example, the accidental release of hydrogen from a plant in Poza Rica, Mexico, in 1950, which was used for the recovery of sulphur from natural gas, caused the deaths of 22 people and the hospitalization of over 300.	Manahan (1997) Perez-Padilla *et al*. (2010)
Heavy Metals			
Cadmium	Industrial discharge may lead to cadmium pollutants in water. Cadmium and zinc are similar and are common water and sediment pollutants	The effects of acute cadmium poisoning in humans are very serious among them are high blood pressure; kidney damage;	Pickering and Owen (1997)

	that are surrounded with industrial installations.	destruction of testicular tissue; and destruction of red blood cells – Disease symptoms ultimately result from cadmium pollutants.	
Lead	Lead occurs in water as a result of a number of industrial sources. Lead from leaded gasoline is a major source of atmospheric and terrestrial lead, which also enters the natural water systems. Lead bearing limestone and galena (PbS) discharges lead to natural waters in some locations	Acute lead poisoning in humans causes severe dysfunction in the kidneys; reproductive systems; liver and the brain. Lead poisoning from environmental exposure is thought to have caused mental retardation in many children. Mild lead poisoning causes anemia; headaches; sore muscles and fatigue and irritability.	Manahan (1997) Pickering and Owen (1997)
Mercury	Mercury generates the most concern of any heavy metal pollutants. Fossil fuel coal and lignite contain mercury, often at levels of 100 parts per billion. Mercury compounds are in paper mills as a slimicide and as a mold retardant for paper	The toxicity of mercury was proven in the Minamata Bay area of Japan during the period 1953 – 1960, whereby a total number of 111 cases of mercury poisoning and 43 deaths were reported among people who had consumed seafood from the bay, which had been contaminated with mercury waste from a chemical plant that drained into the bay.	Manahan (1997)
Arsenic	The combustion of fossil fuels, particularly coal, introduces large quantities of arsenic into the environment, which enters natural waters. Arsenic occurs with phosphate minerals and enters into the environment along with some phosphorus compounds.	Arsenic poisoning can result from the ingestion of more than about 100mg of the element. Chronic poisoning occurs with the ingestion of small amounts of arsenic over a long period of time	Manahan (1997) Pickering and Owen (1997)
Dioxins	The two main sources of dioxins are industrial and combustion processes. Polychlorinated dibenzo-p-dioxins (PCDD) and polychlorinated dibenzo furans (PCDF), are of special concern due to their inherent toxicity, stability and persistence. The largest contribution to the atmospheric load is due to the emissions of 47 municipal waste incinerators. Preliminary results on the emission from thermal processes for the generation and recycling of non-ferrous metals indicate that sometimes a high concentration of PCDD/PCDF and large amounts of gas can be emitted Dioxins are formed in trace amounts as by-products in various industrial processes, as well as combustion processes and secondary sources. Industrial sources may generate high amounts of PCDD and PCDF, which may enter the environment and contribute to human exposure.	Human exposure primarily occurs through ingestion whereas inhalation is a minor pathway. Dermal absorption can be excluded although skin contact to polluted surfaces may occur	Hutzinger and Fielder (1993) Mcgrath *et al*. (1992) Hutzinger and Fielder (1993)

	The main pathway for dioxins to the environment are combustion processes, especially that of incinerators, since dioxins are released directly into the atmosphere. PCDD and PCDF were discovered in the flue gas and fly ash of municipal waste incinerators in 1977 (Hutzinger and Fielder, 1993). Dioxins formed in the industrial processes are considered to be fixed in products. For example, dioxins from pentachlorophernol in wood; form pulp bleaching in paper products; airborne dioxins in sewage sludge; residues from production or industrial processes in municipal or hazardous waste dumps.		

According to Kampa and Castanas (2007), particulate matter (defined by Pandey *et al.* (2005) as a mixture of many chemical pollutants in solid and liquid forms) that penetrates the alveolar epithelium often leads to lung inflammation. With regards to nitrogen dioxide, Brunekreef and Holgate (2002) indicate that nitric oxide in ambient conditions, produced from energy production industries, and are rapidly transformed into nitrogen dioxide by atmospheric oxidants such as ozone. Nitrogen oxides are less soluble and thus pass into the pulmonary region causing it to be an irritant to the respiratory tissues, the alveoli of lungs, and also cause chest pains, pulmonary edema and death. Godish (2004) suggests that a correlation between NO_2 exposure and reduced respiratory function in children exists. According to Godish (2004), similar results have been reported for Swedish school children, whereby cough and respiratory infections were associated with ambient NO_2 exposure.

The impacts of SO_2, NO_2 and particulate matter are detrimental to the health and well–being of communities and individuals that are at the receiving end of pollution emitted from various production industries. McGranahan and Murray (2003) indicate that once sulphur and nitrogen compounds have been emitted to the atmosphere, concentrations of gases and acidic deposition cause impacts to the local environment and can further result in the dispersion of pollutants far from the point of emission, thereby impacting on the health of individuals and communities situated away from the source. The next sub-section uses asthma to illustrate air pollution impacts on specific illness. Asthma was chosen since it is one of the main respiratory and air pollution-related diseases identified in the literature.

3.8.2. Air pollution and respiratory illnesses, with specific reference to asthma

Asthma is a condition that affects more than 300 million people world-wide (Kupczyk and Wenzel, 2012). The majority of asthmatics suffer from mild-to-moderate persistent asthma; their disease and about 5% of asthmatics have severe or difficult-to-control asthma. It is a condition caused by a disease of the larger and medium sized airways of the lungs which obstructs the out flow of air from the lungs preventing the air from reaching the lungs for the exchange of gases (Health Canada, 2006). This results in a rapid breathing effect to compensate for the loss of air. The condition is commonly known as bronchial asthma and coughing is a frequent occurring symptom which occurs as a result of the bodies attempt to release excessive amounts of secretions that are produced in the lungs. A similar process occurs for individuals who suffer from respiratory infections.

Environmental factors such as pollen, fresh cut grass, changes in weather, smoke, strong fumes, dust, physical exercise and air pollution react strongly with the airways of asthmatics (Health Canada, 2006). Although there are many potential asthma triggers or irritants, outdoor air pollution is regarding as the main cause of childhood asthma (Neidell, 2004; Clark *et al*., 2010). The two main pollutants that are known to exacerbate asthma are particulate matter and Ozone (Health Canada, 2006). Pollution from road transport/ vehicle exhaust components, such as polycyclic aromatic hydrocarbons (PAHS) have been found to exacerbate reduced lung function, asthma, bronchitis, wheezing and allergic rhinitis (Krzyzanowski, 2005). Evidence suggests that the poor are subjected to the effects of transport related pollution, particularly in the developing world cities (Meena, 2003). Furthermore, Oudinet *et al*. (2006) assert that asthma has to be considered as a real health threat among residents living in urban areas, in which several air pollutants released locally influence greatly the incidence and severity of this pathology. This is particularly acute residential areas located in close proximity to industrial locations. Oudinet *et al*. (2006) state that when evaluating potential effects of air toxics on asthma or other adverse health problems it is important to determine where the exposure occurs, the contribution of each pollutant and its anthropogenic origin, define the target population and introduce biological indicators or biomarkers of exposure to account for the health adverse impacts of pollutants.

Neidell (2004) estimates that effect of air pollution on child hospitalizations for asthma using naturally occurring seasonal variations in pollution within specific locations (using zip codes) in the USA. The results indicate that carbon Monoxide (Co) has a sign effect on asthma for children ages 1–18 years. Examining childhood asthma is deemed to be important because asthma is the leading chronic condition affecting children; and current pollution standards are based on adult health responses to pollution and children face a greater risk from pollution exposure due to the sensitivity of their developing biological systems (Neidell, 2004).

Wilhelm *et al*. (2009) states that social and physical environment are important factors to consider when tracking the causation and progression of asthma. Numerous studies have found that there are higher reports of asthma morbidity in low socio-economic neighborhoods (Bacon *et al*., 2009; Ekerljung *et al.*, 2010; Wilhelm *et al*., 2009). This could indicate either independent effects or the effects of the interaction between the social and physical aspects of the neighborhood. Furthermore research has shown that air pollution (a physical neighborhood aspect) can have an impact on asthma. Research has also provided evidence of economically deprived neighborhoods being more exposed to air pollution than economically privileged neighborhoods (Mishra, 2003; O'Neill *et al*., 2003; Samet and White, 2004). The social aspects of a socio-economic neighborhood can also impact on asthma morbidity. For example, Wilhelm *et al*. (2009) found that neighborhood factors such as violence, economic deprivation, low social cohesion and social capital can increase stress levels, consequently resulting in the worsening of asthma outcome.

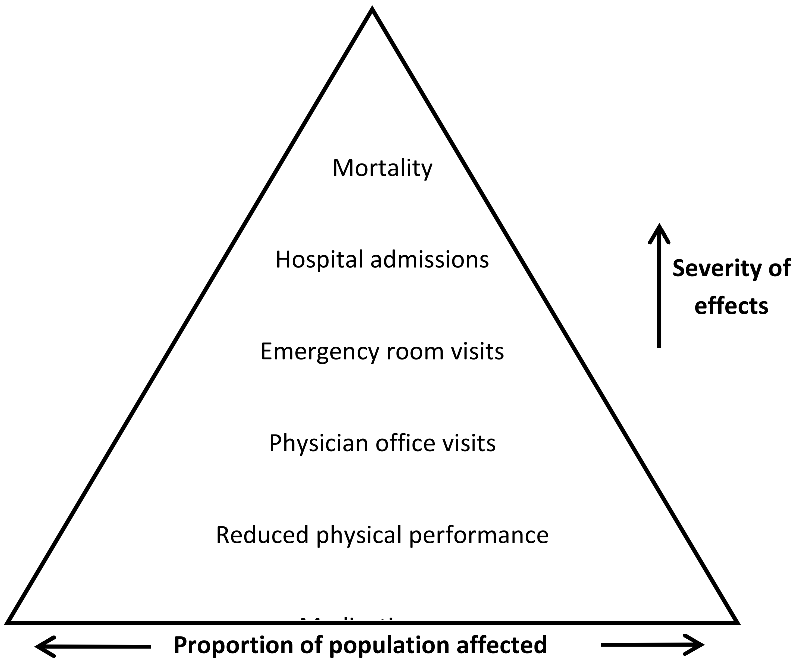
Gold and Wright (2005) argue that community and individual-level factors can act as potential modifiers of the relationships between pollutant exposures and asthma, through differential environmental exposures and/ or psychosocial stress on individual health behaviors. According to Wilhelm *et al*. (2009), psychosocial stress might also contribute to the early onset of asthma and wheezing. In addition, health behaviors such as smoking and diet and the access to health care facilities can also influence asthma and are important aspects to consider. Furthermore, Morello-Frosch and Lopez (2006: 184) show that the interplay of these individual and community-level stressors results in a feedback loop: "individual factors influence community exposures that compound individual vulnerability, which ultimately influences the biological pathways linking pollutant exposures to asthma exacerbation and possibly the development of disease".

Therefore the social aspects of a neighborhood should be considered in order to assess the contributions air pollution to health comes (asthma). The Los Angeles Family and Neighborhood Survey (LA FANS) conducted by Wilhelm *et al*. (2009) collected comprehensive data on the individual, family and neighborhood characteristics of Los Angeles residents. Both the physical and the social environment of the neighborhood were considered in their evaluation of the associations between outdoor air pollution and asthma. The LA FANS dataset supported by government air monitoring data and the US Census enabled Wilhem *et al*. (2009) to assess the associations between outdoor air pollution and the family and neighborhood characteristics of neighborhoods in Los Angeles. The study found that the NO_2 and CO levels increased whilst the O_3 levels decreased with decreasing neighborhood quality. Air pollution levels did not correlate with the family level ratings of social networks and neighborhood support. The study also showed that children living in areas of high 03 and PM_{10} levels had higher chances of being clinically diagnosed with asthma without having attacks in the previous 12 months and children (diagnosed asthmatics) who lived in areas of high levels of CO had a higher probability of reporting asthma attacks in the previous 12 months.

The study by Wilhelm *et al.* (2009) concluded that the observed associations with CO may have been a result of the influence of a combination of pollutants in the traffic exhaust due to CO being emitted directly by motor vehicles and not readily reacting with the atmosphere to form other compounds. Furthermore the study found that the 03 effect estimates for those with asthma without reporting attacks in the previous months was higher in neighborhoods that were regarded as being more safe and cohesive and more economically advantaged. In addition, the study found an increase in the probability of asthma without attacks for children living in more cohesive neighborhoods, whilst there was no association with 03 for children who lived in less cohesive neighborhoods. However, the authors concluded that a possible reason for this could be due to better reporting from parents. According to Wilhelm *et al*. (2009) the reliance on reports from parents of children who were diagnosed with asthma attacks in the previous 12 months and having higher odds of these outcomes for wealthier, educated individuals with health care where limitations to the study because it could indicate under-reporting among the more disadvantaged neighborhoods. Despite the limitations to the study, the study revealed the importance of assessing environmental exposures that are associated with other important factors for asthma. Wilhelm *et al*. (2009), state that the study was able to provide valuable information on the multifactorial nature of asthma.

An increasing area of concern is work-related asthma. Studies have shown that pollutants, depending on the industry type, accounts for almost to 25% of all adult asthma cases (Toren *et al*., 2009). The median proportion of adult cases of asthma attributable to occupational exposure is 16% and around 10% for work-exacerbated asthma (Tarlo *et al*., 2008). Global estimates (2005) indicate that 38 000 occupational asthma deaths and nearly 1.6 million DALYS are due to exposure to occupational airborne particulates (Driscoll *et al*., 2005). Figure 3.5 illustrates the relationship between the severity of the health impacts in relation to the proportion of the population, where the most severe effects are the least common and the mildest effects being the most common amongst the population (Health Canada, 2006).

Figure 3.5: Relationship between the severity of health impacts of air pollution in relation to population size (Health Canada, 2006: 3)



In particular, the respiratory and cardiovascular systems are mainly affected by air pollution (Franchini and Mannucci, 2012). In terms of the respiratory system, the quality of the air is critically important since in addition to oxygen, other air pollutants that are in the atmosphere are inhaled which can be harmful. Health Canada (2006) states that due to the respiratory system being made up of an exposed membrane, it is extremely sensitive to air pollutants. Specifically, lung tissues and cells can be affected negatively by air pollutants such as ozone and free radicals, by damaging the air sacs that are found in the lungs where oxygen and carbon dioxide are exchanged, namely the alveoli (Abelsohn and Stieb, 2011; Ghio and Huang, 2004). Lung tissues, which consist of blood supply to the rest of the body, can also the carry toxic substances obtained from the inhalation of low quality air to other organs of the body. This condition is exacerbated by lung cells responding to toxins by releasing chemical mediators which can affect the functioning of other organs, particularly those of the cardiovascular system.

The function of air pollution in heart and lung disease is a subject of considerable research; however its role remains uncertain. Studies have however found air pollution, along with allergies and infections, to be a cause of worsening these conditions (Abelsohn and Stieb, 2011; Peters *et al*., 1999; Janssen *et al*., 2002; Pope *et al*., 2004). The most prevalent diseases, which are exacerbated by air pollution, include minor lung illnesses; such as the common cold, lung infections; croup, bronchitis and pneumonia, asthma, chronic obstructive pulmonary disease; emphysema and chronic bronchitis, lung cancer, coronary heart disease, heart attacks and angina, heart failure and heart rhythm problems (Abelsohn and Stieb, 2011; Clark *et al*., 2010, Health Canada, 2006; Gauderman *et al*., 2004; Laden *et al*., 2006; Pope *et al*., 2004; Wu *et al*., 2009).

The impact of air pollution on human health depends firstly on the type of air pollutant. Research has found particulate matter to cause systematic inflammatory response resulting in the stimulation of the bone marrow ultimately contributing to cardio respiratory morbidity (Fujii *et al*., 2002; Goto *et al*., 2004; Ishii *et al*., 2004; Tan *et al*., 2000). Acute exposure to oxides of sulphur and nitrogen has been found to be linked to increased bronchial reactivity and vulnerability to viral and bacterial infections (Bruce *et al*., 2000). Carbon monoxide has been found to contribute to anemia and undesirable pregnancy outcomes such as still birth, miscarriage and early infant mortality.

The impact of air pollution on health also depends on its concentration in the air, the duration of exposure and the vulnerability of individuals, as some people are more as well as differently affected by air pollution (Mishra, 2003). It is usually the poor and disadvantaged populations that are likely to have a higher prevalence of diseases such as cardiovascular diseases and asthma which can be exacerbated by air pollution accompanied with the availability and access to health care services, education, lifestyle and behavioral factors or work-related exposures (O'Neill *et al*., 2003; Samet and White, 2004). Studies have shown that it is poor, very young and very old people as well as people with pre-existing respiratory disease or other forms of ill health that are more vulnerable to the effects of air pollution (O'Neill *et al*., 2003, Jerrett *et al*., 2004; Peled, 2011;

Pope, 2000; WHO, 2004). For example, poor people who live in cities are the ones that tend to be situated in and work in the most air polluted areas. Furthermore, previous studies that used individuals characteristics to assess changes in the magnitude of the air pollution effect estimate by socio-economic position indicate that a low level of education (Gouveia *et al*., 2004; Jerrett *et al*., 2004;) and low family income are associated with increased health implications that are related to air pollution (Gouveia *et al*., 2004). According to Mishra (2003), the poor have less accessible health care and more vulnerable to ill health because they are not able to obtain sufficient food and consequently become malnourished.

Fenger (2009) states that air pollution can basically be regulated in various ways: by emission standards, by air quality standards, by emission taxes and by cost benefit analyzes. Most air pollution and health studies, according to Currie *et al*. (2009), assign exposure to pollution by either approximating the individual's location as the centroid of a geographic area or computing average pollution levels within the geographic area.

3.9 Air Pollution, Health and Socio-economic Aspects

Bernauer and Koubi (2009) state that the literature on the determinants of environmental quality has thus far focused largely on economic factors which have shown that many (but not all) forms of environmental degradation tend to decrease with increases in income, and that some forms of pollution usually increase first and then decrease with growing income. Furthermore, Pearce and Kingham (2008) state that many socially deprived, low income and ethnic minority communities are exposed to disproportionately high levels of outdoor air pollution. Furthermore, Makri and Stilianakia (2008) aver that ambient air pollution can have adverse effects on the health of exposed populations, however individuals or groups are not equally vulnerable, and pollution reduction benefits are likely to be unevenly distributed within a population.

Air pollution is caused both by natural and anthropogenic factors, as discussed earlier. The latter was particularly associated with industrialization and historical development processes. As Enger *et al*. (1986: 375) state: "In the past, people tolerated pollution as a necessary price to pay for progress. When coal replaced waterwheels in the factories, smoke polluted the air. Dirty skies meant that jobs were plentiful". This indicates that pollution was associated with economic development and to a large extent was not just tolerated but encouraged. However, the costs associated with this form of development is increasingly being challenged in the context of numerous problems including climate change, environmental degradation as well as negative impacts on human health and well-being.

Briggs *et al.*'s (2008) study on environmental inequities in England shows that environmental pollution's disproportionate impacts on disadvantaged groups is a problem experienced in developed countries as well. They assert that previous studies of environmental inequity have indicated considerable complexity in the associations involved, which merit further investigation. Their study examines the ways in which environmental inequity in England varies in relation to different types of environmental pollutants, different aspects of socio-economic status and different geographical scales and contexts (specifically urban versus rural. Briggs *et al.* (2008) found that the strongest associations occur with what are regarded as contingent components of deprivation (for example, crime, living environment and health) rather than causative factors such as income, employment or education. They also found that associations also became stronger with increasing level of spatial aggregation.

Mukhopadhyay and Forssell (2005) examined the link between air pollution and their impact on health in India. They found that air pollution has severe effects on human health, particularly chronic bronchitis, respiratory problem, asthma and cardiovascular problems. Their study indicates that hat health hazards are seriously caused by air pollution emissions. They specifically highlight the importance of energy efficiency and alternative, renewable energies in addressing air pollution problems in India. The link between energy and air pollution in relation to health is also outlined by Wang and Mauzerall (2006), Zhang *et al*. (2007) and Zhang *et al*. (2010) in China. Zhang *et al*. (2010) state that health damage from air pollution due to energy consumption is a major concern worldwide. They indicate that fossil fuels, the primary source of energy, are the largest source of ambient air pollution in urban areas, producing sulfur- and nitrogen oxides, dust, soot, and other suspended particulate matter.

Oudinet *et al*. (2006) argue that during the last century, the worldwide development of anthropogenic activities as well as modifications of spatial management and occupational uses in urban areas have led to considerable degradation of air quality through the production of a large number of pollutants. The Intergovernmental Panel on Climate Change - IPCC (1992) stresses the importance of developing long-term measures nationally and globally to reduce greenhouse gases.

Greenhouse gases that are emitted from industrial processes include CO_2 from energy use, non-energy uses of fossil fuels, non-fossil fuel sources such as cement manufacture and non-CO_2 gases (IPCC, 2007). According to the IPCC Report (2007), there are 3 options that are available for reducing greenhouse gases from industries which include sector wide options, process-specific options and operating procedures. This has been highlighted since the establishment of the United Nations Framework Convention on Climate Change (UNFCCC) in 1992 to stabilize the concentration of greenhouse gas emissions in the atmosphere. Climate change has emerged as one of the most important environmental issues globally and is certainly a key concern on the African continent that is expected to bear the brunt of climate change given high levels of vulnerabilities associated with poverty and sensitive ecological systems (African Development Bank Group, 2011; Brown *et al*., 2007; Brown and Crawford 2009; IPCC, 2007; Osbahr *et al*., 2008).

Specifically, Bollen *et al*.'s (2009: 161) combined cost-benefit analysis of local air pollution and global climate change reveal shows the "mutual relevance of, and interaction between, policies designed to address these two environmental challenges individually". They state that it is surprising that given the many dimensions air pollution control and climate change management have in common, they have generally not been analyzed in combination so far. They assert that air pollution and climate changes are closely related since they are both driven by the nature of present energy production and consumption patterns. Thus, they conclude that both revised energy policies and local air pollution controls are required to address broader issues that ultimately impact on climate change. However, they underscore that it is more urgent to address the problem of local air pollution than that of global climate change primarily because:

> …the short-term benefits that may be obtained from air pollution control are much larger than the long-term benefits obtainable through strategic climate change measures, while the associated costs are in both of these policy cases much lower than the achievable benefits (even with very low discount rates, see also our sensitivity analysis). So, most environmental and human health policy today should be dedicated to local air pollution.
>
> (Bollen *et al*., 2009: 179)

They indicate, however, that climate change policies should be neglected or postponed but be combined with local air pollution control and global climate change mitigation. They suggest that climate change mitigation is an ancillary benefit of air pollution policy. Rive (2010) and Yoon and

Lee (2003) also examine the links between climate change and air pollution in Western Europe and Korea, respectively.

Namdeo and Stringer (2008) state that several studies have shown that air quality and social factors impact upon health. They indicate a number of studies of health and air pollution, social indicators were included as explanatory factors for poorer health which included overcrowding (defined as more than one person per room) or the presence of a smoker (frequently cited as a contributing factor to poor respiratory health). They also argue that the relationship between air quality and social deprivation is used to test the concept of environmental justice. They conclude the air quality (NO_2) impacts disproportionately on certain, more deprived areas of the city; and that there is a significant welfare inequity in the distribution of urban air quality, with more deprived groups clearly experiencing higher atmospheric concentrations of NO_2 in their residential location.

Jerrett *et al.* (2001) illustrate that groups with lower socio-economic status are exposed to higher levels of ambient particulate air pollution in Hamilton, Canada than are groups with higher socio-economic status. Their study concludes that socio-economic variables, especially unemployment, reveal the `triple jeopardy' for socially deprived groups. Particularly, these groups suffer from higher burdens of socio-behavioral health risks, have greater exposure to environmental pollutants and tend to suffer from poor nutrition that decreases their ability to withstand ailments. These experiences exist both in the home and workplaces. In terms of latter, poorer individuals have jobs in riskier environments and have higher exposure to pollutants. Behavioral risk factors include smoking and excess alcohol consumption (Birch *et al*., 2000; Laurent *et al*., 2007). From a social science perspective, of particular concern is how poor working and living environments interact to increase health risks. The `triple jeopardy' refers to the following (Jerrett *et al.*, 2001: 971):

> …first, increased risks from social and behavioral determinants of health; second, higher risks from high ambient pollution exposure; and, third, an effect modification that makes exposure to ambient pollutants exert disproportionately large health effects on them compared with advantaged groups.

The `triple jeopardy' has serious policy implications. According to Jerrett *et al.* (2001), the recognition of 'triple jeopardy' suggests that the largest health benefits would result not from merely reducing ambient exposures to air pollutants but also from reducing pollution in areas where it is worst and where social deprivation is largest. This also centralizes the important of adopting and environmental injustice approach to addressing air pollution and health impacts. Furthermore, as Bell *et al*. (2005) state, the suitable evaluation of health effects associated with air pollution and socio-economic factors is critically important in establishing the real costs of development and lack of air pollution control policies, and in the distribution of those costs among segments of society. Higginbotham *et al.* (2010) show how in Hunter Valley, Australia the interdependence of state government and corporations in reaping the economic benefits of coal production; lack of political will, regulatory inertia and procedural injustice; and study design and measurement issues contribute to environmental justice. They specifically state that residents, civil society and local government groups struggle with corporations and state government over the burden of imposed health risk caused by air pollution. The United Nations Development Program - UNDP (2006) also states that governance problems like corruption, lacking capacities and failures in implementing environmental legislation often create or aggravate pollution, overuse and ecosystem degradation.

Briggs *et al.* (2008) assert that the ‘triple jeopardy’ of environmental inequity provides only a partial view of the processes involved since it ignores the complex feedback and adaptive processes that may operate within the system. They state that poor health, for example, may itself feed-back to affect employment opportunities, income, mobility and access to power, thereby further constraining people’s ability to move away from, or act to mitigate, hazards within their community. They also argue that individual risk responses (for example, closing windows or sleeping at the back of the house to avoid exposure to traffic noise) may also intercede in the link between hazard and exposure, with varied (and sometimes unpredictable) implications for health.

Similar findings were found in other studies which also link to environmental racism issues discussed earlier. For example, Bacon *et al*. (2009), Jerrett *et al*. (2001), Marschall *et al*. (2006), O’Neill *et al.* (2003), Pearce and Kingham (2008), Perlin *et al*. (2001), Samet and White (2004) and Wilhelm *et al*. (2009) illustrate that low socio-economic position groups tend to have high vulnerability to air pollution, specifically a given exposure level may cause greater-than-average health reduction for these groups. Marschall (2008) further highlights that exposure inequalities to air pollution by ethnic and income group persist even after accounting for population density, daily travel distance, and other attributes. O’Neill *et al.* (2003) state that understanding issues relating to environmental justice is important because if socially disadvantaged communities are exposed to raised levels of air pollution as a result of material deprivation and psychosocial stress, they are generally more likely to be more susceptible to the health effects of pollution exposure.

Krewski *et al*. (2000) found a significant relationship between education level and air pollution health effects. Specifically, they found that persons with the lowest education experienced the largest health effects from sulfate pollution. Neidell (2004) indicates that the effect of pollution is greater for children of lower socio-economic status, indicating that pollution is one potential mechanism by which socio-economic status affects health.

3.9.1 Air pollution and social conflict

Another important aspect to consider is conflicts associated with air pollution in residential areas. Engelbrecht and Walt (2007) assert that responses to the negative impacts of air pollution have often been delayed due to social, political and economic factors. They argue, however, that peoples' awareness, their interpretation of the impacts of air pollution and their willingness to endure a certain degree of air pollution has gradually altered with increased contestation and conflicts. Ozawa (1996) states that conflict is the underlying basis for disagreements between communities and industries based on the perceptions and concerns regarding the undesirable distribution of consequent costs borne often by communities. Furthermore, Ozawa (1996) postulates that conflicts arise in the absence of sound political control over similar decisions in the future and that environmental disputes and conflicts arise not only from residents' perceptions and concerns of undesirable, potential consequences of proposed developments and upgrades of industry; but also as a result of a disregard of the legal rights of individuals and groups, which is institutionalized in national legislation.

Jaggernath (2010) illustrates that unresolved issues pertaining to air pollution in the South Durban Basin area has resulted in several environmental conflicts. The South Durban Basin, according to Jaggernath (2010) is a highly contested locality in relation to the the effects of air pollution on human health and ecology that are caused by the emissions of unacceptable levels of toxins, chemical waste and a large content of sulphur dioxide, which are characteristic of industrial processes and activities. van de Merwe (2004) states that the continuous battles between health and environmental concerns among communities in the Durban South Basin and the increased demand and expansion of industry have resulted in many serious disputes and conflicts between residents and industry. Peek (2002) asserts that conflict between industries and local communities arose when Mondi purchased land from the Durban Council during the apartheid era, and began its operations without consulting surrounding communities. Wiley *et al*. (2002) indicate that there are inadequate mitigating measures in place to handle poor operational practices in industries that have resulted and continue to result in oil spills and industrial accidents in the South Durban Basin which has led to distrust among community members of Mondi. Scammell *et al.* (2009) also found that issues of trust (especially of government departments) influenced greatly community perceptions of air quality and environmental health risks in Boston, USA. They identify tangible evidence, trust and power as being distinct yet related concepts that contribute to community perceptions of environmental health, and studies conducted to address community environmental health concerns.

Jaggernath (2010: 148-149) forwarded suggestions derived from respondents to help address the perceptions and concerns raised in relation to negative impacts that create conflicts between residents and industries :

- There is a definite need for a greater and stronger degree of communication between industries in the area and the community. More attention needs to be directed in making the community understand the benefits and adverse impacts of the development and upgrades of industries. It is also of important that the community is involved in decision-making processes with regards to proposed upgrading and expansion projects and that their views and opinions are taken into account;
- In creating stronger community awareness of activities, developments and upgrades of industries; it is imperative to strengthen awareness campaigns by disseminating information via flyers/ pamphlets, newsletters, brochures, poster boards and media broadcast advertisements rather than relying on public meetings. In terms of the latter, it was also regarded as important that the public is well informed of these meetings. It is also possible to inform individuals and households adequately about conflicting industrial activities through electing road representatives that carry the information directly to the community members;
- Members of the community are also unaware of governments' interaction with local councils and suggest that these representatives identify themselves and work with the community in resolving issues and concerns. The government should therefore be an

integral part of all decision-making processes associated with industries and residents, and thereby cascade relevant information to members of the community;

- Most people in the community are poor and are affected by health problems that may be a direct result of the pollution associated with industries. Therefore, industries should address these health issues as a matter of urgency by working closely with health care practitioners to address health related concerns and gradually allay peoples' fears. The health and safety of the community should be a priority;
- To avoid conflict between residents and industries about employment opportunities, industries should deliver on the by-in promises made of creating more employment opportunities for the local community. Community members should be given first preference in any employment opportunity available in industries in the area, instead of individuals from other regions or provinces; and
- Industries place more emphasis on community projects that focus on the care, conservation and protection of the surrounding environment. Projects should also include the provision of paper to schools that are financially incapable of purchasing reams of paper for printing, drawing, etc. as well as assist and support the upgrade of facilities in the community, as the entire community will benefit from this effort.

These suggestions are important to consider since Mix and Shriver (2007) state that the results from research conducted in communities in conflict can feed into public and social policies that better address community and industry perceptions and concerns.

Another issue of concern is the impacts of economic transitions and restricting on air pollution. This is particularly important in countries such as South Africa that have high levels of development demands and, as a result of colonization and apartheid, have a range of transformational imperatives. Cherp *et al*. (2003) demonstrate the variable impacts of economic restructuring on air pollution in the Russian Federation and they raise more, broader issues in relation to environmental sustainability in transition economies. They assert that they could be positive effects potentially associated with improved efficiency, investments into cleaner technologies, responsiveness to environmentally aware markets, and ending subsidies to heavy industries. However, they argue that market liberalization may result in weaker environmental controls, economic instabilities distracting attention from environmental issues, increasing orientation towards profit-making leading to more intensive exploitation of natural resources, and trade liberalization may result in shifts towards more pollution and resource intensive industries.

Unfortunately, in many developing countries the latter is more prevalent and therefore economic restructuring often undermines environmental sustainability generally and contributes to increased air pollution. Cherp *et al*. (2003) specifically found in their study that in the Russian Federation economic restructuring resulted in more pollution, resource and energy-intensive industries as a result of economic liberalization which emerges as a significant negative factor of the process of economic transition threatening sustainability in emerging market economies. The current global economic recession is also likely to place increased pressures as countries and specific companies attempt to remain competitive and there is a dire need to increase jobs. In this context, the environment often takes a back seat as economic and social needs dominate.

3.10 Responses to Air Pollution

Residents and community-based organizations respond to real and perceived air pollution threats in numerous ways. Neidell (2004) states that households respond to information about pollution with avoidance behavior, suggesting it is important to account for these endogenous responses when measuring the effect of pollution on health. For example, Neidell (2004) argues that people with high preferences for clean air may choose to live in areas with better air quality, if they can afford to do so. Thus, many people ultilize the exit strategy by moving away from areas deemed to have high levels of air pollution and deemed to be an unhealthy environment. Additionally, people can respond to a wide range of readily available information on pollution levels by adjusting their exposure (Neidell, 2004).

Some of the avoidance behaviors identified in the literature include (Neidell, 2004; Barnes *et al*., 2011):

- Responding to smog alerts;
- Make additional investments in health care (seeking preventative health care and having an existing relationship with a doctor;
- Reducing or stopping cigarette smoking; and
- Closing windows

Coping, according to Makri and Stilianalis (2008), is influenced biological, social, political, or other factors which also influence exposure. In terms of indoor air pollution, coping strategies discernible in the literature (Kimemia and Annegarn, 2011; Larson and Rosen, 2002: Smith and Mehta, 2000) include:

- Increasing outdoor cooking;
- Switching to renewable energy sources (often part of hybrid, multiple energy sources at the household level); and
- Purchasing of new stoves

Adopting these strategies, according to Larson and Rosen (2002: 573), results in changes such as:

- lower emissions and concentrations of indoor air pollutants;
- altered risk of burns and poisonings (for example, from kerosene);
- changes in cooking practices that could alter women's and children's time in the kitchen;
- changes in the cost of cooking (for example, by altering stove efficiency) that could change the amount of food prepared each day, the types of foods prepared, and the frequency of preparation;
- reallocation of women's and children's time spent on gathering fuels;
- reallocation of household income if money is spent or saved on the stove and fuel;
- shifts in other household production activities, such as agricultural production, and therefore in household income, due to the changes in fuel costs, time allocations, and labor productivity; and
- changes in medical expenditures to avoid and treat morbidity.

Failing to adequately understand how people respond to air pollution and attempt to mitigate and/ or minimize impacts "can yield misleading estimates of the causal effect of pollution on health" (Neidell, 2004: 1210).

The role of political institutions, community-based/ civic organizations and NGOs (especially environmental NGOs) is well documented in the literature (Ballard *et al.*, 2004; Bernauer and Kouber, 2009; Binder and Neumayer, 2005; Bond, 2002: Carter, 2001; Canton, 2008; Desai, 2002; Leonard, 2011; Leonard and Pelling, 2010; Neumayer, 2003; Scott and Barnett, 2009) both internationally (for example, Greenpeace and the Chipko Movement) as well as in South Africa nationally (for example, SDCEA and Groundwork South Africa). Binder and Neumayer (2005) in particular state that there is an established theoretical and empirical case-study literature arguing that environmental pressure groups have a real impact on pollution levels. Furthermore, they assert that environmental NGOs have played a significant role in preventing environmentally harmful projects or persuading legislators and policy-makers to promulgate protective laws and regulations. Bernauer and Koubi (2009) and Neumayer (2003) state that environmental quality benefits from the presence of green parties and illustrates that green parliamentary strength is associated with lower air pollution levels. Bernauer and Koubi (2009) argue that environmental policy and, by implication, environmental quality are affected by many interest groups, ranging from business associations to homeowners to anti-globalization groups.

Cole *et al.* (2005) examine the linkages between industrial activity, environmental regulations and air pollution in the manufacturing sector in the United Kingdom. They found that pollution intensity was a positive function of energy use and physical and human capital intensity but was a negative function of the size of the average firm in an industry, the productivity of an industry and the industry’s expenditure on capital and research and development. They also show that both formal and informal regulations have been successful in reducing pollution intensity.

Bernauer and Kobi’s (2009) examination of the role of political organizations from the Global Environment Monitoring Projects for 107 cities in 42 countries from 1971 to 1996 in relation to air quality issues revealed that the degree of democracy has an independent positive effect on air quality. They also found that among democracies, presidential systems are more conducive to air quality than parliamentary ones. Additionally, Bernauer and Koubi (2009) indicate that testing competing claims about the effect of interest groups on public goods provision in democracies show that labor union strength contributes to lower environmental quality, whereas the strength of green parties has the opposite effect.

Despite the importance of regulations in controlling and monitoring air pollution, Fleishman *et al.* (2009) warn that there is limited rigorous research that examines whether regulations improves efficiency and improves air quality. Furthermore, Kathuria (2007) indicates, using the case study from India that in developing countries where there are high levels of informality there is a growing interest in the potential of informal regulations to achieve environmental goals since many polluting industries fall under the rubric of the unorganized sector. Specifically, there is growing interest in “information disclosure” and “rating” as potential tools of industrial pollution control (Kathuria, 2007: 403). Kathuria (2007) also states that evidence suggests that when formal regulation is weak or non-existent, informal regulation through local community participation has forced the polluter, especially 'visible' ones, to take corrective action. Informal regulation can closely align to formal regulation and include (Cole *et al.*, 2008; Kathuria, 2007; Pargal *et al.*, 1997):

- demands for compensation by community groups;
- social ostracism of the polluting firm's employees;
- the threat of physical violence, and efforts to monitor;
- public disclosures;
- ratings of firms/ industries; and
- publicize the firm's emissions/ discharges.

Additionally, Kathuria (2007) identifies two formal channels of informal regulation: reporting violations of standards to the regulatory agencies (where such standards and institutions exist) and putting pressure on regulators (through politicians and administrators) to tighten monitoring and enforcement.

Carter (2001: 131) states that "there is little doubt that environmental groups have been the most effective force for progressive environmental change". Various activities (lobbying, threats, and so forth.) are used by environmental NGOs to influence decisions in relation to environmental issues. These include informal, discreet lobbying; formal lobbying; collecting and sending letters or petitions from the public; producing scientific research and reports; taking legal action; organizing demonstrations and marches; staging media stunts; promoting consumer boycotts; engaging in non-violent direct action; and engaging in violent direct action (Smith and Connelly, 1999). Additionally, contributions to campaigns or endorsements are also given to specific candidates or political parties (Grossman and Helpman, 1999).

Developing air pollution policies and regulations is also a key response. However, Yusuf and Resosudarmo (2009) warn that there are serious difficulties involved in effectively implementing clean air policies in developing countries. They state that this is largely attributed to many governments in developing countries not making an air pollution policy their top priority.

The above discussions include case studies that reveal the locality specific dimensions of understanding air pollution and health impacts. However, it is important to note that while most of the sources for the literature review undertaken in this Chapter focus on case studies, there is a tendency to generalize impacts and concerns within localities. None of the studies unpack the differential impacts spatially which this research thesis attempts to do.

3.11 Conclusion

The literature reviewed in this chapter showed that there are a range of industrial air pollutants and indoor pollutants globally that impact significantly on respiratory health. In addition, the geography of health was explored which highlighted the need to take space and place seriously, especially with regard to health and health care issues and investigate the relationship between health and health care and people and place in South Africa. Furthermore, environmental racism in South Africa was discussed in detail. It also highlighted that socio-economic and political forces unavoidably create a situation in which overlapping pollution plumes, emitted by various sources into our air, soil, food and water pose a range of health risks to diverse surrounding communities, where the poorest are the most vulnerable. Case studies were used as examples to show the relationship between pollution and health, particularly in lower income communities. Furthermore, pollution sources from industry and the associated health impacts were reviewed and discussed. The literature also pointed out that pollution from transportation should be considered when investigating pollution.

In addition, this chapter shows that air pollution may induce social conflict among residents and degradation of ecosystems. Existing policies to control and monitor air pollution is often influenced by non-governmental organizations, democratization processes and politicking of informal organizations.

CHAPTER FOUR
RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

A research design is a framework or a master plan specifying the methods and procedures for collecting and analyzing data to get the needed information (Zikmund, 2008). This research investigation evaluates the socio-economic and spatial aspects of the health implications of air pollution in Richards Bay, KwaZulu-Natal. The research places specific emphasis on the health implications that are associated with pollutants, including those released by industries in the Richards Bay area and indoor pollutants. Richards Bay is part of the uMhlathuze Municipality, including Empangeni and other rural surrounding areas in KwaZulu-Natal, South Africa.

In order to conduct this research, it was important to bear in mind that there was an array of methodological tools and that the choice of tools to adopt for the study was pivotal to determining the situation within which they are to be employed. The broad research design adopted in this research is the case study approach and triangulation or mixed methods which are discussed in greater detail later. Nieuwenhuis (2011) describes a research design as a plan or strategy that move from the underlying philosophical assumptions to the selection of respondents, the data gathering techniques to be used and the data analysis to be undertaken while, according to McGivern (2006), research itself is about enquiry, that is, the systematic investigation to examine phenomena and it is the process by which evidence or knowledge is produced.

Burton (2000) and Sekaran and Bougie (2009) indicate that a research design is dependent on the overall research aim, research objectives as well as logistical aspects such as the resources and time available. The research approaches adopted in the study is intended primarily to address the research questions formulated which emanate from the objectives identified. These are:

- What are the socio-economic demographic profile of selected households and communities in the study area?
- What are the perceptions, issues and concerns relating to health of the sampled communities in Richards Bay?

- How does indoor pollutants and housing conditions impact on health in the different communities under study?
- What are the coping strategies that households in the sampled communities use to deal with air pollution and health problems?
- How do households view industries in the area? What specific advantages and disadvantages do the communities associate industries with?
- What are the spatial distributions and patterns of specific health problems that are experienced by households in the study areas?
- Which industries in the area do households perceive to be the main polluters? Where are these industries located?

Therefore, the methods employed in this research were influenced by the research objectives defined in Chapter One. Accordingly, this chapter examines the practice of different data collection methods and factors that influence the choice of suitable data collection methods. The data and information collected on poverty, low socio-economic status, sources of energy, behavioral patterns, coping strategies as well as air pollution and health impacts during this research tend to identify with similar studies in other developing countries.

The research methodology chapter thus is an attempt to identify and explain the research methods used in this research. A detailed description of the study area is provided and the research methodologies are defined. This chapter also provides a review of research theories, paradigms and methods and their effect on the research data interpretation. Additionally, the most relevant biophysical, social, economic and political features of Richards Bay, describing the research environment, are discussed in this chapter.

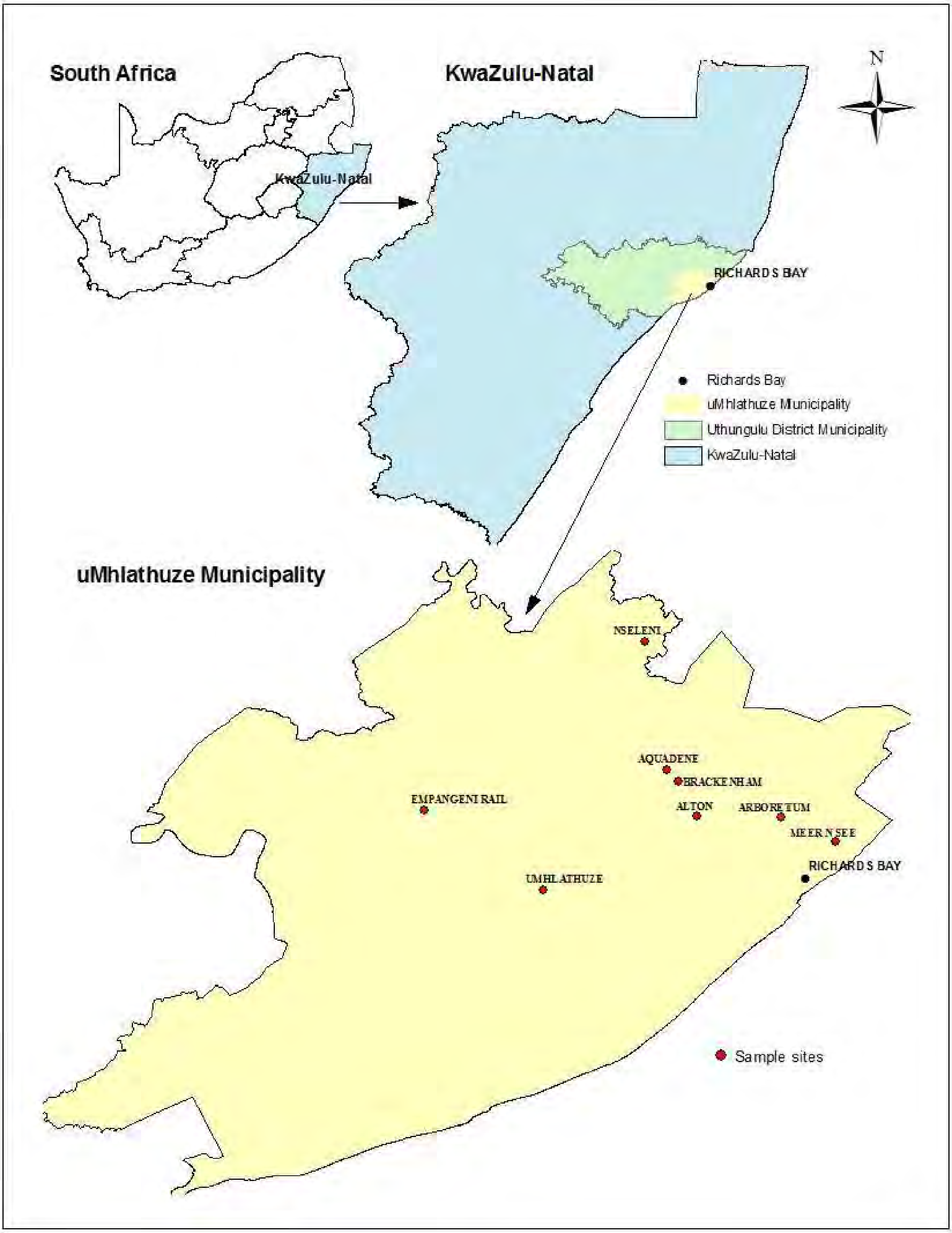
4.2 The Case Study Area Location and Characteristics

The case study used in this study is seven selected residential communities in Richards Bay. Thus, Richards Bay is the focus of the research and this section provides the necessary background information in terms of the socio-economic and physical environments.

4.2.1 Study environment

The study area (Richards Bay) is located approximately 200 km north of Durban in the KwaZulu-Natal province (Figure 4.1). It comprises of a population of approximately 345 776 (uMhlathuze Municipal Area Statistics, 2009) and also incorporates Empangeni, Esikhawini, Ngwelezane, Nseleni, Felixton and Vulindlela as well as the rural areas under Amakhosi Dube, Mikhwanazi, Khoza, Mbuyazi and Zungu (Scott *et al.*, 2004).

Figure 4.1: Richards Bay in the context of KZN in South Africa



Source: Generated by author

Richards Bay, once a small fishing village nestled on high ground overlooking the natural Mhlanthuze estuary and wetlands on the coast of northern KwaZulu-Natal, has evolved over the years as a key economic node in South Africa (Van Zyl, 2004). The area was transformed into a modern port center in the mid-1970s due to state intervention and the decision to develop a deep water harbor at Richards Bay, along with an extensive rail and road infrastructure. The Richards Bay town developed around the harbor and is the home to numerous global corporations that have contributed to the economy of the area. In 1971, the country's first aluminum smelter was established in Richards Bay. This was the catalyst for future development in the area and since then more than R50 billion has been invested in the area (Richards Bay Spatial Development Initiative Investor's Report, 2000).

The town of Richards Bay has since grown to become the City of uMhlathuze. The uMhlatuze City is a merger of the towns of Richards Bay and Empangeni and includes the surrounding rural and tribal areas, namely, Esikhawini, Ngwelezane, Nseleni, Felixton and Vulindlela, as well as the rural areas under Amakhosi Dube, namely, Mkhwananzi, Khoza, Mbuyazi and Zungu (Goussard and Demont, 2007; Municipal Demarcation Board, 2002). It is estimated that the area has a population of 450 000 (Mondi SEAT Report, 2005). The population comprises of the following historical race classifications: 78% African, 14% white, 4% Indian, 1% colored; and 3% other race/ethnicity, of which almost 72% are rural based, while 28% being urban (Mondi SEAT Report, 2005). According to the Mondi SEAT Report (2005), 64% of the population was within the economically active age group, while 33% of the population was under 15 years old.

The amalgamation of Richards Bay with Empangeni and other surrounding areas into the uMhlathuze City Municipality was done with the intention of attracting investment and development to the area. The Umhlathuze City Municipality is home to several of the largest industries in South Africa, such as BHP Billiton, Indian Ocean Fertilizers, Central Timber Cooperative, Suncrush, Bell Equipment Company, Syncat and SilvaCel and others (Mondi SEAT Report, 2005). According to the Mondi SEAT Report (2005), the communities within uMhlathuze Municipality are classified as:

- Suburbs: Arboretum, Birdswood, and Brackenham are highly urbanized suburbs
- Old Town of uMhlathuze Municipality: Empangeni
- Townships (as referred to during the apartheid era and is now being called suburbs): Esikhawini and Nseleni

- Semi-rural to rural: Mbonambi and Madlankala.

According to the Demarcation Board 2001, approximately 34% of the population of the City of uMhlathuze was employed, while 15% was unemployed. According to the 2001 South African census data, the unemployment rate stood at 40% while 46% of all households survived on an income of less than R800 per month, which indicates that close to 40 000 people were unemployed compared to the 1996 census, which estimated that 22 000 people in the area was unemployed. This indicates that despite significant development in the area, the unemployment rate remains significantly high.

The economy of the uMhlathuze Municipality which includes Richards Bay, Empangeni and the surrounding rural settlements is based on an industrial environment. According to the Mondi SEAT Report (2005), agriculture contributes to an estimated 24% of economic activity whilst other important areas of economic activity are the services (19%) and manufacturing sector (18%) and the transport sector (14%). Manufacturing contributes the most (55%) in terms of sectoral contribution to Gross Geographic Product (GGP) while agriculture contributes an estimated 5% to GGP.

Figure 4.2 shows that the population in uMhlathuze Municipality is concentrated in three main areas, specifically in the Richards Bay area which included the industrial zone, as indicated in Figure 4.3. The main transport infrastructure is also linked to the built areas and the industrial zone.

Figure 4.2: Infrastructure and population density of study sites in uMhlathuze Municipality

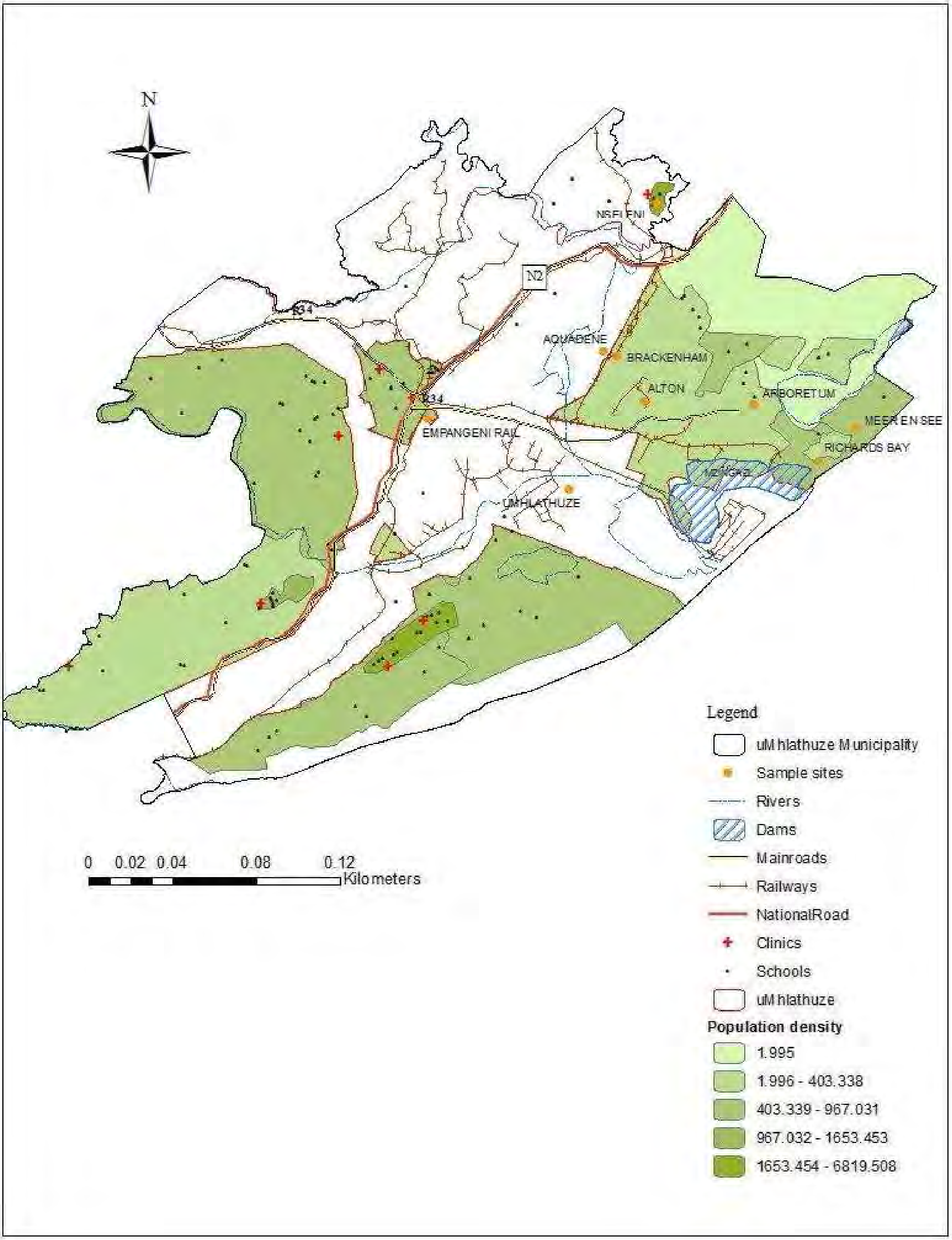


Figure 4.3 below shows the main industries in relation to the chosen communities. It is clear that most of the main industries are located in an industrial zone. Richards Bay is rapidly becoming one of the leading industrial towns of South Africa (RBCAA, 2010; Groundwork South Africa, 2004). RBCAA (2010) also states that Richards Bay started out as a tourist town. Groundwork South Africa (2004) and RBCAA (2010) assert that the area's location with respect to both local and international industrial regions, the availability of raw materials and the harbor make it an attractive location for heavy industry, reliant on import and export facilities and an electricity supply.

Figure 4.3: Aerial photograph depicting main industries (in yellow) and the study locations (in blue)

According to RBCAA (2010), the main industrial plants that are located within and in close proximity to Richards Bay are India Ocean Fertilizers (Foskor which manufactures and exports fertilizers), Bay side and Hillside Aluminum (the leading industry being the Aluminum Smelting industry which is one of the leading producers of aluminum in the world), Mondi Kraft (a paper mill linked to the large timber plantations in the area), Richards Bay Coal Terminal (which is a coal exporting company), Bell Equipment (which deals with the manufacturing of heavy industrial and construction vehicles and equipment), Richards Bay Minerals (the extraction and refining of heavy minerals from sand deposits), and Central Timber Company and Silvacel (a wood chipping plant). Most of these industries release vast amounts of airborne pollutants. Ambient air quality conditions in Richards Bay are currently monitored by the RBCAA (2002; 2010).

4.2.2 Weather: temperature and climate

Richards Bay has a subtropical climate with warm moist summers comprising an average temperature of 26°C during the summer months and an average temperature of 18°C during the winter months (Hounsome *et al.*, 2000). The mean annual rainfall in this area is approximately 1 092 mm. It is estimated that 60% of the rain falls during the summer months. According to Hounsome *et al*. (2000), abnormal rainfall events in Richards Bay coincide with cyclones and cut-off low pressure systems, which can result in extensive flooding. Hounsome *et al*. (2000) state that the mean annual evaporation is estimated to be 1 250 mm, implying an annual moisture deficit of 158 mm.

The prevailing winds in Richards Bay are predominantly north-easterly and south-westerly winds (RBCAA, 2002), with the annual frequency of occurrence of north-easterly winds, with a combined frequency of south-westerly and south south-westerly winds being more than 20% (Hounsome *et al*., 2000). The north-easterly wind is generally associated with clear, fine weather, while the south-easterly winds are associated with cold fronts and overcast weather (Scott *et al.*, 2004). Hounsome *et al*. (2000) further state that calm winds are infrequent, with a frequency of occurrence being less than 2%. Poor pollution dispersion is associated with stable atmospheric conditions. Unstable conditions occur mostly in spring and summer as a result of stronger surface heating (improved dispersion conditions).

4.2.3 Air quality in Richards Bay

Richards Bay is characterized by very poor air quality conditions (Richards Bay Industrial Development Zone - RBIDZ - Status Quo Report, 2010). The RBCAA was established to monitor ambient air quality conditions in Richards Bay. The RBCAA is a section 21 company that was developed in 1997 due to public concerns regarding the levels of air pollution in Richards Bay. The objective of RBCCA is to run a real time air pollution-monitoring network to understand the dynamics of air quality in the area. The Association focuses on SO_2 and has a network of five monitoring sites which are located in Arboretum, Wildenweide, Mlathuze, Esikhawini and in the main industrial area and the two aluminum smelters. These networks collect SO_2 data continuously and transmit the data to the central base station complemented with data collected from seven meteorological stations. The HAWK modeling system processes the data at the base station. The association also monitors ozone (O_3) at Esikhawini and particulate matter (PM_{10}) at the industrial site (RBCAA, 1999 cited in Hounsome *et al*., 2000). According to the Tata Steel Environmental Impact Assessment, the major industries (Table 4.1) in the area are the primary sources of SO_2, NO_2, particulate matter, chromium, and greenhouse gas emissions (Council for Scientific and Industrial Research - CSIR Environmentek, 2004). The shaded areas indicate the prevalence of specific types of air pollution associated with the particular industry. In addition, SGS South Africa operates 10 monitoring stations in the Richards Bay area on behalf of the RBCAA in the following areas (Feig and PrEng, 2011):

- Arboretum (Met, SO_2)
- Brackenham (Met, SO_2, PM_{10})
- CBD (situated at the sports complex) (SO_2, TRS, PM_{10})
- Harbor West (near the entrance to the harbor) (Met, SO_2)
- Scorpio (at the intersection of the John Ross highway and West Central Arterial) (Met, SO_2)
- Mtunzeni (at the fish farm) (Met, PM_{10})
- St Lucia (Met, PM_{10})
- Airport (Met)
- Bayside (at the Bayside aluminum smelter) (Met)
- RBM at the Richards Bay minerals facility (Met)

RBCAA has raised numerous concerns at the proximity of major industries in Richards Bay to the surrounding residential areas (RBCAA, 2010).

Table 4.1: Sources of industrial air pollution in Richards Bay (Feig and PrEng, 2011: 4-15)

SOURCES OF POLLUTION	POLLUTANT										
	PM10	SO2	NOx	HF	NH3	H2S	VOC	CO	CO2	SO3	Other
Hillside Aluminium											
Bayside Aluminium											
Mondi Richards Bay											
Mondi Felixton											
Exxaro											
Foskor											
Richards Bay Minerals (RBM)											
Richards Bay Coal Terminal											
Lafarge Cement											
AAFC (AECI)											
Transnet National Port Terminal											
Transnet Port Terminals											
Tongaat-Hullet											
Richards Bay Bulk Storage (IVS)											
Tata Steel											
Pulp United											

Several sources of air pollution in Richards Bay that have been identified by the RBCAA and are presented in Table 4.2. According to Feig and PrEng (2011), the existing sources of air pollution in the uMhlathuze area are:

- Industrial operations: Stack, vent and fugitive emissions from industrial operations
- Fugitive emissions: industrial, mining, commercial and miscellaneous operations
- Waste treatment facilities: water treatment plants, landfills, incinerators, etc.

- Miscellaneous fugitive dust sources: agricultural activities, wind erosion, vehicle-entrainment of dust along paved and unpaved roads, etc.
- Emissions from vehicle tailpipes
- Household fuel combustion
- Biomass burning: veld fires, forest fires, sugar cane burning, etc.

Table 4.2: Summary of the main sources of air pollution in Richards Bay (Status Quo Report, 2009: 2)

Type of Industry/ Activity	Sources
Industrial sources	Bayside and Hillside Aluminum, Mondi Paper and Pulp Mills,Richards Bay Coal Terminal, Foskor, Tongaat Hulett, Lafarge Cement, Ticor SA, Tata Steeland Pulp United, and the National Ports Authority. Other smaller industrial and commercial operations and activities such as spray painting, sand blasting, dry cleaning, small boiler and incineration processes, etc
Mining operations	Ticor Hillendale and Hlanganani Sandwork Operations. Although Richards Bay Minerals are considered to be outside the municipal boundaries, emissions from their operations impact on air quality in the city
Transport-related emissions	Road vehicles, railroad, airport and shipping
Household fuel combustion	Fuels used in households/ communities for space heating and cooking, lighting within local communities.
Biomass burning	Burning of crop-residue and wild fires associated with agriculture and forestry
Waste treatment facilities	• Mondi Richards Bay and Mondi Felixton • Bayside Aluminum - ash site
Miscellaneous emissions	• Wind-blown dust • Informal burning of refuse • Burning of tyres

The inter-annual average SO_2 concentrations collected by the RBCAA monitoring stations are displayed below. Figure 4.4 shows that the annual average SO_2 concentrations are growing as industrial sources have been introduced and expanded. There was a decrease in 2006. Furthermore, the highest concentrations occur close to the major industries (Scorpio), the Central Business District (CBD) and the Harbor. There is, moreover, an exceedence of the short term standards at Scorpio as well as an exceedence of the South African 24 hour PM_{10} standard even though the annual ambient air quality standard was not exceeded anywhere in the area (Thornhill and van Vuuren, 2009).

Figure 4.4: Inter-annual comparison of annual average SO_2 from 2003-2010 (Feig and PrEng, 2011: 4-21)

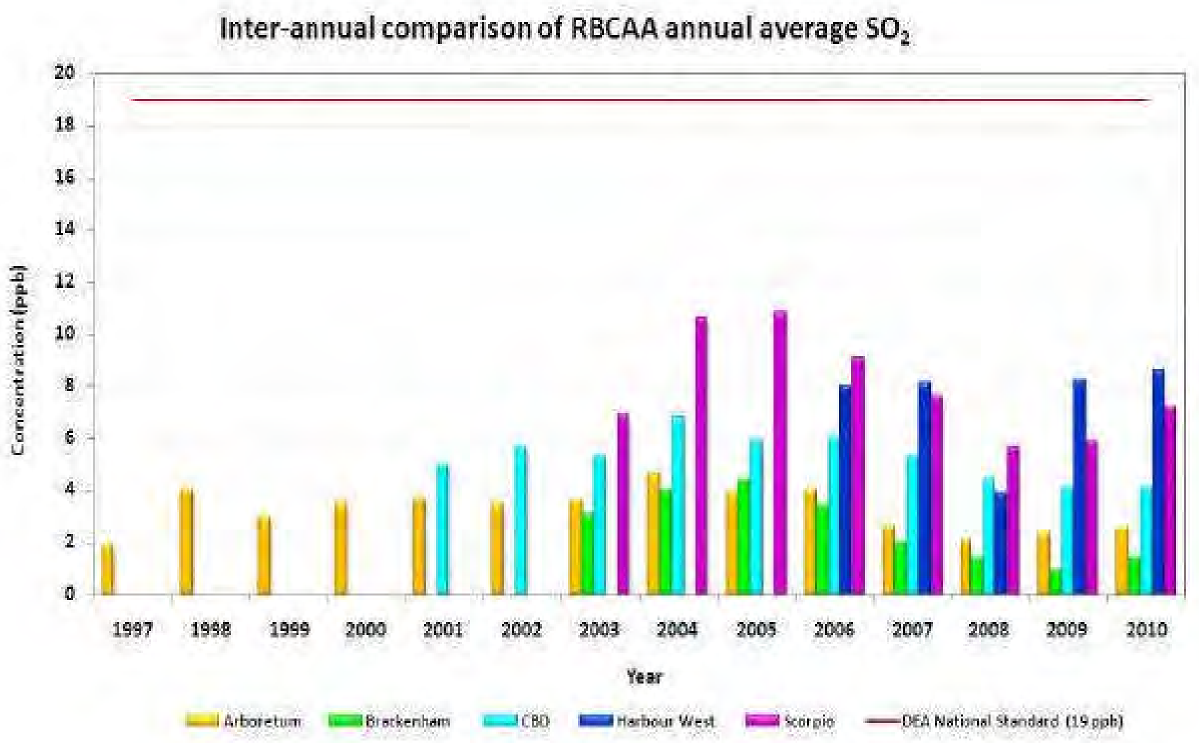
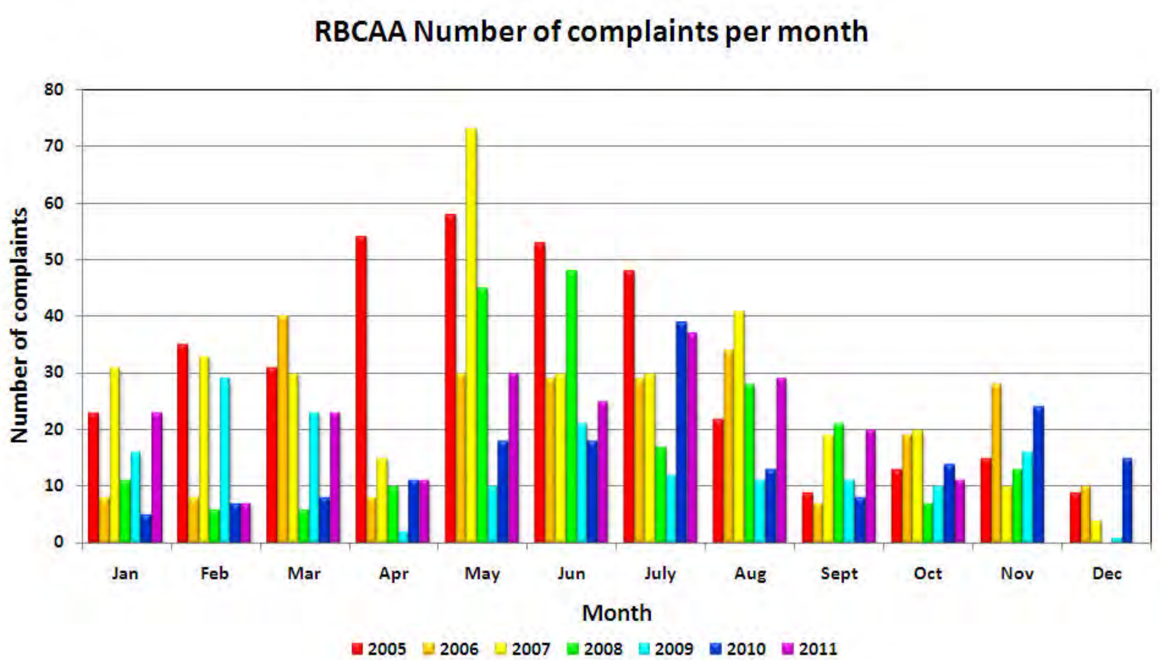
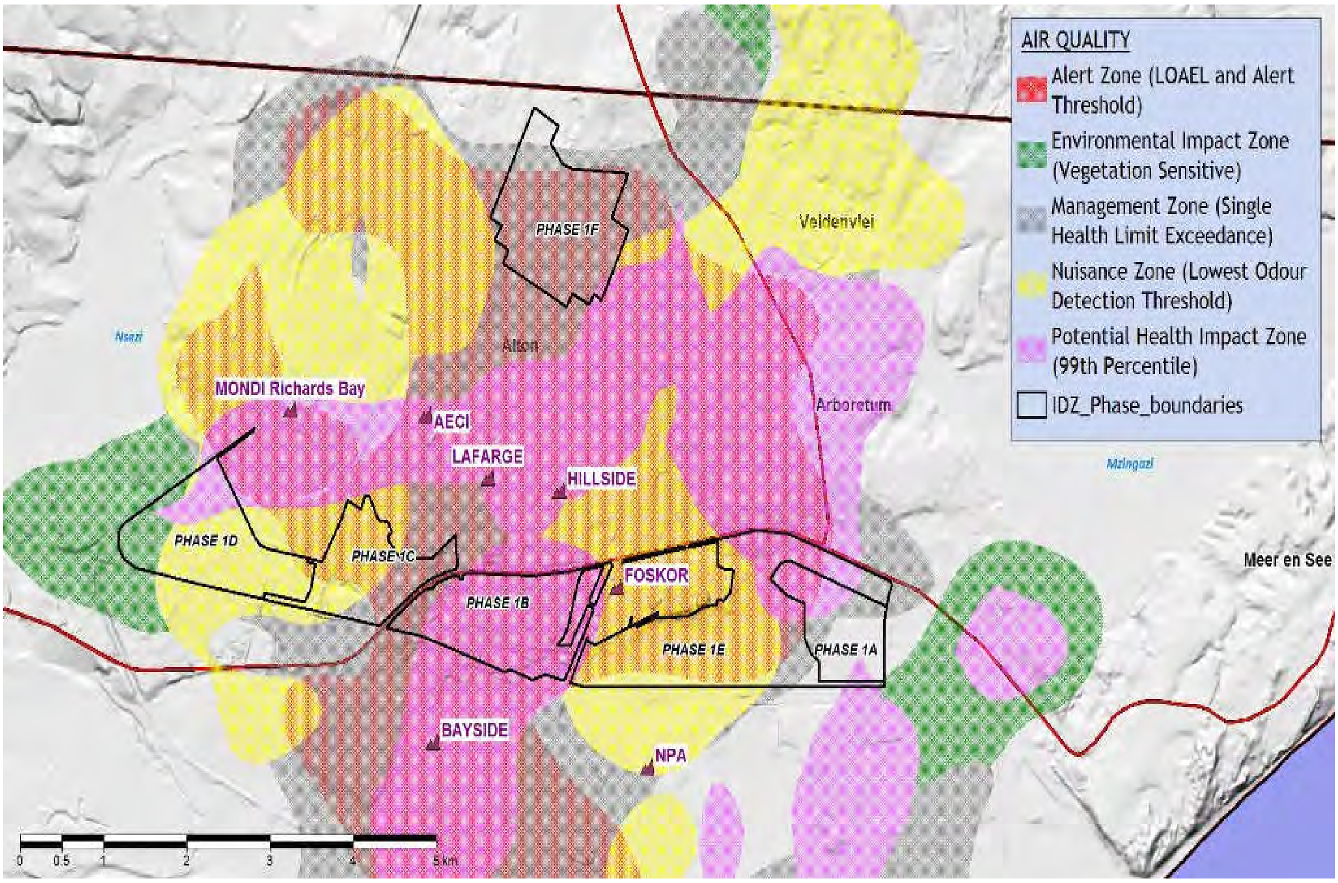


Figure 4.5: Air quality complaints from 2005 – 2011 (SGS, 2011: 13)



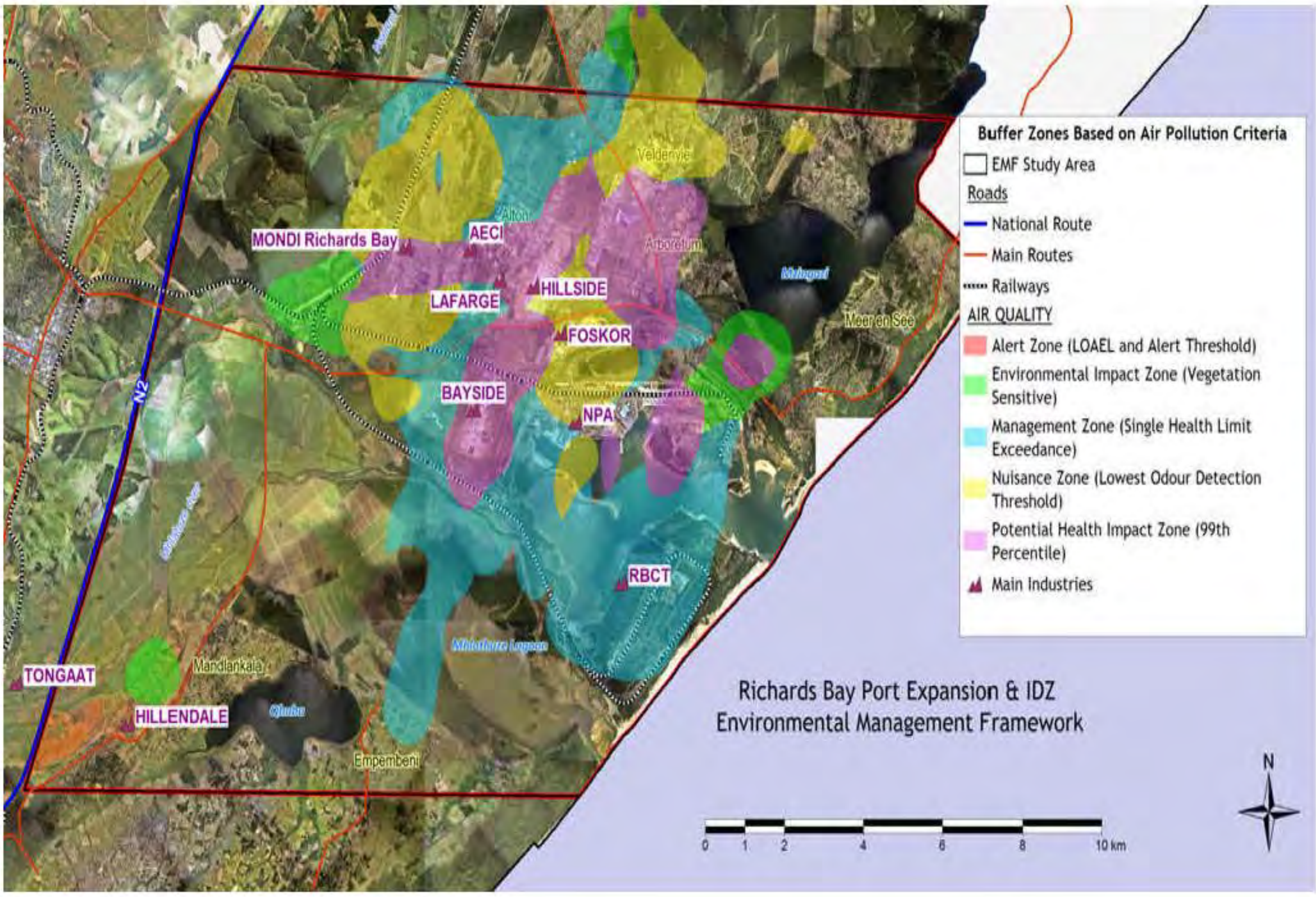
Numerous complaints were logged per month from 2005-2011 (Figure 4.5). The pattern displayed in the figure above shows that complaints logged were highest between March and August in 2007. In 2008, complaints dropped slightly during the period May to August, however, it showed an increase in September as compared to the previous year. In 2010, the complaints were the highest in July and November. A similar trend is evident for July and August 2011.

Figure 4.6: Air quality constraints in the RBIDZ (Thornhill and Thornhill, 2010: 30)



Thornhill and Thornhill (2010) highlight a study that assessed air quality in Richards Bay, and the conditions that place constraints (Figure 4.6) to the further development of industries in the area in the future. The study which was commissioned in 2005 also identified impact areas where air quality limits have exceeded and are in jeopardy of being exceeded. Figure 4.7 shows the buffer zones that stemmed from the study. According to Thornhill and Thornhill (2010), the zones were created with regards to the existing air quality status quo in Richards Bay and they depict those areas that are not suitable for residential and other sensitive land uses.

Figure 4.7: Buffer zones on air pollution criteria



4.3 Methodological Approach

Welman and Kruger (2003) define research methodology as the application of various methods, techniques and principles in order to create scientifically obtained knowledge by means of objective methods and procedures within a particular discipline. Additionally, Greener (2008) defines a research methodology as a strategy chosen to answer research questions. As indicated in the conceptual framework presented in Chapter 2, research is guided by the theoretical framework adopted and the researcher/s' understanding of the issue/s under examination. Manicas (n.d.) indicates that it is recognized that research in the social sciences requires both methods and theory, but it is not always clear how method and theory relate. Denzin (1978: 307) asserts that "no study will be conducted in the absence of some theoretical perspective" since theoretical perspectives exert influence and control on methods of knowing, procedures of inquiry and investigation as well as providing an intellectual context within which data is acquired, organized, analyzed and interpreted. Therefore, theoretical/ conceptual frameworks play a central role in research by shaping how knowledge is understood, what questions are raised, how information is collected and how data is analyzed and interpreted.

To recount, this study is informed by a multi-conceptual framework (political economy incorporating political ecology, place perspectives and environmental justice) which influenced the methods chosen. The conceptual framework highlighted the need to adopt multiple approaches to examine air pollution and health impacts at the local level. Drawing from this, the methodological framework used is triangulation or mixed methods which informs the specific methods chosen. Mararike (1999: 21) defines methodology as the epistemological and theoretical underpinnings of the methods applied in the various scientific disciplines while methods refers to the specification of steps to be taken in a given sequence to gather and treat data, arguing that "methodology is the theory of method". Similarly, Bryman (2004: 75) states that qualitative and quantitative research "exhibits a set of distinct but contrasting preoccupations reflected in epistemologically grounded beliefs about what constitutes acceptable knowledge".

Creswell (2011) and Ivankova *et al. (*2011:263) assert that mixed methods (or triangulation) is a procedure for collecting, analyzing and 'mixing' both quantitative and qualitative data within a single study to understand a research problem more completely. Ghrayeb *et al*.

(2011) define triangulation as a strategy used for the purpose of assessing and improving the validity of research findings which relies on using multiple data sources and techniques to support a finding by showing that independent measures of it agree with it or, at least, don't contradict it. Additionally, Maree and van der Westhuizen (2011) state that triangulation permits the researcher to examine whether inferences based on qualitative data are supported by a quantitative view, and vice versa. The process of triangulation which, according to Olsen (2004), is the use of multiple methods which cuts across the qualitative-quantitative divide was employed during the research. The various sources of information validate and clarify data by deepening and widening one's understanding. Triangulation therefore specifically refers to the use of two or more methods which Global Environment Facility (GEF, 2010) states is widely used in the social sciences to generate wholesome results and to double or triple check results. Mathison (1988: 13) states:

> Good research practice obligates the researcher to triangulate, that is, to use multiple methods, data sources, and researchers to enhance the validity of research findings. Regardless of which philosophical, epistemological, or methodological perspectives an evaluator is working from, it is necessary to use multiple methods and sources of data in the execution of a study in order to withstand critique by colleagues.

Triangulation consists of four strategies (Martella *et al.*, 1999; Mathison, 1988):

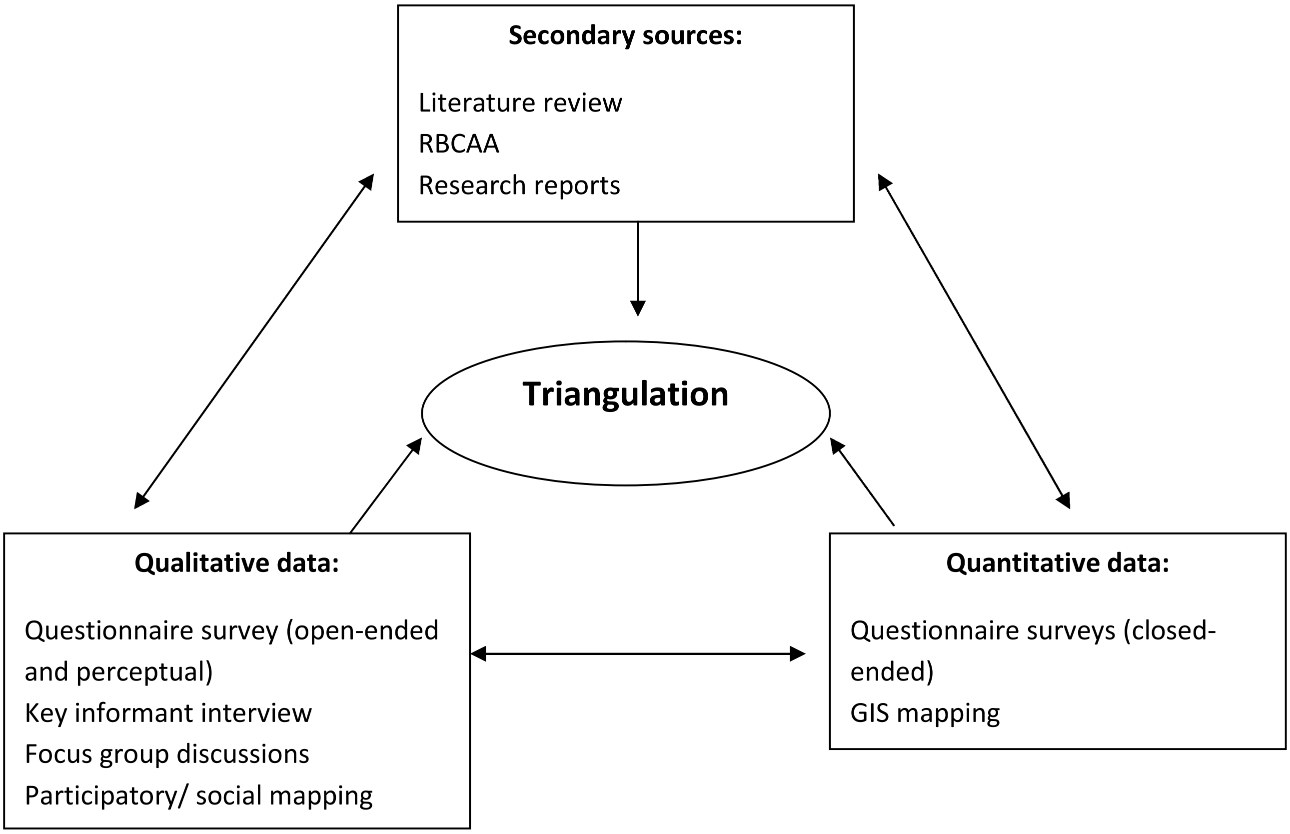
- Data triangulation including time, space, and person: the use of several data sources (including the inclusion of more than one individual as a source of data and secondary information such as reports) to provide validation for information through the use of more than one source.
- Theory triangulation: focuses on the necessary presence of theoretical perspectives in any performed study or research work which permits the interpretation of data through different perspectives.
- Methodological triangulation: the use of multiple methods in the examination of a social phenomenon, hoping that researchers can arrive at the same conclusion using different methods and that different perspectives as well as concerns can be compared.
- Investigator triangulation: involves more than one investigator in the research process aimed to reduce bias.

With the exception of investigator triangulation, the rest of strategies were used in the study. Several data sources were used (including undertaking research with different individuals and groups). As indicated in the theoretical framework, a multi-conceptual framework was used. This chapter reveals that multiple methods were also used.

In this research both qualitative methods (focus group discussions, key informant interviews and observation) and quantitative methods (questionnaires and GIS mapping) were used. Husein (2009) states that using both qualitative and quantitative methods in the same study have been debated with some researchers arguing that the two paradigms differ epistemologically while others raise a question whether the assumptions underlying qualitative and quantitative methods really are mutually exclusive. Husein (2009) states that both paradigms are designed towards understanding a particular subject area of interest and both of them have strengths and weaknesses thus, when combined, there is a great possibility of neutralizing the flaws of one method and strengthening the benefits of the other for better research results. Furthermore, as stated by GEF (2010), triangulation is organized for cross-checking information and analysis by using perceptions, validation and documentation which should culminate in the identification of evaluation findings.

There are numerous methods to capture information which include desk-stop studies, interviews, surveys, observation, focus group discussions, case studies, spatial data and experiments. Figure 4.8 below illustrates the various sources of information and methods that were used in this study.

Figure 4.8: Multiple sources of information and methods for study



The Figure above illustrates that both primary and secondary sources of data were used in the study. According to Sekaran and Bougie (2009), primary data is information that is acquired first-hand by the researcher and secondary data refers to information from sources that already exist.

4.3.1 Secondary sources

Information exists from different sources and, as McGivern (2006) states, data is rarely exhausted after its primary application and may be useful at a later date. This information can inform the theoretical framework and literature review, provide the background to the research (especially in relation to case studies which is the approach used in this study) as well as be a source of data in itself to address specific research objectives. The information available can be in various forms including text, numerical, spatial (in the form of maps), visual (for example, photographs, oral testimonies and documentaries. In this study, a preliminary literature review was undertaken to develop the research proposal that outlined the motivation for the study, the aim and objectives, the conceptual framework as well as the planned methodological approach. The initial literature search permitted gaps in the research area to be identified which informed the scope and context of the study. During the course of the entire thesis, an extensive literature review was conducted by sourcing relevant published books and journals. Other documentary sources including reports, policy documents and unpublished articles were obtained from the internet. The information was processed using the content analysis approach as explained by McGivern, (2006).

The primary sources of information also related to data that focused specifically on the GIS mapping aspect and included:

- RBCAA sources
- Consultancy reports
- GIS datasets

In addition to the use of secondary sources, this study engaged in primary data analysis through the use of direct household surveys, focus group discussions and a key informant interview. As Guion *et al*. (2011: 2) assert, although primary data collection has limitations in relation to time and costs, "the effort made in collecting a lot of data from focus group surveys and from individual or group interviews is crucial in validating the quantitative data collected and therefore minimizing the margin of error".

4.3.2 Quantitative research

Kitchen and Tate (2000: 40) assert that quantitative data are generally structured and "consists of numbers or empirical facts that are easily 'quantified' and analyzed using numeric (statistical) techniques". Bless *et al.* (2006) state that quantitative research approaches depend on measurement and the use of various scales which emphasize the quantification of constructs and the use of statistics. Manicas (n.d.: 3) states that quantitative methods are an important paradigm in the social sciences evolving from positivist philosophies and the recognition that aspects of social phenomena can be quantified:

> Ordinary life is filled with statistical information, from who is in first place in soccer standings, the cancer rates for smokers, to the number of Hawaiians in Hawai'i. Just

> as many ordinary conversations make use of statistical information, most research projects will employ statistical data of some sort. Much of this serves to have an abstracted description of vital 'social facts' and much of it serves as evidence which either confirms or falsifies critical assumptions and hypotheses. Of course, there are problems in the effort to use numbers to represent features of the world, some always noticed, some not.

Tewksbury (2009: 38) views quantitative research as the more "scientific approach to doing social science". Niño-Zarazúa (2012) states that the use of the quantitative method in research is widely accepted because of its distinguishable/ verifiable data that represents what was measured. Breakwell *et al*. (2000) assert that quantitative methods address the following questions: What the processes are? How often they occur? What differences in their magnitude can be measured over time? According to McGivern (2006), quantitative research is used to describe patterns and explain relationships between variables.

4.3.2.1 Questionnaire

In this study, a questionnaire (Appendix 1) was used which is defined by Malhotra (2006: 176) as "a formalized set of questions for obtaining information from respondents" and is regarded as the main means of collecting quantitative primary data. Babbie and Mouton (2003) assert that the survey questionnaire is a popular instrument for quantitative methodology which is an excellent tool for measuring attitudes and orientations of a population. A similar point of view is expressed by Finn *et al*. (2000: 94) who state that survey questions are a means of measuring and obtaining information regarding key concepts within the research framework. De Vaus (2002: 5) states that although survey research is often viewed as being "sterile and unimaginative", they are seen to be "well suited to providing certain types of factual, descriptive information – the hard evidence". Adams and Cox (2008) describe questionnaires as paper based and comprise questions participants will be asked to complete whether by themselves or with the help of a translator/ fieldwork. This study utilized the latter approach and face-to-face interviews were conducted with the assistance of trained fieldworkers who were proficient in both English and isiZulu.

Survey questionnaires are a mode of eliciting the feelings, beliefs, experiences, perceptions, or attitudes of a particular sample of individuals. As a data collecting instrument, it can be structured or unstructured and includes a variety of styles: closed-ended questionnaires, structured interviews and observation using data recording sheets. This research required the administration of questionnaire interviews to retrieve data (based on individual perceptions, concerns and issues) pertaining to air pollution and health impacts in the sampled communities, both urban and rural, in the designated research area as discussed earlier. The questionnaire was chosen as the main and most suitable instrument since, as indicated by Ivankova *et al.* (2007) and Leedy and Ormrod (2010), it permits researchers to describe trends and explain relationships between variables by making use of large randomly selected sample sizes, with the intention to generalize. De Vos *et al*. (2005) also indicate that questionnaires are also associated with relatively low costs to design, a high degree of freedom which respondents enjoy in the completing of it, and the obtaining of information from a large number of respondents within a brief period of time.

The questionnaire included socio-demographic variables (age, sex, length of residence in the area, employment status, job location, income levels, educational level and access to grants and remittances). This was followed by an examination of dwelling types and attitudes towards current living conditions. The questionnaire included a section on water and sanitation facilities at the household levels as well as the types and implications of the energy sources. The next section included questions on the knowledge and perceptions of polluting industries, including areas perceived to be the most and least polluted. Additionally, in this section the advantages and disadvantages of industries in Richards Bay are included. In this regard, household member employment in the industries is also considered. The next aspect deals with respondents' knowledge of organizations that address air pollution and health impacts in Richards Bay. Subsequently, community health issues and concerns are addressed with a focus on general illnesses among household members, respondents' perceptions pertaining to what they deem to be the main cause/s of the present health conditions, person/s seen to be the most affected as well as treatment sought. The questionnaire then focuses on the four main respiratory illnesses: coughing, wheezing, asthma and chest pains. The respondents were then asked about general information regarding the household and household health, including perceptions concerning health status and whether household members smoke or have pets. Coping strategies, including whether households were willing to move out of the area, the methods households use to deal with air pollution and health problems were then examined. Finally, respondents were asked to identify the main household and community challenges faced.

Goddard and Meyville (2007: 48) illustrate that there are three main ingredients to a well-designed questionnaire:

- A clear understanding of the research objectives and the product, concept or issue under investigation.
- An ability to write clear, intelligent questions using language common to the respondents targeted for the survey. The target population for this study was for different socio-economic groups. Therefore, at all stages of the data collection process fieldworkers who were proficient in both English and isiZulu were used to assist.
- Attention should also be given to the flow and logic of the questionnaire such that respondents should be asked only those questions appropriate to their situation and experiences.

De Vos *et al*. (2002) identify several guidelines, adopted in this study, which should be considered when compiling questions. They state that sentences must be brief and clear and the vocabulary and style of the questions must be understandable by the targeted respondents. Furthermore, they assert that every question must contain only one thought or idea to reduce confusion and misinterpretation. Additionally, every question must be relevant to the purpose of the questionnaire and be clearly linked to stipulated objectives and research questions. They also assert that clarity needs to be ensured, especially in relation to abstract concepts because researchers should not take for granted that respondents will always have knowledge about the subject. This is particularly relevant in this study where there is significant socio-economic and educational difference. Finally, De Vos *et al*. (2002) aver that the sequence in which questions are presented must be aimed at general, non-threatening questions first, and more sensitive, personal questions at a later stage. The survey instrument took these aspects into consideration and was structured in relation to thematic issues. Furthermore, an explanatory letter of introduction was included (communicated to the respondent by the fieldworkers) aimed at adequately orienting the respondents towards the purpose and scope of the research and to reassure the respondents of confidentiality. This was in keeping with Rubin and Babbie's (2001) assertion that the questionnaire should have an introductory component and be supported by clear instructions. This is supported by De Vos *et al.* (2002) who state that such a component will make the respondents fully comprehend the study and be able to thoroughly and voluntarily decide about their participation.

In relation to the above, the questions were designed as close-ended (choose an answer/s from a given set of responses) or open-ended questions (respondents answer in their own words). It is important to note that in this study most close-ended questions also had a specify option to permit respondents to add to the list provided. de Vaus (2002) views close-ended questions as ‘forced questions’. Gomm (2008) states that closed-ended questions are generally popular in the design of questionnaires since the responses are uniform and can easily be coded and processed. The consistency also allows responses to be systematically compared as done in this study. On the other hand, Burton (2000) states that open-ended questions are useful when all possible responses cannot be predicted. Burton (2000) further indicates that open-ended responses require that they be categorized and then coded for statistical analysis. Kumar (2011) states that open-ended questions in a questionnaire can provide a wealth of information provided respondents feel comfortable about expressing their opinions and are fluent in the language used.

4.3.3 Qualitative research

An important aspect to triangulation is the use of qualitative techniques which, according to Guion *et al*. (2011: 3), deepens the researchers’ understanding of the issues and maximizes their confidence in the findings, and this approach has data in text form that is “detailed, sensitive, nuanced and contextual.” Ritchie and Lewis (2003: 3) assert that qualitative research provides an interpretation of the social world of research participants by focusing on their “experiences, perspectives and histories”. This approach privilege the social construction of knowledge rather than seeking ‘objective truths’. Nieuwenhuis (2011) states that qualitative research attempts to collect rich descriptive data that is primarily concerned with investigating the why questions of research. Breakwell *et al*. (2000: 269) define qualitative data as verbal rather than numerical, and that the method outweighs the confines of quantitative research that is widely used but lacks flexibility in its approach to meanings of variables as well as conclusions. They indicate that qualitative methods are applicable and relevant to social issues that would not be addressed by the rigidity of quantitative data. Specifically, Jankowska *et al.* (2006: 67) state that qualitative data provides a “richness and context that add life to numbers, and meat to the bones of quantitative data”. Cresswell (2003) views the qualitative method of inquiry as exploratory in that it searches how people feel about conditions and circumstances they face; things they go through or may have done as well what they think will happen.

As indicated previously, a focus group discussion (incorporating participatory mapping), a key informant interview and observation were the main qualitative techniques used. These are discussed next. A component of the qualitative data collected was also the open-ended questions that were included in the structured questionnaire which was discussed in the previous sub-section.

4.3.3.1 Focus group discussion

Clifford *et al.* (2010) state that a focus group is a group consisting of between 6 and 12 people, who meet to discuss a particular topic that has been set by a researcher Tewksbury (2009: 47) states that focus groups are also regarded as group interviews with "guided conversations in which a researcher (or research team) meets with a collection of similarly situated persons for purposes of uncovering information about a topic". Kreuger (1988: 18) asserts that a focus group is a "carefully planned discussion designed to obtain perceptions in a defined area of interest in a permissive, non-threatening environment". De Vos *et al.* (2005) state that the advantages of focus groups include that they provide an opportunity to observe and stimulate a large amount of interaction on a topic in a limited period of time by providing rich information and direct evidence regarding similarities and differences in participants' opinions and experiences. This allows multiple viewpoints to be expressed in a short period of time as compared to individual interviews. On the other hand, De Vos *et al.* (2005) claim that the key disadvantages include increased costs, they can be time-consuming, the facilitator can influence the outcomes (interviewer effect), some respondents could be inhibited, invasion of privacy, the need for skilled researchers and problems relating to researcher bias.

The researcher conducted focus group discussions in the study areas in Richards Bay to determine the perceptions, concerns, and attitudes of communities in relation to air pollution, the associated health impacts and conflicts that result with industries. Focus group facilitators or translators who were proficient in both English and isiZulu, the most widely used languages in the area, were used to conduct the focus groups in isiZulu in December 2011. Focus groups comprised of 15 individuals from the community who were selected by the local community leader. The focus group consisted of 8 female adult representatives and 7 male adult representatives of different age categories. For the focus group interviews a schedule of questions and activities were developed to guide the process. The interview schedule for the focus group is included in Appendix 2 and reflects that similar issues that were included in the survey were probed during the discussions. Furthermore, participatory mapping and ranking exercises were conducted during the focus groups.

The mapping exercises entailed participants identifying on a map the following aspects:

- areas that they viewed as being the least and most polluted;
- the main polluting industry; and
- areas that have the most disease prevalence (in relation to specific diseases).

The latter aspect was part of the disease mapping exercise. The participants were firstly orientated to the areas in terms of the main physical features and the study location areas. Ahmed (2010) states that this type of mapping can assist to help outsiders/ researchers understand how stakeholders see and interact with the spatial environment.

The ranking exercise used a similar approach to that adopted by Ahmed (2010). Ahmed (2010) states that pairwise ranking and scoring are tools that are used for identifying issues of concern, their causes and prioritizing these problems. Pairwise ranking and scoring was used in relation to participants' views on what they perceived to be the main factors that had a negative impact on health conditions in Richards Bay. The discussion included an examination of how different groups in the community perceive the issues/ aspects identified. The focus group participants were asked what they perceived to be the main factors impacting negatively on health conditions. These were listed as they were stated. Using a matrix, each factor identified was weighted against another. Finally, the factors were scored and ranked, that is, the factor that received the most scores was ranked 1. If two or more factors received the same score, they received the same ranking (for example, if two factors received the same ranking score of 3, the driver ranked after these two would receive a score of 5).

While focus group discussions have many advantages as detailed above, they are not without their limitations which include (Breakwell, 2004; Krueger and Casey, 2000: 111; Steward *et al.*, 2007):

- There could be dominant participant(s) that may repress the opinions of others;
- Some participants may not feel confident about expressing an opinion in public;

- Some participants may prefer to submit to the opinions of others rather than cause conflicts/ arguments to develop if they hold a different opinion about a certain issue; and
- Some participants may feel tempted to give opinions that they feel will be respected by the group as opposed to giving their personal opinion.

To minimize these challenges, the researcher utilized an experienced and well-trained facilitator to guide the discussion and ensure broader participation. Clifford *et al.* (2010) and Flick (2009) state that the facilitator's/ moderator's duty is to guide the session and keep the group focused on the topic without disturbing the interaction among the participants. They indicate that this allows the group to explore the subject from as many angles as they possibly can. Additionally, at the start of the focus group the facilitator established the ground rules and addressed important issues pertaining to confidentiality. Breakwell (2004) and Denscombe (2007) stress the importance of assuring participants of the ethical considerations taken by the researcher and facilitators including what is expected of the participants in terms of respecting the views of each other by ensuring that personal details and potentially sensitive material are not discussed outside the context of the group. The facilitator conducted the discussion in the preferred language of the participants which was mainly isiZulu and English. It was interesting to note that while most issues were discussed in isiZulu, for some aspects (especially in relation to air pollution) the participants switched to English.

4.3.3.2 Key informant interview

A semi-structured interview was undertaken with a RBCAA representative in August 2012 to gather a sense of how the organization is involved in monitoring the health impacts of air pollution in Richards Bay as well as what measures are in place to control air pollution emmission levels. In adition, the semi-structured interview was also used to elicit the perceptions, and concerns of the representative in relation to air pollution and the associated health impacts and complaints in the study area. An interview schedule (Appendix 3) was used to guide the conversation which included similar thematic aspects as raised in the questionnaire and focus group discussion. This approach offered flexibility in the way in which the question could be asked or rephrased and permitted responses to be probed or further questioning for clarification or additional information. Thus, as Burton (2000) stated, respondents' answers during a semi-structured interview often determine the direction of subsequent questions.

4.3.3.3 Observation

Rudestam and Newton (2007) regard observation as the instrument of choice within the qualitative paradigm. In this study, the researcher was in the field during the entire duration of the primary data collection process. During this time, aspects in the landscape and with the communities under study specifically were observed to inform the spatial mapping exercises. Additionally, the conditions in the household were observed since the questionnaires were completed in the homes of the residents.

4.4 The Sampling Process

De Vos *et al.* (2002: 339) state that data analysis includes "the process of bringing order, structure and meaning to the mass of collected data". Martella *et al*. (1999) regard sampling as a means of gaining information about the population without the need to examine the entire population. A similar assertion is made by Gray (2004: 82) who defines a population as the total number of possible units or elements that are included in a study and since it is not often possible to evaluate the entire population, a sample is selected. They state that sampling is undertaken to draw inferences across the entire population. Additionally, McGivern (2006: 274) indicates that sampling "is about selecting, without bias and with as much precision as resources allow, the elements from which or from whom we wish to collect data". Neuman (2003) asserts that if sampling is well executed, it enables the researcher to measure variables on the selected sample cases and generalize results accurately to all cases.

4.4.1 Household surveys

A multi-stage sampling approach was adopted to obtain data for the household survey, starting with the selection of the specific communities that were deemed to be sufficiently close to industrial zones. Furthermore, the main residential areas as illicitied from documents providing background information to Ricahrds Bay (discussed in the previous section) were included. Thus, a purposive sampling approach was adopted to identify the seven communities.

Four hundred and seventy nine housholds (479) were interviewed in the area. The targeted sample size was 400 as indicated in Table 4.3 since this was deemed to be a statistically relevant sampling size at a 95% confidence level as per the Probability Proportional to Size (PPS) sampling guidelines advocated by Isaac and Michael (1981), given that there are approximately 12 916 households in the designated study areas using Census 2001 data.

These areas are Alton (183), Aquadene/ Brackenham (2 469), Arboretum (1 657), Meer-en-See (1 002), Empangeni Rail (2 039), Nseleni (1 728) and Umhlathuze (3 838). Alton, Aquadene/ Brackenham, Arboretum and Meer en See are classified as predominantly White and middle/ upper income areas, with Aquadene/ Brackenham being classified as comprising of people who are of predominantly Indian and mixed historical race categories. The areas with the highest percentages of low income groups (Empangeni Rail, Nseleni and Umhlathuze) are classified as predominantly African populated areas as per the historical race classification and apartheid segregated areas. Due to apartheid and the segregation of the South African population into pockets of Bantustan groups, these areas were provided with limited opportunities for employment, education and services such as health care, water supply, proper sanitation, etc.

Census 2001 data was used to identify households in the demarcated area to determine the target population. Additionally, ground truthing was used to locate informal settlements in the defined area and estimates were made in relation to the area of interest. For example, Empangeni Rail is part of a larger residential and built-up area. The decision was taken to conduct interviews only within a designated community that was closest to the main polluting industries to focus the study. Also, Umhlathuze is a relatively larger rural residential area. Again, those residents who were close to the industrial zone was targeted. The proportionate sampling approach was used to determine the number of households to be included in the study as indicated in Table 4.3. In most cases, the actual sample size was more than the number targeted with the exception of Aquadene/ Brackenham (15 less than intended), Arboretum (17 less than intended) and Empangeni Rail (2 less than intended). It was easier to conduct questionnaires in the other areas (especially the lower income areas of Umhlathuze and Nseleni where households were generally willing to participate). Despite the deviations from the intended sampling framework, these are not significant and generally more surveys were conducted than planned making the sample robust for descriptive and inferential statitical analysis.

Table 4.3: Proportionate sampling approach used in the study

	Total population (number of households)	Proportion of total population	Intended sample size	Actual sample size	Proportionate distribution of actual sample
Alton	183	1.4	6	16	3.3
Aquadene/ Brackenham	2 469	19.1	76	61	12.7
Arboretum	1 657	12.7	51	68	14.3
Empangeni Rail	2 039	15.9	63	61	12.7
Nseleni	1 728	13.4	54	76	15.8
Meer en See	1 002	7.8	31	33	7.0
Umhlathuze	3 838	29.7	119	164	34.3
Total	**12 916**	**100**	**400**	**479**	**100**

In terms of the selection of the households within the targeted communities, conditional point random sampling using Hawth's Analysis Tools Version 3.27 extension for ArcGIS 9_{+} was used to randomly choose the determined number of points in each of the communities as indicated in Table 4.3. GPS was used to locate the points. The household at or nearest to the chosen sampled point was interviewed. If the chosen household was not available or did not agree to participate in the study, the nearest neighbor was interviewed to replace the selected household. The spatially-based approach described above saves time and resources since household rosters do not have to be created and they help in facilitating the fieldwork process since housholds are already geographically identified for easier location and access. Sekaran and Bougie (2009: 270) state that simple random sampling (which was essentially used in this study to identify the household) has the "least bias and offers the most generalizability".

The household surveys were conducted at the homes of respondents where an adult member of the household was asked to participate in the study. This was done to create a less hierarchical relationship between the respondents and the researcher since these were environments with which they were familiar and comfortable, as indicated by Dyck (1997).

4.4.2 Key informant interviews

In addition to the household surveys that focus on information pertaining to health issues and problems that are experienced by household members in the area, the research included a semi-structured interview with the RBCAA. The intention was to conduct key informant interviews with selected stakeholders, including industry representatives and government officials. Thus, a purposive sampling approach was used in the selection of the other stakeholders that were to be interviewed. However, with the exception of RBCAA, the rest of the stakeholders were reluctant to participate and this may be indicative of the politics around air pollution in the area. RBCAA agreed to participate and is included in the study. Purposive sampling refers to participants being selected because of some "defining characteristics that make them the holders of the data needed for the study" (Nieuwenhuis, 2011: 79).

4.4.3 Focus group discussion

As indicated earlier, community members were purposively sampled to participate in the focus group. The members chosen reflected diversity in terms of location of residence, age and gender. The interview schedule described above was used to guide the discussions.

4.5 Validity and reliability

In terms of methods chosen, it is important to consider reliability and validity. Reliability refers to accurately measuring the concept while reliability refers to consistency between one measure and the next. More specifically, Goddard and Melville (2007) state that reliability determines whether the tool that is used in the research will provide the same information if used by different people, under the same conditions and at the same time. They view validity as the correspondence between the research and the real world, that is, the data includes everything it should and does not include anything it should not. Martella *et al*. (1999: 56) regard validity as central and that all research which they define as the degree to which accurate inferences can be made on the results of the study.

In this study validity and reliability was achieved by:

- Developing the survey instruments and schedules for the focus group and key informant interview which were in line with previous studies including Moodley (2002).
- Piloting the questionnaire: the questionnaire was piloted in the South Durban Basin area which is similar to Richards Bay as indicated in the literature review since it has high levels of industrial air pollution with concomitant health impacts. Based on the piloting, the questionnaire was revised for final implementation in Richards Bay.
- The sampling process was chosen to minimize bias. To this end, for the surveys, the random sampling approach informed the study. This approach is considered to be the

only probability, sampling technique that ensures that each individual, object or event has an equal probability of being included in that sample (Martella *et al*. 1999).

4.6 Data Analysis

Spencer *et al.* (2003) state that the pathway to forming ideas start right at the beginning of the research project and ends with the writing up of the results. Aldridge and Levine (2001) indicate that the items of information gathered from the respondents are variables which can be classified into three broad types, depending on the types of information they provide:

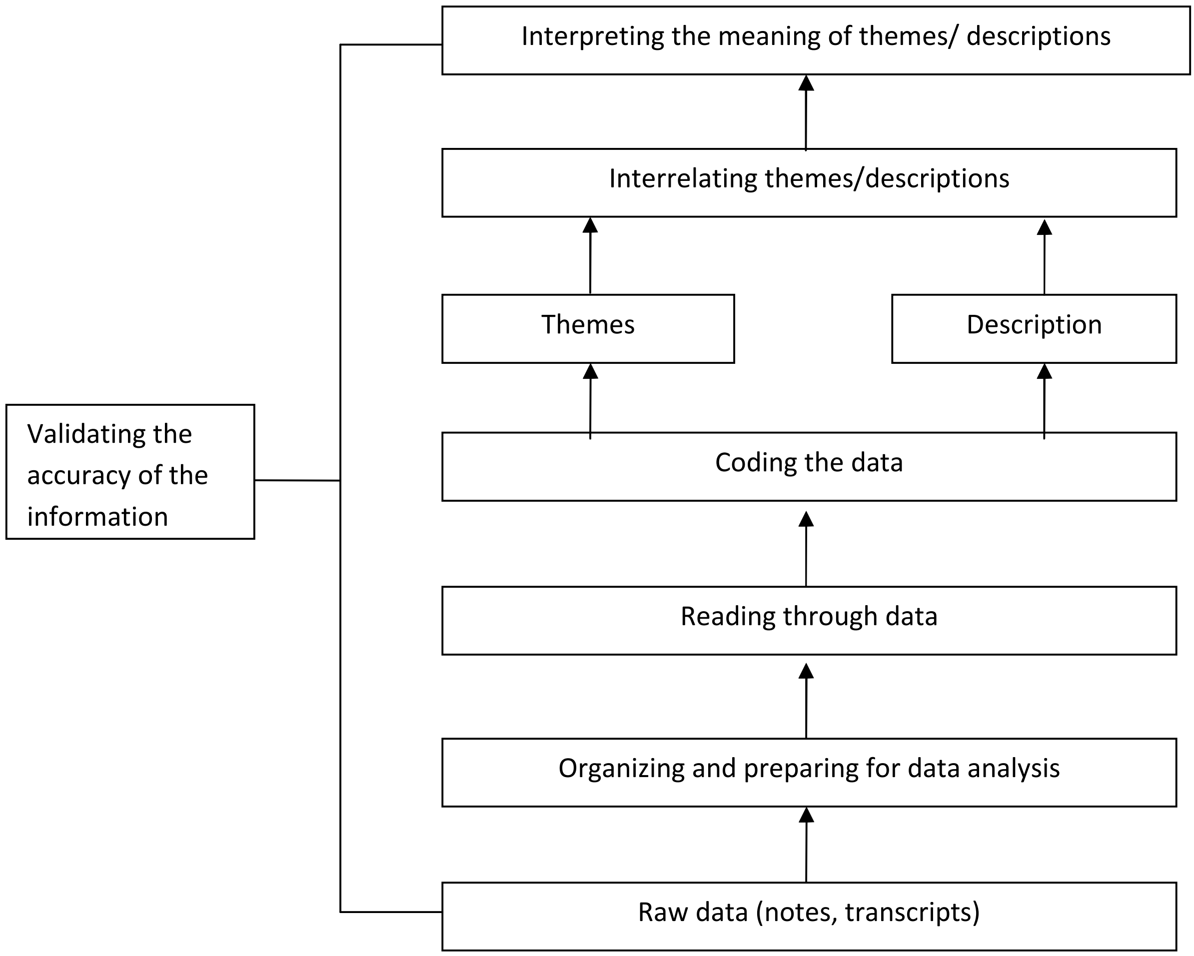
- Attributes: characteristics such as age, sex, marital status and previous education
- Behavior: addressing questions such as what, who, how and when
- Opinions, beliefs, preferences and attitudes: questions on these four aspects probe the respondents' points of view

To facilitate proper analysis of the primary data collected, the information gathered must be properly organized and coded. Mathison (1988) warns that researchers should be cautious and skillful in their handling of triangulated information (especially in terms of drawing conclusions and documentation/ presentation of data) because of inconsistencies, contradictions and convergence of data may still occur.

Wegner (2001: 3) states that statistics can be a "useful tool in converting masses of data into meaningful information". The purpose of descriptive statistics is to enable the researcher to meaningfully describe the distribution of scores or measurements using a few indices or statistics. Multiple response questions was analyzed and displayed in the form of tables. Despite the use of a quantitative survey instrument, the data produced was largely non-parametric. Therefore, cross-tabulations and chi-square tests comprised the basis of the statistical analysis used to reveal trends, associations and relationships within the data set. These statistical tests were conducted using a software package for social sciences (SPSS, PASW, version 19). The chi-square test (statistical formula) is used primarily for categorical data which allows relationships between variable/ categories to be examined and highlighted. The SPSS data was also used to facilitate the spatial analysis.

Cresswell's (2009) approach presented in Figure 4.9 to analyze qualitative data entails capturing the essence of the information collected via the methods adopted and then distilling the data rather than merely reducing the volume of information. This is done by being methodical, systematic and goal-orientated. In this study, specific themes formed the framework to guide this process.

Figure 4.9: Data analysis approach in qualitative research (adapted from Cresswell, 2009)



Maps were generated using the ArcGIS (version 9.3) package which was used to depict spatially the differences and/ or relationships in the data obtained. These maps depicted respondent's perceptions of high and low pollution zones and prevalence of perceived diseases. The compilation of maps shows how patterns of spatial distribution of disease can be revealed and how these relate to socio-economic profiles. Furthermore, maps were generated that present perceptions regarding main industry polluters. The maps generated were also discussed in relation to the relevant themes.

The data analysis was undertaken thematically, by drawing on both the quantitative and qualitative information collected, using the constant comparative approach specifically in relation to the seven communities under study in Richards Bay. Additionally, secondary sources of information were examined in relation to key issues and concerns emerging from the literature and primary data to provide a more detailed analysis. Thematic analysis requires the identification of master or first order themes emanating from the information collected and where appropriate, sub-themes or second order themes can emerge as well (Fereday and Muir-Cochrane, 2006; Kitchin and Tate, 2000). Once the themes were extracted, the approach described by Kitchen and Tate (2002: 235) to interpret the data was adopted:

- describing the data (portraying the data in a way that is easily understandable);
- classification of the data (breaking up the data into similar components and placing them into similar groups); and
- examining the interconnectivity of the data (finding associations and relationships).

Data was presented in text format, maps, tables and figures. In terms of the quantitative survey data, cross-tabulated frequencies are mostly used together with averages and Chi-square test results, wherever applicable.

4.7 Conclusion

This chapter has provided a detailed background of the case study in relation to physical and socio-economic attributes. The differences between methods and methodology are discussed together with the justification for the use of triangulation. The specific quantitative and qualitative methods used in the study were then discussed together with the sampling approaches used. This enabled the study to provide enriched and well augmented results and also whose individual shortcomings cancel each other out. This chapter also brought to light how respondents were sampled and put strategically in focus groups, as well as the use of the questionnaires and interviews to collect essential data. This chapter also gave a brief explanation of the data processing procedures, which is the use of the SPSS. The following chapter focuses on data presentation and analysis.

CHAPTER FIVE
DATA DESCRIPTION AND ANALYSIS

5.1 Introduction

Assessments of air pollution and health care impacts require a thorough examination of community and household level dynamics. Several interconnected relationships between air pollution and health exist as indicated in the literature review undertaken in Chapters 2 and 3. Specifically, socio-economic and spatial attributes are key and therefore forms the focus of this research endeavor. This Chapter presents the results from the research conducted on the socio-economic, spatial and health implications of air pollution in Richards Bay, KwaZulu-Natal. The study was conducted in Alton, Aquadene/ Brackenham, Arboretum, Empangeni Rail, Nseleni, Meer en See and Umhlathuze. The chapter is based on an analysis of the data obtained from the questionnaire survey which was administered to a sample of households within each study area and includes the results obtained from the focus group discussions (including the mental maps created by the participants), the key informant interview with RBCAA and direct observations made.

This chapter addresses the research objectives of the study through the statistical analysis of components such as demographic and socio-economic profiles of respondents, access to water, sanitation and energy supplies, respondents general knowledge on industries and the associated health impacts of air pollution, especially on the respiratory system, access to health care services and the copying strategies that those affected by air pollution employ in Richards Bay. The questionnaires were designed with a combination of single responses, multiple responses, and open-ended questions that were administered to 479 respondents from Richards Bay, which included the following areas: Alton (A, n=16), Aquadene/ Brackenham (A/ B, n=61), Arboretum (Ar, n=68), Empangeni Rail (ER, n=61), Nseleni (N, n=76), Meer en See (MS, n=33) and Umhlathuze (U, n=164). SPSS (version 19.0) and Microsoft Excel were used to analyze the survey results. Empirical data analysis is generally undertaken using descriptive tabulations. Where it is appropriate, Chi–square tests are used to examine relations between specific variables. It should be underscored, however, that only in cases where a relationship was deemed to exist, further inferential statistical calculations were undertaken. The data collected through the use of qualitative techniques is also integrated into this chapter.

The data is analyzed under the following thematic areas:

- socio-economic and demographic characteristics of the sampled population;
- dwelling environment/ conditions;
- availability of services (including, water and sanitation as well as energy sources;
- general knowledge of industrial pollution in Richards Bay;
- knowledge of air pollution associations/ organizations in Richards Bay;
- health implications of air pollution;
- coping strategies in response to air pollution; and
- household and community challenges.

An analysis of respondents' demographic profiles, including their age, gender, level of education and income sources of respondents' surveyed is presented next. This is undertaken to unpack socio-economic differences within the communities under study and provide the context in which the analysis of the linkages between air pollution and health impacts can be understood and evaluated.

5.2 Demographic Profile of Respondents

The main component of any analysis in the social sciences is the socio-economic characteristics of respondents since it provides a backdrop to the demographic characteristics and possible direct or indirect influences they could have on the attitudes, perceptions and health status of individuals and communities within a specific case study. Furthermore, an analysis of the socio-economic aspects within communities provides the context for health-related research as demonstrated in Chapter 2. Mayer (1998) and Richmond *et al.* (2006) specifically highlight the importance of examining the broader socio-economic context when attempting to understand human-environmental relations, including health and air pollution impacts. Socio-economic variables such as age, sex, marital status, education, employment, household composition and relationships in specific communities within the case study communities are discussed below.

Table 5.1: Age of Respondents (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
25-34	12.5	19.7	5.9	20.3	8.1	27.3	18.9	16
35-44	50	23	23.5	18.6	28.4	18.2	28.1	25.7
45-54	25	36.1	35.4	30.5	12.2	21.2	20.7	24.9
55-64	-	13.1	23.6	16.9	31.1	21.2	15.8	18.9
65-74	12.5	4.9	11.8	13.6	16.2	12.1	14	12.6
75+	-	3.3	-	-	4.1	-	2.4	1.9

The study population comprised of 16% of respondents who were between the ages of 25-34, 25.7% who were between 35-44 years old, 24.9% who were between the ages of 45-54, 18.9% who were between 55-64 years old and 12.6% who were between 65-74 years old (Table 5.1). A small percentage of respondents (1.9%) were 75 years and older. The above table shows that the majority of respondents (50%) that were interviewed in Alton were found to be between the ages of 45-54 years and 25% were between 45-54 years old. In all other communities the respondents were distributed across the range of age categories. Only 12.5% of the respondents from all the study areas were between the ages of 25-34 and 65-74 years old. The ages of household heads ranged from 25 years to more than 75 years with the average age being 48.3 years (Table 5.1). The average ages of respondents in the specific communities were 44.6 years in Alton, 46.6 years in Aquadene/ Brackenham, 50.8 years in Arboretum, 48 years in Empangeni Rail, 52.6 years in Nseleni, 47.2 years in Meer en See and 48.3 years in Umhlathuze (Table 5.2).

Table 5.2: Average age of total population (including household head)

Community	**Total size of sampled household population**	**Average age of respondents (in years)**	**Average age of all household members (in years)**	**Average household size**
Alton – A	54	44.6	33.5	3.4
Aquadene/ Brackenham - A/B	280	46.6	26.2	4.2
Arboretum – Ar	169	50.8	44.7	2.5
Empangeni Rail – ER	298	48	22.9	4.9
Nseleni –N	361	52.6	26.7	5.2
Meer en See – MS	109	47.3	32.8	3.3
Umhlathuze – U	672	48.2	29	4.7
Total	**1 943**	**48.3**	**28.3**	**4.8**

When the data of the household heads was combined with the rest of the household members, the average age of the total population decreased significantly as indicated in Table 5.2 in Richards Bay generally and in all communities surveyed. The ages of all members of the households ranged from less than 5 years to more than 80 years with the average age being

28.3 years. The average ages of respondents in the specific communities were 33.5 years in Alton, 26.2 years in Aquadene/ Brackenham, 44.7 years in Arboretum, 22.9 years in Empangeni Rail, 26.7 years in Nseleni, 32.8 years in Meer en See and 29 years in Umhlathuze. The communities with the households having the most youthful populations were Aquadene/ Brackenham, Empangeni Rail, Nseleni and Umhlathuze (the latter three being the lower income areas) while Alton, Arboretum and Meer en See (the middle/ upper income areas) had more elderly populations. This is in keeping with the economic status of the communities which revealed that lower income areas have more youthful populations with significant numbers being children while upper income areas have more elderly populations. Similar trends were also found in relation to household size presented in Table 5.2. The overall average household size of the communities under study was 4.8 with communities having higher average household sizes being Aquadene/ Brackenham (4.2), Empangeni Rail (4.9), Nseleni (5.2) and Umhlathuze (4.7) while Alton (3.4), Arboretum (2.5) and Meer en See (3.3) had lower average household sizes. Clearly, the lower income areas have higher household sizes compared to the upper income areas. Additionally, in terms of the composition of the household members, extended families (especially with grandparents and grandchildren) were dominant in Unhlathuze, Nseleni and Empangeni Rail while the rest of the communities had mainly nuclear families (parents and children).

Generally though, the main feature of the population in most communities, especially where the population is larger and poorer, is their youthful nature with a large proportion of children and young adults. Furthermore, the recent release of the 2011 South African Census data (Statistics South Africa, 2012) supports this assertion. The youthfulness of the population could also be attributed to the migration of the younger age cohorts from the rural areas of KwaZulu-Natal to urban and industrial settlements as indicated by Hunter (2010) and Moodley (2002). The youthfulness of the population is a cause for concern, especially in terms of the provision of health services, facilities, employment and the probable health impacts it may lead to in industrial urban areas. Children in particular are susceptible to a range of air pollution related ailments including asthma (Jin *et al.*, 2006; Larson and Rosen, 2002; WHO, 2004; Wilhelm *et al.*, 2009). During the focus group discussions, it emerged that population growth is occurring in most communities but especially in the African township areas (Umhlathuze, Empangeni Rail and Nseleni) in Richards Bay. The consequences of this youthful population growth with increases in air pollution levels present serious health challenges for the communities that reside in close proximity to industries in

Richards Bay. As indicated earlier, children are particularly susceptible to air pollution related ailments and particularly poorer communities have more young populations. In these instances, children's health is undermined even further since they have higher exposure to other environmental risk factors (such as water borne diseases), lower nutritional status and lesser access to health care.

Table 5.3: Gender of respondents (in %)

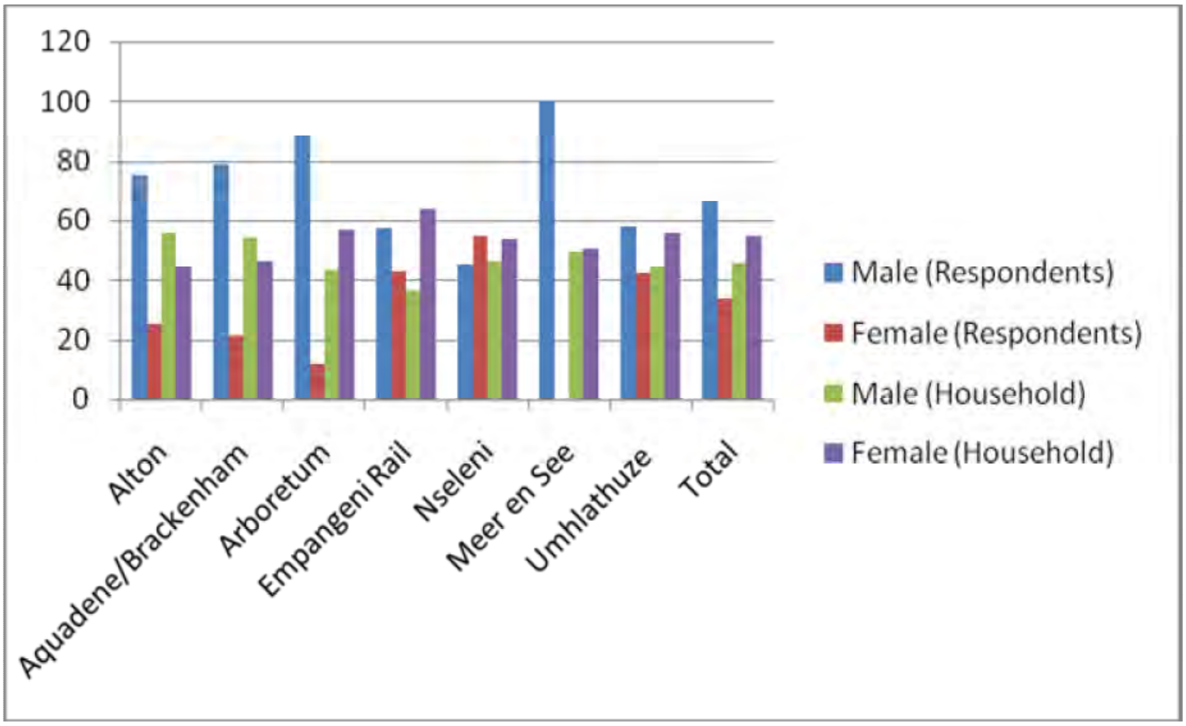
	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	E (n=76)	MS (n=33)	UV (n=164)	Total (n=479)
Male	75	78.7	88.2	57.4	45.2	100	57.9	66.4
Female	25	21.3	11.8	42.6	54.8	-	42.1	33.6

The majority of the respondents (66.4%) were male, whilst only 33.6% were female (Table 5.3). In Meer en See, all respondents were males. Males constituted the majority in Alton (75%), Aquadene/ Brackenham (78.7%), Arboretum (88.2%), Empangeni Rail (57.4%) and Umhlathuze (57.9%). In Nseleni, the majority of respondents (54.8%) were females. This is in keeping with household survey trends where it is usually the head of the household that responds to the survey and in South Africa, this is generally deemed to be men. However, in terms of the total population of the sampled households shown in Table 5.4 and represented comparatively in Figure 5.1, the majority are females (56.6%) as compared to males (45.4%). This is particularly prevalent in Umhlathuze (55.5% are females), Nseleni (53.7% are females) and Empangeni Rail (63.8% are females).

Table 5.4: Gender of all household members (in %)

	A (n=54)	A/B (n=280)	Ar (n=169)	ER (n=298)	E (n=361)	MS (n=109)	U (n=672)	Total (n=1943)
Male	55.6	53.9	43.2	36.2	46.3	49.5	44.5	45.4
Female	44.4	46.1	56.8	63.8	53.7	50.5	55.5	54.6

Figure 5.1: Comparison between gender of respondents and gender of all household members (in %)



The larger proportion of females in households may reflect migration trends. As Hunter (2010) indicates, migration of males to larger urban centers was common in African townships and rural areas in South Africa. This is probably also the case in these communities. This trend of the proportion of females being dominant in poorer communities is also reflected in other studies (for example, Jaggernath, 2010; Moodley, 2002). The predominance of females, especially amongst poor households, is likely to have health implications that will be considered later. Participants during the focus group discussions raised this as an indication of inadequate job creation in Richards Bay despite the number of industries in the area. Additionally, some participants stated that more recently young women are also migrating to the larger urban areas in search of work, especially in the domestic sector. This is also shown by Hunter (2010) who indicates that they often seek jobs in the domestic sector or sex industry which make them extremely vulnerable.

As highlighted in the literature review, children and women are the most vulnerable to air pollution health impacts (Braveman, 2006; Brulle and Pellow, 2006; Higginbotham *et al.*, 2010; Jin *et al.*, 2006; Larson and Rosen, 2002; Sze and London, 2008). The results indicate that a significant population of the communities in the study area is made up of these vulnerable groups and therefore the health impacts are likely to be more pronounced.

Table 5.5: Martial status of Respondents (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
Currently Married	75	75.4	88.2	65.6	42.1	90.9	40.7	60
Single (Never Married)	12.5	11.5	-	14.8	35.5	-	27.8	18.9
Widowed	-	9.8	5.9	3.3	14.5	6.1	18.5	11.5
Divorced	12.5	-	5.9	6.6	-	3	6.2	4.4
Separated	-	-	-	-	-	-	2.5	0.8
Abandoned	-	-	-	-	-	-	2.5	0.8
Single Parent	-	3.3	-	9.8	7.9	-	1.9	3.6

Sixty percent of all respondents indicated that they were currently married while 18.9% indicated that they are single/ have never been married, 11.5% stated that they are widowed and 4.4% said that they were divorced (Table 5.5). A small percentage of respondents (3.6%) indicated that they were single parents, whilst 0.8% of the respondents revealed that they were separated from their partners and a further 0.8% indicated that they were abandoned by their partners. Table 5.5 above shows that the majority of the respondents were married in Meer en See (90.9%), Arboretum (88.2%), Aquadene/ Brackenham (75.4%), Alton (75%) and Empangeni Rail (65.6%). Less than half of the respondents were married in Nseleni (42.1%) and Umhlathuze (40.7%). This again reflects in part the socio-economic conditions in the different communities. The higher proportion of single and widowed respondents in the lower income areas is indicative of higher levels of poverty and vulnerability.

Table 5.6: Employment status of respondents (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
Professional	62.5	35.6	23.5	37.7	9.5	27.3	5.3	20.6
Technical	12.5	8.5	23.5	6.6	-	15.2	2.6	8
Managerial	12.5	10.1	5.9	6.6	-	9.1	-	4.2
Clerical	-	-	5.9	-	-	-	1.3	1.3
Sales	-	3.4	11.8	-	-	3	9.2	5.5
Craftsman	-	-	5.9	3.3	-	6.1	-	1.8
Laborer	-	6.8	-	6.6	14.3	-	29.6	13.7
Retired/ pensioner	12.5	3.4	11.8	19.7	11.1	12.1	24.3	15.9
Housewife	-	-	-	3.3	-	-	4.6	2
Unemployed	-	20.3	-	9.8	39.7	-	12.5	13.7
Self-Employed	-	13.6	11.8	6.6	20.6	27.3	9.9	12.6
Driver	-	-	-	-	3.9	-	0.6	0.8

The above Table displays the employment status of the sampled population in Richards Bay. Respondents indicated that they were professionals (20.6%), technical workers (8%), managerial (4.2%), clerical workers (1.3%), sales (5.5%), craftsman (1.8%), laborers (13.7%) and drivers (0.8%). Almost 14% of the respondents were unemployed, whilst 12.6% indicated that they were self-employed, however, they did not state the activity that they were involved in. Two percent of the respondents that were interviewed indicated that they were housewives. The highest percentages of unemployment, as indicated in Table 5.7, were in Nseleni (39.7%) and in Aquadene/ Brackenham (20.3%), whilst the highest percentages for retirement/ pensioner were in Umhlathuze (24.3%). Almost 30% of the economically active sampled population in Umhlathuze and 14.3% in Nseleni are laborers in comparison to the highest percentages of professionals who are located in Meer en See (27.3%), Alton (62.5%), Aquadene/ Brackenham (35.6%), Arboretum (23.5%) and Empangeni Rail (37.7%).

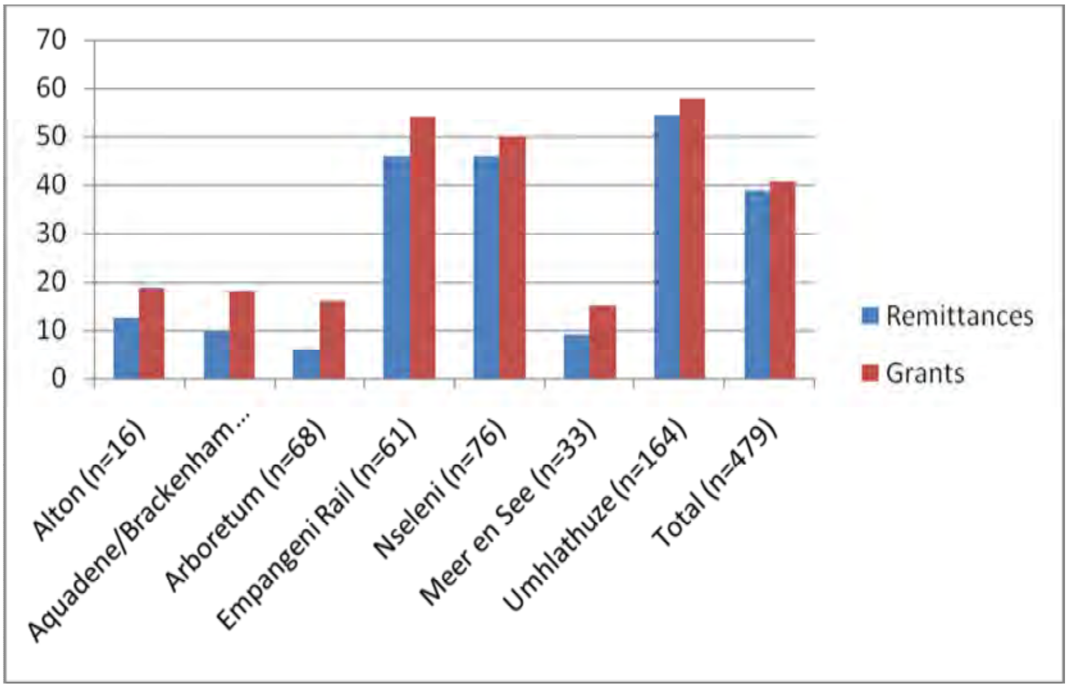
Table 5.7: Employment status of household members (in %)

	A (n=54)	**A/B (n=280)**	**Ar (n=169)**	**ER (n=298)**	**N (n=361)**	**MS (n=109)**	**U (n=672)**	**Total (n=1943)**
N/A	29.6	37.9	10.1	44.6	42.9	6.4	33.5	33.9
Professional	25.9	15.7	16.6	13.1	4.7	11.9	2.2	8.7
Technical	3.7	3.6	11.8	2	1.7	5.5	1	2.9
Managerial	7.4	2.9	4.7	2.9	-	5.5	-	1.7
Clerical	-	0.4	9.5	1.3	0.6	11.9	0.3	2
Sales	-	3.6	4.7	0.7	2.2	1.8	5.1	3.3
Craftsman	-	-	4.7	0.7	-	-	0.9	0.8
Laborer	-	5.4	-	2.9	9.1	-	11.6	6.9
Retired/ pensioner	11.1	2.5	11.8	4	2.5	4.6	7.9	5.8
Housewife	3.7	0.4	4.7	2	0.6	10.1	3.4	2.7
Unemployed	11.1	17.9	4	23.5	28.5	9.2	26.8	22.3
Self-Employed	-	4.3	7.1	2.9	5.8	10.1	3	4.4
Driver	-	-	-	-	0.8	-	0.1	0.2
Tertiary level student	7.4	5.7	11.8	-	-	22.9	3.9	5
Domestic worker	-	-	-	-	0.6	-	0.3	0.2

Table 5.7 presents the results in relation to the employment status of all household members. A third of all household members (33.9%) were too young to be employed (including high school children). It is interesting to note that only 6.4% of the household members in Meer en See belonged to this category. Among the rest, a large proportion of the household members (22.3%) were unemployed, mainly from Empangeni Rail (23.5%), Nseleni (28.5%) and Umhlathuze (26.8%). Unemployment levels are a good indicator of poverty in the communities. The main employment types of household members were professional (8.7%), laborer (6.9%), self-employed (4.4%) and sales (3.3%). Some of the respondents were

retired/ pensioners (5.8%) or students (5%) while the rest were employed in technical professions (2.9%), housewives (2.7%), clerical jobs (2%), managerial (1.7%), craftsmen (0.8%), drivers (0.2%) and domestic workers (0.2%). Similar to patterns discerned in relation to the respondents specifically, higher income jobs were mostly in the middle/ upper income areas while lesser paying jobs were confined to the lower income areas. The results reinforce the economic differentiation within Richards Bay that informed the sampling framework and the disaggregation of the results.

Figure 5.2: If grants and/ or remittances were received by households in the last 12 months (in %, yes responses only)



It is important to note that a significant proportion of households indicated that they received grants (38.7%) and remittances (40.7%) (Figure 5.2). There were more households who received grants (18.8% in Alton, 18% in Aquadene/ Brackenham, 16% in Arboretum, 23.5% in Empangeni Rail, 50% in Nseleni, 15.1% in Meer en See and 57.9% in Umhlathuze) than remittances (12.5% in Alton, 9.8% in Aquadene/ Brackenham, 5.9% in Arboretum, 54.1% in Empangeni Rail, 50% in Nseleni, 15.1% in Meer en See and 57.9% in Umhlathuze) in all communities. For both remittances and grants, more households in poorer areas (specifically Empangeni Rail, Nseleni and Umhlathuze) received grants and remittances. Again, grants and remittances relate very strongly to poverty levels. During the focus group discussions, it was highlighted that the main type of grants were old age pensions and child support grants.

HIV/ AIDS and disability grants were also identified. The importance of remittances (especially linked to migrant labor) is underscored by Posel (2002) while Case *et al.* (2005) and Meintjes *et al.* (2010) highlight the importance of grants among poor households in South Africa. From an air pollution and health perspective, it is interesting to note that while there are several types of grants available to address the needs of the indigent in South Africa, they do not include any assistance or compensation for individuals suffering from air pollution ailments although research indicates that in some cases they can be extremely debilitating and are also carcinogenic.

Table 5.8: Monthly income of respondents after taxes in Rand (in %)

	A (n=16)	**A/B (n=61)**	**Ar (n=68)**	**ER (n=61)**	**N (n=76)**	**MS (n=33)**	**U (n=164)**	**Total (n=479)**
No response/confidential	-	18.8	11.7	-	39.6	6	12	13.5
< 500	-	3.3	-	6.6	2.6	-	7.9	4.4
500 - 1 500	-	14.8	-	32.8	27.6	-	46.7	26.3
1 500 - 2 500	12.5	14	-	29.5	23.7	-	28.6	18.8
2 501 - 5 000	-	-	-	6.6	6.5	3	2.4	3.5
5 001 - 10 000	12.5	19.5	29.5	24.6	-	6.1	2.4	11.5
10 001 – 15 000	37.5	26.3	23.5	-	-	15.1	-	8.9
15 001 – 20000	37.5	3.3	29.4	-	-	30.4	-	7.9
20 001 - 25 000	-	-	-	-	-	24.3	-	3.3
30 000	-	-	5.9	-	-	15.1	-	1.9

The Table above shows the monthly income of respondents with 11.5% of the respondents from all the study areas, excluding Nseleni, earning between R5 001 - R10 000, 3.5% earning between R2 501 – R5 000, 18.8% earning between R1 500 – R2 500, 26% earning between R500 – R1 500, and 4.4% of respondents earning less than R500. Based on the figures displayed in the Table above, only a small percentage of respondents (5.2%) indicated that they earn more than R20 000, 7.9% of respondents said that they earn between R15 001 – R20 000 and 8.9% of the respondents indicated that they earn between R10 001 – R 15 000 a month. Unsurprisingly, respondents who fall in the higher level earning brackets (R10 001 – R30 000) were found to reside in Alton, Aquadene/ Brackenham, Arboretum and Meer en See. The Table also shows that the majority of the sampled population (64.5%) were earning less than R10 000, of which 49.5% earned less than R2 500. These respondents were located mostly in Aquadene/ Brackenham (51.6%), Empangeni Rail (100%), Nseleni (100%), Meer en See (9.1%) and Umhlathuze (88%). Again, the results reflect the differentiation in the economic status of the communities under study.

Table 5.9: Monthly income of household members after taxes in Rand (in %)

	A (n=54)	A/B (n=280)	Ar (n=169)	ER (n=298)	N (n=361)	MS (n=109)	U (n=672)	Total (n=1943)
NA/ no response	55.6	61.4	40.8	50.7	69	45.9	58.6	57.4
< 500	-	3.6	-	13.4	7.8	19.3	9.7	8.4
500 - 1 500	-	8.6	2.4	11.4	12.2	-	18.3	11.8
1 501 - 2 500	11.1	4.6	2.4	14.1	7.5	1	11	8.6
2 501 - 5 000	-	0.7	-	1.3	1.4	1	1.5	1.1
5 001 - 10 000	11.1	10	33.1	6.4	-	7.3	0.6	6.2
10 001 – 15 000	11.1	6.1	11.8	-	-	6.4	0.1	2.6
15 001 – 20000	11.1	5	7.1	-	-	12.8	0.1	2.4
20 001 - 25 000	-	-	-	2.7	2.2	1.8	-	0.9
30 000	-	-	2.4	-	-	4.6	-	0.5

The monthly income of all household members revealed similar patterns to those of the respondents (Table 5.9). Most household members did not have an income (children, students, etc.) or there was no response (57.4%), probably because the respondent did not know what the other member of the household earned. The income levels were also higher in the middle/ upper income areas than the lower income areas.

There are clearly major variations in household income and employment types in Richards Bay, linked in part to the geographical location of communities based on economic and racial groups. This is typical of South Africa societies. As Alemu (2012: 9) states, variations in income are quite common in South Africa (especially in rural and marginalized areas) because of differences in sources of income part of which include “income from wages, salaries and commissions; income from own businesses; income from sales of farm produce and services; income from rents and interest; and finally, income from remittances, pensions and grants”. This was also reinforced during the focus group discussions when respondents stated that many households engage in multiple livelihood generating activities to diversify incomes. One respondent stated, “The members of my household work more than one job, some do laboring jobs during the weekdays and also do gardening on the weekends. My husband sells fresh produce from our garden at the factory that he works for after working hours”. They also indicated that this was necessary given the limited formal, full-time job opportunities available and that when jobs are available they are generally low paying and therefore incomes have to be supplemented. In Umhlathuze, Nseleni and Empangeni the role of agriculture was also highlighted as important, in particular the subsistence production of crops and livestock rearing.

The economic status of households is extremely important in relation to air pollution and health issues. Bernauer and Koubi (2009), Bullard (2000), Buzzelli (2007), Day (2007), Hanchette (2008), Marschall (2008), Morello-Frosch (2002) and Pearce and Kingham (2008) specifically show how socio-economic inequalities impact on health outcomes which are mainly linked to levels of economic deprivation and poverty which appear to be key predictors of adverse health conditions experienced within a population. They also indicate that the poorer segments in society are subjected to a disproportionate share of negative environmental impacts (particularly in relation to air pollution) and have higher levels of exposures to pollutants. Economic status also influence resident location and coping options as indicated by Hunter *et al.* (2003) and elaborated upon later.

The prevalence of HIV/ AIDS that intersects with air pollution-related ailments was also raised during the focus group discussions. The prevalence of HIV/ AIDS in South Africa has been highlighted by several researchers as a major socio-economic and health challenge (Meintjes *et al.*, 2010). Participants during the focus groups indicated that HIV/ AIDS patients are particularly vulnerable to health impacts because of their low levels of immunity. One participant stated, “I am aware of HIV/ AIDS patients who feel considerably worse on days when higher levels of pollutants are recorded”. She stated that this was reported to the health department and RBCAA but not much has been done to examine and deal with these types of issues. This issue was not raised in any of the documents reviewed in this study. It is imperative that air pollution-related health impacts are also examined in relation to other types of diseases prevalent in communities, especially marginalized areas where vulnerabilities are already relatively high.

Table 5.10: Level of education of respondents (in %)

	A (n=16)	**A/B (n=61)**	**Ar (n=68)**	**ER (n=61)**	**N (n=76)**	**MS (n=33)**	**U (n=164)**	**Total (n=479)**
No formal education	-	-	-	-	13.6	-	9	5.1
Nursery	-	3.6	-	-	-	-	-	0.4
Primary	-	10.7	-	11.3	40.9	-	33.5	20.4
Secondary	25	33.9	52.9	26.4	39.4	42.4	52.3	43.4
Tertiary	75	51.8	47.1	62.3	6.1	57.6	5.2	30.6

Almost 31% of all the respondents from the study sampled areas received tertiary education and 43.4% received a secondary level of education (Table 5.10). In Alton, all respondents received secondary education (25%) or tertiary education (75%). This was also found in all respondents of Arboretum and Meer en See with Arboretum: secondary education (33.9%) and tertiary education (47.1%), and in Meer en See: secondary education (42.4%) and tertiary education (57.6%). Twenty percent of the respondents indicated that they attended Primary school while 0.4% indicated that their highest level of education was at the nursery school level. Primary school was attended by 10.7% of respondents in Aquadene/ Brackenham, 11.3% in Empangeni Rail, 40.9% in Nseleni and 33.5% of the respondents in Umhlathuze. Nursery school was attended by 3.6% in Aquadene/ Brackenham. No formal education was attained by 5.1% of respondents, of which 13.6% of the respondents were located in Nseleni and 9% were located in Umhlathuze. As mentioned previously, these areas are predominantly occupied by populations of African descent who were denied access to services, educational opportunities and health care as a result of apartheid policies and a skewed distribution of services.

Table 5.11: Level of education of all household members (in %)

	A (n=54)	**A/B (n=280)**	**Ar (n=169)**	**ER (n=298)**	**N (n=361)**	**MS (n=109)**	**U (n=672)**	**Total (n=1943)**
No response	-	5.4	-	9.4	-	2.8	-	2.4
No formal education	7.4	2.1	-	5.7	5	-	10.3	5.9
Nursery	7.4	5.7	5.3	6	4.7	6.4	9.2	6.9
Primary	3.7	14.6	2.4	17.4	35.7	17.4	34	24.4
Secondary	44.4	43.9	59.1	37.6	49.6	46.8	43.8	45.4
Tertiary	37	28.2	33.1	23.8	5	26.6	2.8	15

In terms of the level of education of all household members, there was no response for 2.4% of the household members and 5.9% had no formal education (7.4% in Alton, 2.1% in Aquadene/ Brackenham, 5.7% in Empangeni Rail, 5% in Nseleni and 10.3% in Umhlathuze) (Table 5.11). Most household members (45.4% and 24.4%, respectively) had secondary level (44.4% in Alton, 43.9% in Aquadene/ Brackenham, 59.1% in Arboretum, 37.6% in Empangeni Rail, 49.6% in Nseleni, 46.8% in Meer en See and 43.8% in Umhlathuze) or primary level (3.7% in Alton, 14.6% in Aquadene/ Brackenham, 2,4% in Arboretum, 17.4% in Empangeni Rail, 35.7% in Nseleni, 17.4% in Meer en See and 34% in Umhlathuze) education. A few (6.9%) who were mainly children had completed nursery level education. Fifteen percent of the household members had tertiary level education (37% in Alton, 28.2% in Aquadene/ Brackenham, 3.1% in Arboretum, 23.8% in Empangeni Rail, 5% in Nseleni, 26.6% in Meer en See and 2.8% in Umhlathuze). Unsurprisingly and similar to the respondents, higher levels of educations were found in middle/ upper income areas compared to lower income areas.

A consideration of the level of education is critically important when addressing health issues in general and air pollution issues more specifically (Briggs *et al.*, 2008; Cubbin *et al*., 2008; Elliot *et al.*, 1999; Krewski *et al.*, 2000; Macintyre *et al*. 2002). The researchers also state that the level of education often influences employment status and income levels. Cubbin *et al.* (2008) further indicate that education level is directly linked to access to health care facilities and that the differences in education levels and employment opportunities among communities (which was evident in Richards Bay) create and reinforce social disadvantage which results in increased vulnerability. The RBCAA representative interviewed as well as policy documents reviewed highlight the importance of educating local communities and also encouraging community members to provide information and assistance with monitoring pollution levels and impacts. However, it is imperative that mechanisms be created to communicate given the appropriate levels of education. A telling example is that many of the pollution reports are highly technical and scientific. However, the RBCAA representative did indicate that more user-friendly materials are developed to communicate with the general public. Additionally, during the focus group discussions respondents stated that community meetings are often held to discuss pollution related issues. However, they did state that the focus was often on “scientific jargon” and “the experts talk in a way that only they can understand”. A few participants stated, “We do not understand when people come to our community to tell us about what they are doing because they use very big words and we do not know the meanings and are too afraid to ask them because they may think that we are stupid”. The air pollution and related health fields are loaded with a range of technical jargon and terms (in relation to types of pollutants, ailments, pollution movement, etc.) as evident in the literature review undertaken.

Table 5.12: Place of employment of respondents (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
Not applicable	12.5	23.7	11.8	32.8	50.8	12.1	41.4	32.3
Close proximity to or from home	-	13.6	-	1.6	13.2	6.1	19	10.9
Brackenham	-	1.6	-	-	-	-	-	0.2
Alton	-	3.3	-	-	-	-	1.2	0.8
Nseleni	-	-	-	-	7.9	-	0.6	1.7
Esikhawini	-	-	-	13.1	-	-	-	1.7
Richards Bay Town	50	44.3	64.7	39.3	13.2	39.4	8.5	29.2
Port of Richards Bay	-	-	-	3.3	2.6	6.1	-	1.3
Mpumalanga	-	-	-	-	-	-	2.4	0.8
Umhlathuze	-	3.3	-	-	-	-	3.7	1.7
Empangeni	-	1.6	17.6	8.2	3.9	18.2	11	9.4
Other areas outside Richards Bay	37.5	8.6	5.8	1.6	7.9	18.2	12.2	10.2

Table 5.12 indicates that 48.1% of the respondents worked in areas within Richards Bay. Specifically, 29.2% of respondents from all the study areas were employed in the Richards Bay Town and 10.9% worked either in their homes or in close proximity to their homes. Other places of employment listed by respondents in Richards Bay were Brackenham (0.2%), Alton (0.8%), Nseleni (1.7%), Esikhawini (1.7%), Port of Richards Bay (1.3%), Mpumalanga (0.8%) and Umhlathuze (1.7%). The place of employment was not applicable for 32.3% of respondents and this corresponded with those who were retired/ pensioners, housewives or unemployed. As anticipated, the highest responses where in Umhlathuze, Esikahweni and Empangeni Rail; the lower income areas. Furthermore, 9.4% of respondents from all communities worked in Empangeni, a town in close proximity (23 km away) to Richards Bay, with the exception of respondents living in Alton. Some of the respondents (10.2%) worked in areas outside Richards Bay, mainly from the economically better off communities of Alton, Aquadene/ Brackenham and Meer en See. During the focus group discussions, it was revealed that most household members who live at home work in Richards Bay or nearby areas which is similar to those of the respondents. It was also stated, as reflected in relation to the higher percentage of households (especially in poorer areas that receive remittances), that many households have members who have migrated to work in other areas. One women participant stated, “My husband left me to raise the children and take care of the home because he could not find a job here and went to work in the city”.

The results indicate that most respondents work within the Richards Bay area and this supports the literature that industrial areas tend to create job opportunities for locals (Cubin and Pedregon, 2008; Jaggernath, 2010; Pulido, 2000). However, the authors also warn that due consideration should be given to the types of jobs created and the working conditions that have serious and long-term health impacts. As already indicated in relation to the income levels (Tables 5.8 and 5.9) and job types (Table 5.7), most employment opportunities in the area tend to be low paying and highly differentiated. However, there is no doubt that in a country where there is dire need for jobs with unemployment rates averaging 25.5% (Statistics South Africa, 2012), local industries and sectors in Richards Bay are creating jobs for local residents as will be discussed in greater detail in this chapter. However, not enough jobs are being created with an unemployment rate of 22.3% among the households surveyed. This is in keeping with provincial and national trends. Furthermore, this is particularly worrying since the demands for jobs (and the promise of employment creation in particular in relation to the industrial sector) results in support for industrial development and pollution (as well as related negative impacts) becoming a necessary evil to promote economic development. Block and Whitehead (1999: 66), as indicated in the literature review, refers to this as the “double edged sword for the poor” as people make tradeoffs to be closer to job opportunities and support job creation, even when there are negative environmental and health consequences.

5.3 Dwelling environment/ conditions

When examining the health status of communities, it is imperative that the conditions in which people live are also assessed since this has a bearing on people’s health and well-being. In this respect, Morello-Frosch and Lopez (2006) indicate that household and community level stressors (of which living conditions are central) influence health outcomes. They particularly identified household crowding as a key variable. Furthermore, Macintyre *et al*. (2002) state that health conditions within a household influence socio-economic stability. Additionally, in the framework provided by Day (2007) to examine ways in which place may be important in experiencing environmental hazards, the relationship between housing and health outcomes were identified as a key component of the materialist landscape.

Figure 5.3: Household dwelling types (in %)

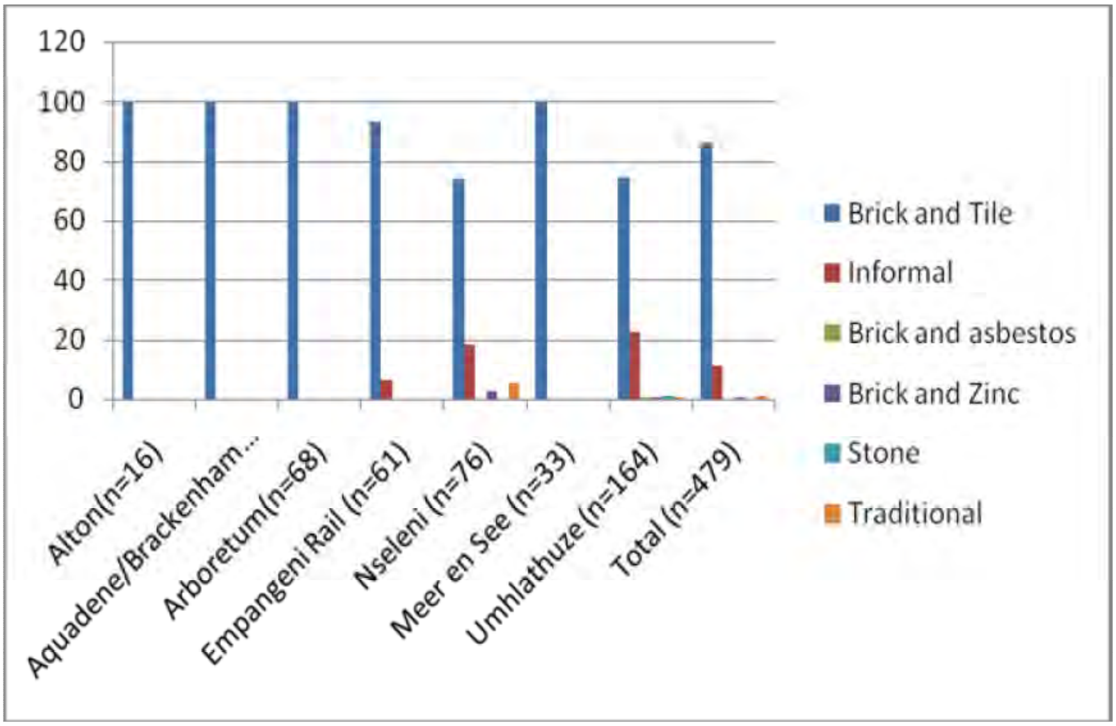


Figure 5.3 shows the composition of dwellings/ dwelling types that respondents live in. The majority of all respondents (86.2%) live in dwellings/ households made from brick and tile: all respondents in Alton, Aquadene/ Brackenham, Arboretum and Meer en See, 93.4% of the respondents in Empangeni Rail, 74.4% of the respondents in Umhlathuze and 73.7% of respondents who reside in Nseleni. The Figure also shows that 11.5% of the respondents live in informal dwellings/ households. Of those who reside in informal households, 22.6% reside in Umhlathuze, 18.4% reside in Nseleni, and 6.6% of the respondents reside in Empangeni Rail. Dwellings constructed with brick and asbestos were reported by 0.2% of the respondents with small proportions for other types: brick and zinc (0.6%), stone (0.4%) and traditional materials (1%). These households are located in Nseleni and Umhlathuze. Poorer communities in South Africa often have informal dwellings and/ or alternate combination materials in terms of dwelling types as shown by Thomas *et al*. (1999). The relatively high percentage of brick homes in lower income areas is also reflective of the housing delivery development projects in South Africa post-apartheid to provide housing to the poor and provide *in situ* upgrading of informal homes.

Table 5.13: Living space within dwelling (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
1 room	-	1.6	-	4.9	6.6	-	20.1	8.8
2 rooms	6.4	6.6	-	24.6	22.4	-	46.3	23.6
3 rooms	25	8.2	26.5	37.7	36.8	9.1	28.7	26.7
4 rooms	50	33.7	30.9	21.3	23.7	30.3	3	20.5
5 rooms	12.5	39.3	17.6	4.9	10.5	42.4	1.2	13.6
6 rooms	6.4	3.3	14.7	4.9	-	9.1	0.6	4.2
7 rooms	-	3.3	5.9	1.6	-	3	-	1.7
8 rooms	-	-	2.9	-	-	3	-	0.6
9 rooms	-	-	1.5	-	-	3	-	0.4
Average number of rooms	**3.9**	**4.3**	**4.6**	**3.2**	**3.1**	**4.9**	**2.2**	**3.3**

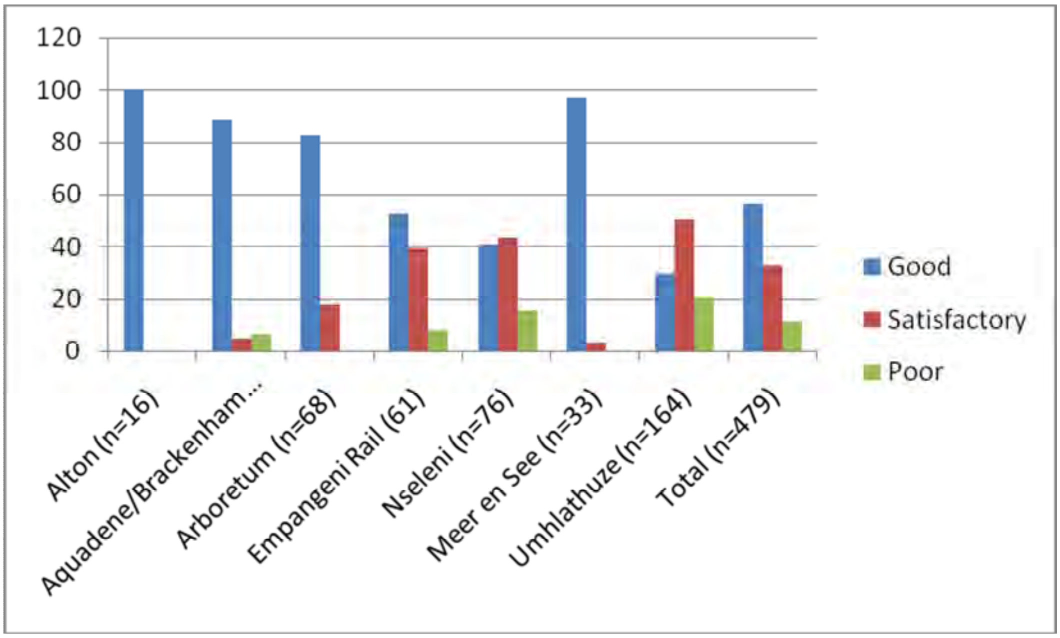
Living space is an important indicator of overcrowding which impacts on health at the household level. Macintyre *et al*. (2002) identify size and quality of home to provide adequate shelter and amenities to provide for a variety of household activities including for food preparation and personal hygiene, location of resident in close proximity to services and employment, and the availability of recreations spaces for members of the households to rest and relax. Spatial crowding using the number of rooms in relation to the number of inhabitants is deemed to be a useful indicator of household quality (Moodley, 2002). From a health perspective, Aldridge (1993), Surjadi (1993) indicate that crowding facilitates the spread of respiratory infection and exacerbates these ailments which are strongly linked to air pollution as indicated in the literature review.

The average number of rooms for all households surveyed was 3.3 rooms with 3.9 rooms in Alton, 4.3 rooms in Aquadene. Brackenham, 4.6 rooms in Arboretum, 3.2. rooms in Empangeni Rail, 3.1 rooms in Nseleni, 4.9 rooms in Meer and See and 2.2 rooms in Umhlathuze (Table 5.13). Clearly, on average, people who lived in middle and upper income areas had more rooms than those who lived in lower income areas. Specifically, in Empangeni Rail, Nseleni and Umhlathuze most respondents indicated that household sizes were less than 4 rooms while in Alton, Arboretum and Meer en See most household sizes were more than 4 rooms. Most dwellings (70.8%) within all the study area consisted of 2 to 4 rooms, while 23.6% dwellings from Alton (6.4%), Aquadene/ Brackenham (6.6%), Empangeni Rail (24.6%), Nseleni (22.4%) and Umhlathuze (46.3%) had 2 rooms and 8.8% of the households from Aquadene/ Brackenham (1.6%), Empangeni Rail (4.9%), Nseleni (6.6%) and Umhlathuze (20.1%) consisted of only 1 room. Additionally, 26.6% of the households had 3 rooms; 25% in Alton, 8.2% in Aquadene/ Brackenham, 26.5% in

Arboretum, 37.7% in Empangeni Rail, 36.8% in Nseleni, 9.1% in Meer en See and 28.7% in Umhlathuze (46.3%). Also, in all study areas, 20.5% of households had 4 rooms; 50% in Alton, 33.7% in Aquadene/ Brackenham, 30.9% in Arboretum, 21.3% in Empangeni Rail, 23.7% in Nseleni, 30.3% in Meer en See and 3% in Umhlathuze. Additionally, 13.6% of the households had 5 rooms (12.5% in Alton, 39.3% in Aquadene/ Brackenham, 17.6% in Arboretum, 4.9% in Empangeni Rail, 10.5% in Nseleni, 42.4% in Meer en See and 1.2% in Umhlathuze). Some of the households interviewed (4.2%) had 6 rooms: 6.4% Alton, 3.3 in Aquadene/ Brackenham, 14.7% in Arboretum, 4.9% in Empangeni Rail, 9.1% in Meer en See and 0.6% in Umhlathuze. A few stated 7 rooms (1.7% with 3.3% in Aquadene/ Brackenham, 5.9% in Arboretum, 1.6% in Empangeni Rail and 3% in Meer en See), 8 rooms (2.9% in Arboretum and 3% in Meer en See) and 9 rooms (1.5% in Arboretum and 3% in Meer en See).

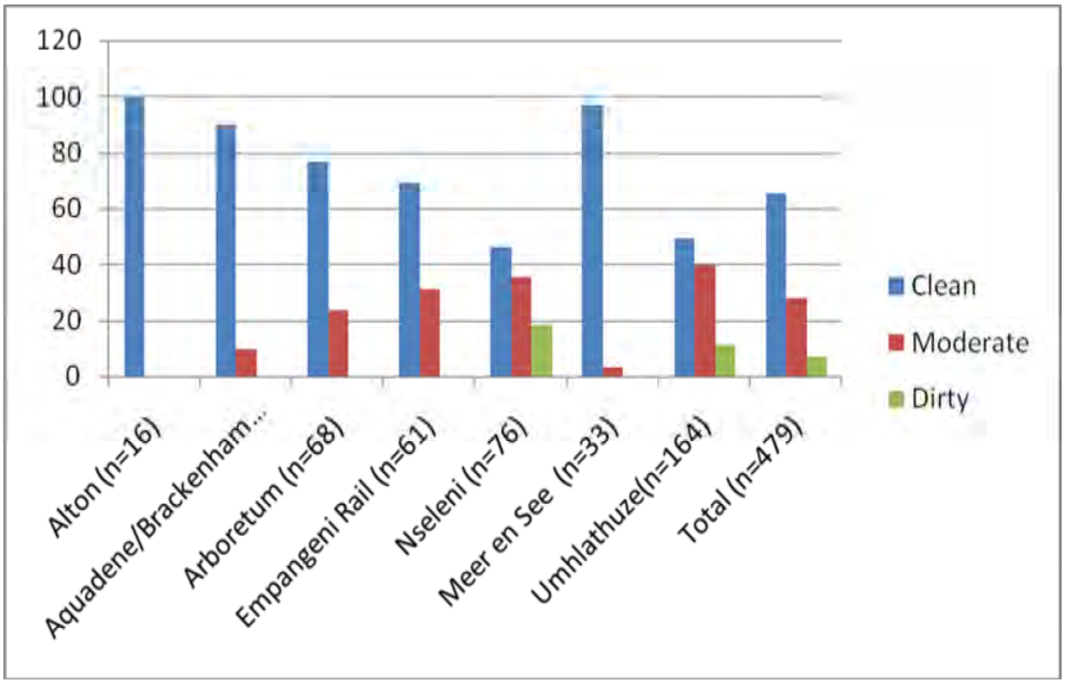
As expected, most respondents in the lower income areas had fewer rooms. The relationship between crowding and poverty is well established as indicated earlier. This study supports this assertion and reveals that overcrowding is most prominent in lower income areas. From observation, it can be noted that the larger number of rooms can be confusing in these areas which are rural and peri-urban. Some properties have homesteads with multiple resident structures for more than one family.

Figure 5.4: Respondents' perceptions of the condition of their dwelling (in %)



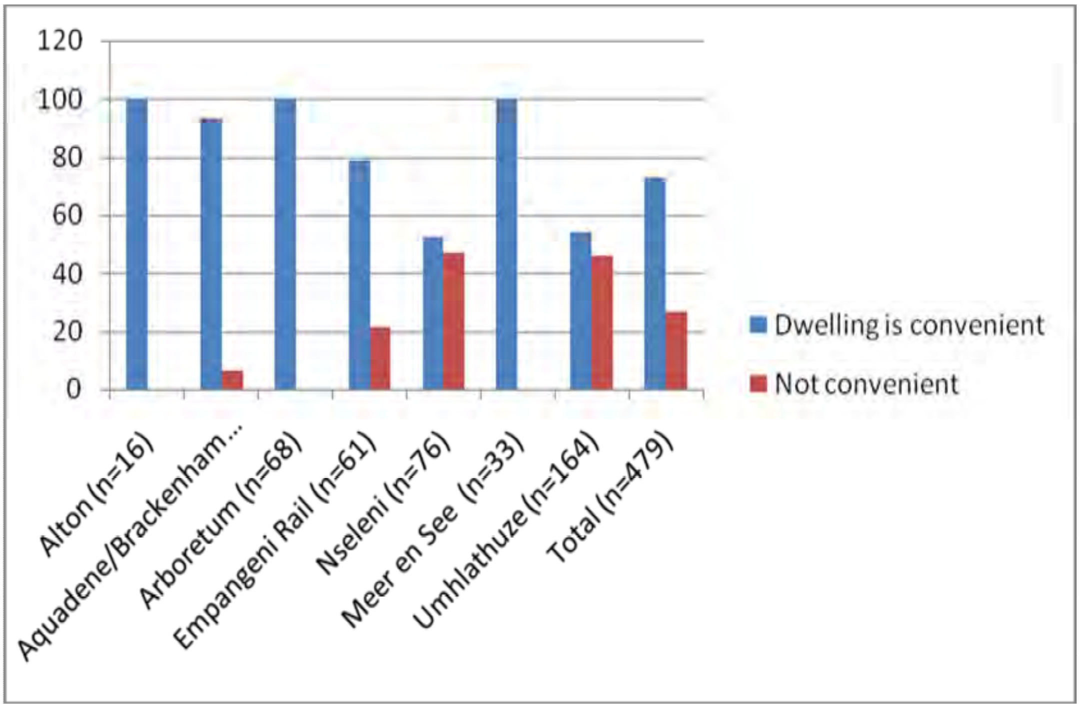
Fifty six percent of all respondents indicated that the condition of their dwelling was good, 32.6% indicated that the condition was satisfactory, while 11.3% indicated that their dwelling conditions were poor (Figure 5.4). Of those who reported that their dwelling type was good, all respondents' dwellings were from Alton, 97% were from Meer en See, 88.5% were from Aquadene/ Brackenham, 82.4% were from Arboretum, 52.5% were from Empangeni Rail, 40.8% were from Nseleni and 29.3% were from Umhlathuze. Respondents in Umhlathuze (50.6%) indicated that their dwellings were satisfactory, while 20.1% indicated that their dwellings were of a poor condition. Additionally, 11.3% of the respondents who indicated that their dwellings were in a poor condition, 6.6% were located in Arboretum/ Brackenham, 8.2% in Empangeni Rail, 15.8% in Nseleni and 20.1% in Umhlathuze. The Chi-square test revealed that there is a significant relationship (p=0.000) between location and respondent's perceptions of their housing conditions. The results show that generally respondents who were dissatisfied with the condition of the housing were from lower income areas. However, it is interesting to note that the majority of respondents in all communities rated the condition of their dwelling as either good or satisfactory showing that respondents were generally happy with the condition of the housing. Jaggernath (2010) states that perceptions of the conditions of housing are often more an indication of place attachment with the home as well as the community.

Figure 5.5: Respondents' perceptions of housing environment (in %)



Respondents housing environments were considered to be clean by 65.3% of the respondents, moderate by 28% of respondents and in a dirty condition by 6.7% of all respondents (Figure 5.5). All households in Alton, 90.2% respondents from Aquadene/ Brackenham, 90% from Meer en See, 76.5% from Arboretum, 68.9% from Empangeni Rail, 49.4% from Umhlathuze and 46.1% from Nseleni were reported as being clean. Dirty housing environments were reported by 18.4% in Nseleni and 11% in Umhlathuze. Again, as was discernible in relation to perceptions pertaining to the condition of housing, there is generally a positive attitude towards respondents' housing environments. It seems that respondents have a higher positive attitude towards their home but not the broader community in which they live. This could certainly be linked to the high levels of industry in Richards Bay. The Chi-square test undertaken to examine whether the location of the community influenced perceptions of housing conditions and environments showed that there was a significant relationship (p=0.001). This is unsurprising given the different environmental conditions in the communities.

Figure 5.6: Convenience of dwelling to cater for respondents needs (in %)



Seventy three percent of the total respondents indicated that their dwellings cater for their needs, whilst 27% of the total respondents felt that their dwellings did not sufficiently cater for their needs (Figure 5.6). Of those who reported that their dwelling did not cater for their needs, 47.4% lived in Nseleni, 46% lived in Umhlathuze, 21.3% lived in Empangeni Rail and 6.6% lived in Aquadene/ Brackenham. Generally, more respondents who resided in lower income areas did not feel that the dwelling catered for their needs. Furthermore, respondents in dwellings with fewer rooms indicated that they did not feel that the housing catered for their needs. Thus, the extent of crowding experienced may be an influential factor. However, it is important to note that the responses again reinforce a level of satisfaction among most respondents in relation to whether they felt that the dwelling they occupy caters to their needs. It is worth highlighting that when the Chi-square test was performed in relation to the responses and community location, a significant relationship was found (p=0.004) which indicates that location appears to influence respondent perceptions. An examination of the cross-tabulations revealed that lower income locations had a higher level of responses that indicated that dwellings did not cater for their needs than middle/ upper income areas. These respondents suggestions on the changes required to improve their dwellings are presented below.

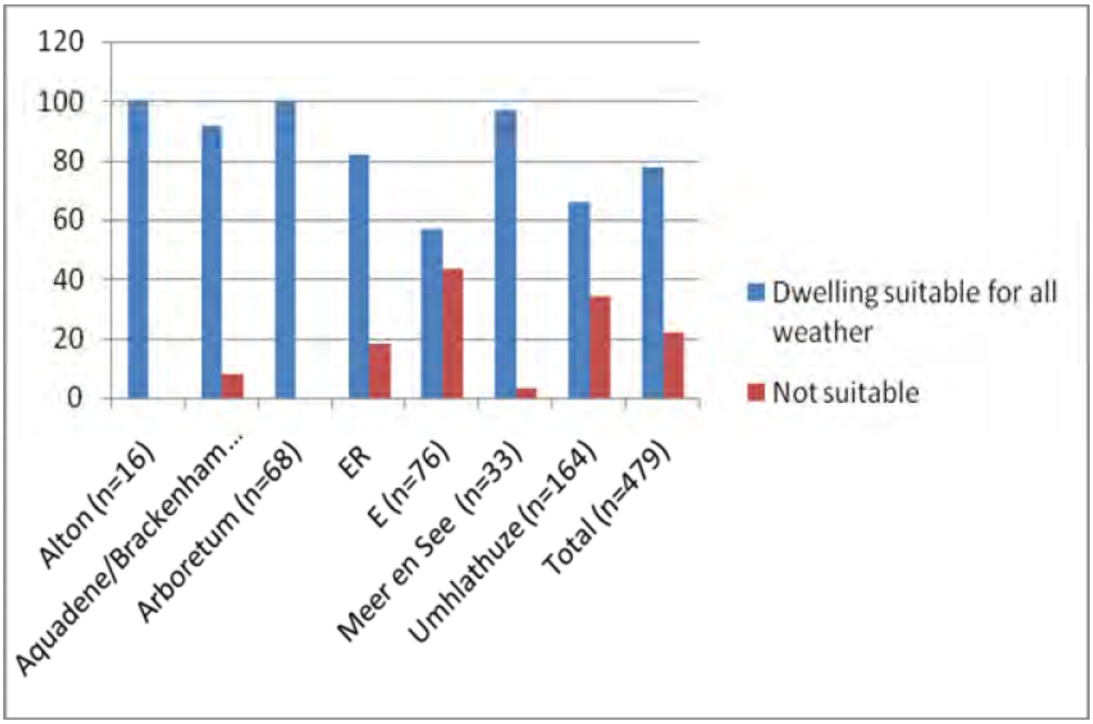
Table 5.14: Changes required to improve dwelling (in %)

	A/B (n=4)	ER (n=13)	N (n=36)	U (n=75)	Total (n=128)
Add more rooms/ increase size of dwelling	50	76.9	44.4	64	59.5
Renovate the roof	-	15.4	11.1	8	9.4
Renovate the house	50	17.7	30.6	11.1	14.1
Provide basic services	-	-	-	2.7	1.6
Improve ventilation	-	-	-	2.7	1.6
Clean surrounding environment	-	-	-	11.1	3.1
Build a toilet	-	-	-	1.3	0.8
Buy furniture	-	-	-	2.7	1.6
Improve living standards	-	-		8	4.7
Build a new house	-	-	8.3	-	2.3
Move out of the area	-	-	5.6	-	1.6

Table 5.14 reveals that the most prominent suggestion was the need to have more rooms added to the dwellings (59.5% in total): 50% from Aquadene/ Brackenham, 66.9% from Empangeni Rail, 44.4% from Nseleni and 64% from Umhlathuze. This supports earlier findings that reveal that respondents residing is dwellings with fewer rooms were more likely to be dissatisfied with their properties. An option to renovate the dwellings were listed by 14.1% of respondents from Aquadene/ Brackenham, Empangeni Rail, Nseleni and Umhlathuze, while 9.4% of respondents from Empangeni Rail, Nseleni and Umhlathuze indicated that their dwelling roofs need to be renovated. In Nseleni and Umhlathuze, 12.5% of the respondents indicated that increasing the size of the dwellings is necessary to improve

the dwellings. Respondents from Umhlathuze (28.5%) expressed the need for basic services (1.6%), improved ventilation (1.6%), a clean surrounding environment (3.1%), building a toilet (0.8%), buying furniture (1.6%) and an improved living standard (4.7%). A few of the respondents (8.3%) from Nseleni felt that they would need to build a new house and 5.6% said that they would need to move out of the area as opposed to improving the condition of the dwelling. The results indicate that most of the suggestions related directly to the quality of the homes and general living standards/ quality of life issues with only a few respondents from Nseleni insinuating that the location was a problem since only in this area did some of the respondents stated that they wanted to move out. Some environmental issues were identified including improved ventilation and cleaning the surrounding environmental. However, it is important to note that most of the suggestions forwarded relate to conditions in the home that influence environmental quality of the dwelling that can affect health.

Figure 5.7: Suitability of dwelling for all weather types (in %)



Macintyre *et al*. (2002) identified that a key function of adequate housing is protection and shelter from weather and pests. Figure 5.7 shows that 77.9% of the respondents reported that they their dwelling types were suitable for all weather types, of which all was in Alton and Arboretum, 97% was in Meer en See, 91.8% was in Aquadene/ Brackenham, 82% was in Empangeni Rail, 6.9% was in Umhlathuze and 56.6% was in Nseleni. The rest of the respondents (22.1%) stated that their dwellings were not suitable for all weather conditions. These dwellings were located in Nseleni (43.4%), Umhlathuze (34.1%), Empangeni Rail (18%), Aquadene/ Brackenham (8.2%) and Meer en See (3%). A closer examination of the data revealed that the few respondents from Aquadene/ Brackenham and Meer en See were from lower income groups in these locations. Again, the unsuitability of the dwelling for all weather types was generally in the lower income areas and resonate with the quality of the dwelling and levels of poverty. The Chi-square test indicates that there was a statistically significant relationship between location and suitability of the dwelling for all weather types ($p=0.002$) supporting the assertion that socio-economic attributes influence perceptions of suitability.

Table 5.15: Problems experienced in dwelling due to weather (multiple responses, in %)

	A/B (n=5)	ER (n=11)	N (n=33)	MS (n=1)	U (n=56)	Total (n=106)
Affected by rain and wind	-	-	9.1	-	3.6	4.7
Flooding	-	-	-	-	7.1	3.8
Gets too hot	-	54.5	-	-	16.1	14.2
Gets too cold	40	-	9.1	-	3.6	6.6
Leaks during rain	80	45.5	69.7	100	57.1	61.3
Part of the dwelling collapses with strong wind	-	-	-	-	10.7	5.7
Poor rain water drainage system	-	-	-	-	14.3	7.5
Poor ventilation	-	-	-	-	3.6	1.9
Broken windows	-	-	27.3	-	-	8.5

Table 5.15 shows that of the total respondents who indicated that that they experienced problems in the dwelling as a result of bad weather conditions, 61.3% indicated that their dwellings leak during rain fall, 14.2% felt that their dwellings retain heat in hot conditions, 8.5% said that their windows break during extreme weather conditions, 7.5% of respondents (14.3% in Umhlathuze) said that they have poor rain water drainage systems and 4.7% indicated that they are affected by rain and wind (9.1% in Nseleni and 3.6% in Umhlathuze). A small percentage of the respondents (1.9%) indicated that they have poor ventilation in the dwelling, 6.6% felt that their dwellings get too cold, 3.8% said that they experience flooding in the household and 5.7% of the respondents (3.6% in Umhlathuze) indicated that parts of their dwellings collapse with strong wind. One respondent in Meer en See, 80% in Alton, 45.5% in Aquadene/ Brackenham, 69.7% in Empangeni Rail, and 57.1% in Umhlathuze indicated that their dwellings leak during rain fall. Almost 55% of the respondents in Empangeni Rail and 16.1% in Umhlathuze indicated that their dwellings retain heat and become too hot, 40% of respondents in Alton, 9.1% in Empangeni Rail and 3.6% in

Umhlathuze said that their dwellings become too cold, while 7.1% of the respondents in Umhlathuze indicated that their dwellings are prone to flooding and 27.3% in Nseleni experience broken windows. The data indicates that most of the respondents in Umhlathuze identified at least one of the problems listed with their dwelling with the exception of broken windows. The majority of respondents who indicated that their dwellings leak in rainy conditions are located in Nseleni (69.7%) and Umhlathuze (57.1%). It is worth highlighting that some of the problems identified (such as poor ventilation and broken windows) can exacerbate air pollution impacts, increasing susceptibility to health-related ailments. In particular, being able to close windows properly is identified by Briggs *et al*. (2008) as a key way in which households reduce exposure to pollutants.

5.4 Availability of services at the household level

The availability of proper services at the household level has an obvious impact on health. In particular, access to water and sanitation as well as energy sources are deemed to be the two main services which are examined in this section. From an air pollution and health perspective, the type of energy sources used at the household level can impact on air quality and have been known to have severe consequences on health and well-being. Additionally, high levels of air pollutants can pollute water sources from particulate matters and undermine the health of households that use multiple sources of water, some of which could be contaminated. This is supported by Kawachi and Berkman (2003) who also indicate that the close proximity of industries also pollute water sources directly since industrial waste/ discharge is often dumped into water sources and pollutants seep into ground water sources as well. Thus, industries have a direct and indirect impact on water quality.

5.4.1 Water and sanitation

Butala *et al.* (2010), Hubbard *et al.* (2011), Mara (2003), Moodley (2002) and Whittington *et al.* (2012) state that the availability of piped water and proper sanitation has an obvious health impact and communities that do not have proper water sources are more likely to be prone to illness and disease. Whittington *et al.* (2012) specifically state that addressing water and sanitation issues are key priorities for preventative health interventions in developing countries. Additionally, Butala *et al.* (2010) illustrate that water and sanitation are key to achieving the MDGs. As indicated earlier, air pollutants can contaminate water sources and there is a strong link between water and air pollution (Rowe, 2011).

Table 5.16: Sources of drinking water available to household (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	E (n=76)	MS (n=33)	UV (n=164)	Total (n=479)
Tap	100	100	100	100	92.1	100	95.1	97.1
Tank	-	-	-	-	7.9	-	3.7	2.5
River/stream	-	-	-	-	-	-	1.2	0.4

Table 5.16 indicates that a tap was identified as the main source of drinking water in the household by 97.1% of the respondents, while 2.5% of respondents indicated that they have access to a tank and 0.4% reported that their primary source of drinking water was from the river or stream. Respondents who had access to a water tank resided in Nseleni (7.9%) and Umhlathuze (3.7%). Furthermore, 1.2% of the respondents in Umhlathuze reported that their primary source of drinking water was from a river or stream. These areas are more rural and have poor locations. Two key aspects emerged during the focus group discussion that are relevant to the above findings. Firstly, the respondents indicated that tap supply of water for many in areas such as Empangeni Rail, Nseleni and Umhlathuze included a tap on the property, standpipes and communal boreholes. Water is collected from these sources and often can become contaminated because of exposure to airborne pollutants or improper transportation of the water, including the containers that are used. Secondly, many households in the communities mentioned using multiple sources of water supply despite tap water being their main source. Nearby dams and rivers/ streams were identified as natural sources of water and some households also engaged in rainwater harvesting on their properties. The water was generally used for non-drinking purposes and included washing clothes and other cleaning purposes, watering gardens and for livestock. One participant stated that these sources are used by some households for drinking purposes and most households in the areas use these available sources if taps break (which is experienced regularly in relation to communal taps) or when water is disrupted. Thus, households in poorer communities are exposed to the possibility of air pollution-related contamination of water supplies used in the household.

Table 5.17: Water storage facilities in household (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	E (n=76)	MS (n=33)	UV (n=164)	Total (n=479)
Not applicable (use private taps)	100	96.7	100	90.2	89.5	100	85.4	91.6
Tank	-	3.3	-	9.8	10.5	-	14	8.1
Plastic buckets	-	-	-	-	-	-	1.2	0.4

The mode of storage of water in households is an important component in any health survey. Stephens and Harpham (1991) indicate that poor water storage facilities impact negatively on health and increase environmental risk factors for households. Almost all the respondents (91.6%) of the respondents indicated that they do not have to have a water storage facility in their household as they have access to taps, whilst 8.1% indicated that they store water in tanks in the household and 0.4% use plastic buckets (Table 5.17). The use of tanks to store water in households were reported by 14% of the respondents from Umhlathuze, 10.5% from Nseleni, 9.8% from Empangeni Rail and 3.3% from Aquadene/ Brackenham. In Umhlathuze, only 1.2% of the respondents indicated that they use plastic buckets to store water in their households. While storage facilities are not widely used in the communities under study, it is worth recounting the focus group discussions that indicated that natural sources are used directly and households use other sources when tap water supply is disrupted.

Table 5.18: Whether respondents travelled to obtain water (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
N/A / available in household	100	100	100	100	84.2	100	78.7	91
Travelled to obtain water	-	-	-	-	15.8	-	21.3	9

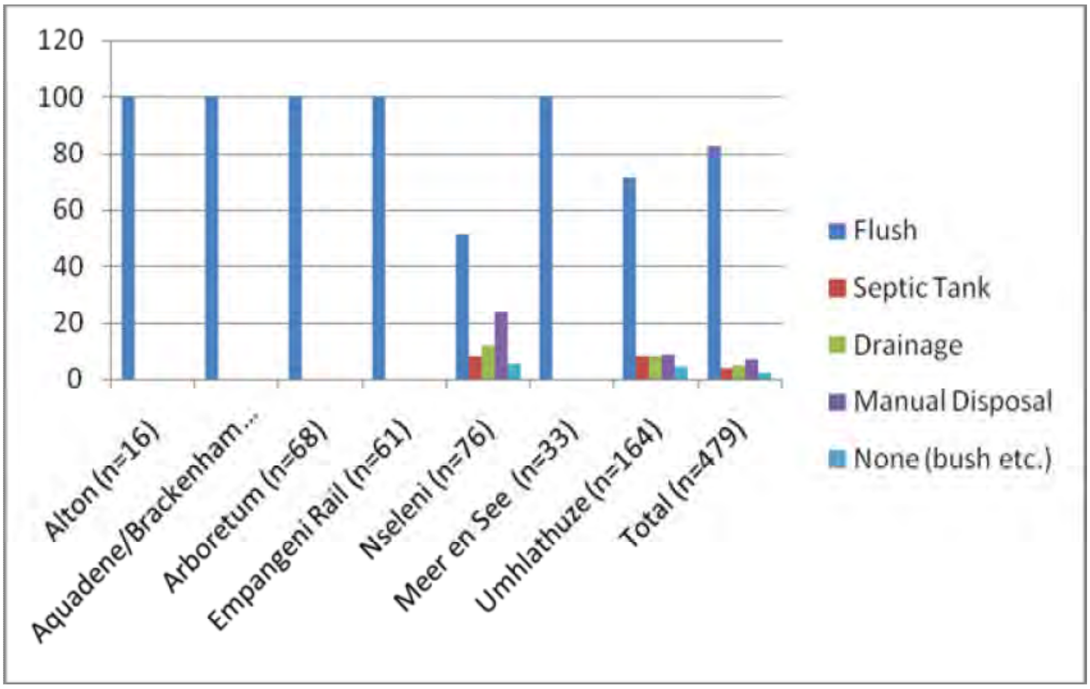
Ninety one percent of the respondents reported that they did not need to travel to obtain water as they had access to private taps in the household or to a public tap close by to their households, while 9% of the respondents in Nseleni (15.8%) and Umhlathuze (21.3%) traveled to obtain water (Table 5.18).

Table 5.19: Distance travelled by respondents to obtain water (in %)

	N (n=12)	U (n=35)	Total (n=47)
< 1 km	100	31.5	49
1-2 km	-	48.6	36.1
3-5 km	-	20	14.9

Of those who travelled to obtain water, all of the respondents from Nseleni and 31.5% from Umhlathuze had to travel less than 1 km to obtain water while the rest in Umhlathuze stated that they needed to travel between 1-2 km (48.6%) and between 3-5 km (20%) to obtain water (Table 5.19). In Umhlathuze most of the respondents travelled more than a km to obtain water. This could expose those who collect water to air pollution-related ailments. During the focus group discussions it emerged that it is mainly women and children in the community that are water carriers. It was observed during field visits that women and children generally carried water containers on their heads and as indicated by Moodley (2002), this practice could lead to present and future health problems such as head and spinal injuries with symptoms such as headaches and backaches. Headaches are already a symptom of air pollution ailments (Manahan, 1997) that can be worse among women and children who are burdened with having to transport water for household use. The literature review showed that this group is the most vulnerable to environmental and health hazards. Their reproductive roles reinforce this vulnerability.

Figure 5.8: Toilet facility in household (in %)



Ashton (1992), Govender *et al.* (2011), Konteh (2009) and Mara (2003) highlight the importance of sanitation facilities in relation to environmental and human hygiene and well-being. A flush toilet facility was reported by 82.5% of the respondents, including all respondents from Alton, Aquadene/ Brackenham, Arboretum, Empangeni Rail and Meer en See, while 71.3% of the respondents were from Umhlathuze and 51.3% were from Nseleni (Figure 5.8). A septic tank was available in 7.9% of households in Nseleni and 7.9% of households in Umhlathuze. Eleven percent of households in Nseleni and Umhlathuze reported having either a drainage system (4.6%) or using manual disposal (6.7%), while 2.3% of households did not have access in these areas to any toilet facility and used the bush or other nearby facility. The results again reveal the vulnerability of poor households to unhygienic conditions with inadequate sanitation facilities being found only in Nseleni and Umhlathuze. When overcrowding is also considered, the health impacts are likely to be worse. The lack of proper sanitation facilities can lead to a spread of infectious diseases. The manual disposal of waste (burying) and use of nearby bushes by some of the respondents are particularly disconcerting as these become the breeding ground for pests. Furthermore, when waste is not properly disposed off, the environment (land and water) can be polluted.

Table 5.20: Availability of public toilet facility (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
Not applicable/ do not use of need	25	3.3	64.7	-	-	69.7	0.6	15.4
Yes	-	4.9	-	-	28.9	3	10.4	9
No	75	91.8	35.3	100	71.1	27.3	89	75.6

Nine percent of the total population sampled in all areas indicated that there was a nearby public toilet facility available, however, 75.6% reported that there was no public toilet facility available in their communities (Table 5.20). Of the respondents who indicated that there was a public toilet facility, 28.9% reside in Nseleni, 10.4% of the respondents reside in Umhlathuze, 4.9% live in Aquadene/ Brackenham and 3% of the respondents live in Meer en See. Some of the respondents (15.4%) stated that they do not need or use public toilets, mostly in the middle/ upper income areas of Arboretum (64.7%) and Meer and See (69.7%). It is interesting to note that public toilets were found mostly in the lower income areas. Butala *et al.* (2010) underscore the importance of proper public toilets or sanitation facilities to improve outcomes in poor communities. They specifically focus on the upgrading of urban slums in Ahmedabad, India but their findings are relevant in the South African context as well.

Table 5.21: Distance to nearest public toilet facility (in %)

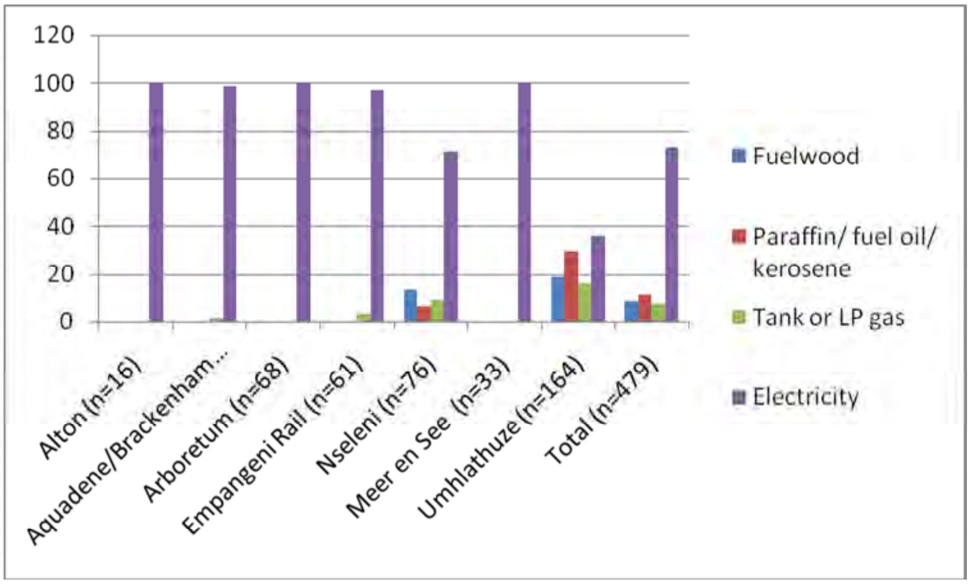
	A/B (n=3)	N (n=22)	U (n=17)	Total (n=43)
< 1 km	100	81.8	100	90.6
3 km – 5 km	-	18.2	-	9.4

Among those respondents who indicated that public toilet facilities were available, almost all (90.6%) stated that these were located less than 1 km away from their place of residence (Table 5.21). Only 18.2% of the respondents in Nseleni stated that the public toilet facility was 3 to 5 km away. The results show that the facilities are generally close to households which is positive from a health perspective since people will be more likely to use them. However, the use of public toilet facilities is not without their problems. As indicated during the focus group discussions, community members are weary of using public toilets because of concerns over safety, particularly among women. One participant stated, “There has been a recent incident of rape in one of the public toilets”. Another participant reported, “It is not safe to use public toilets because there have been too many cases of muggings and beatings”. If need be, participants indicated that community members prefer to use the nearest bush to their homes.

5.4.2 Main Source/s of Energy and Lighting in the Household

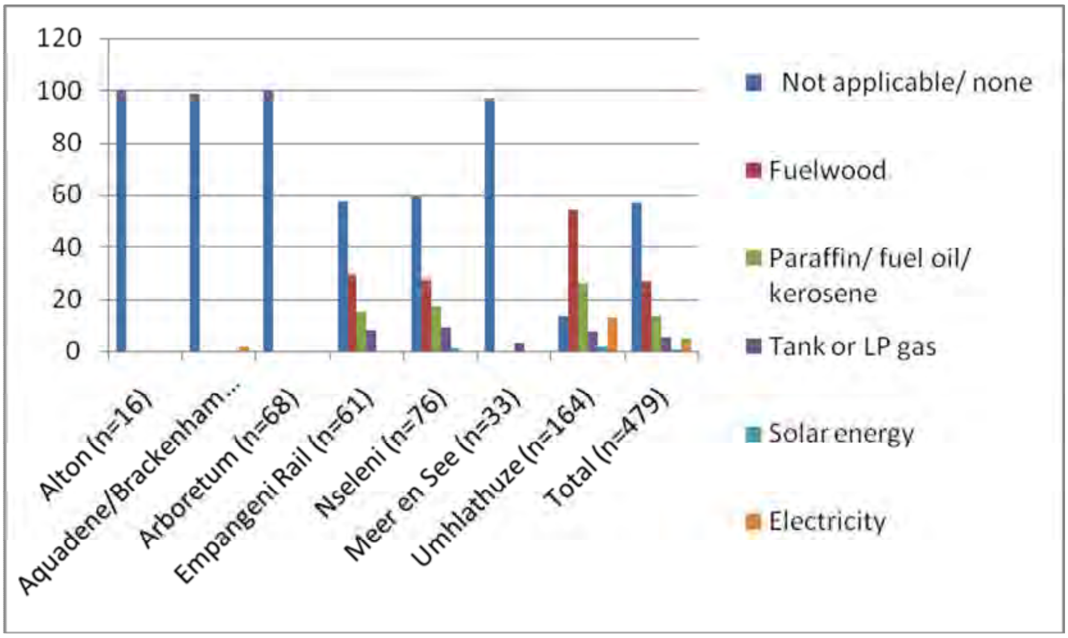
The literature clearly illustrated the linkages between energy sources and indoor air pollution in households that rely on fuel-based sources such as fuelwood, paraffin, gas and candles (Karekezi and Kithyoma, 2002; Sagar, 2005). These are generally cheap, unsustainable sources of energy. Energy use at the household level is mainly for cooking, lighting and heating (Karekezi and Kithyoma, 2002). This sub-section examines these uses in relation to the main energy sources, location/ storage of energy source and place where energy source is used. The analysis is confined to these aspects which were included in the survey since they relate to air pollution and health impacts. The Figure below illustrates the main energy sources for cooking.

Figure 5.9: Main source of energy for cooking (in %)



Electricity was the main source of energy used by 72.9% of the respondents from all study areas for cooking (Figure 5.9). However, only 36% of respondents from Umhlathuze indicated that their main source of energy for cooking is electricity. Other sources of energy used for cooking in Umhlathuze were wood (18.9%), utility gas/ fuel oil/ kerosene (29.3%) and tank of LP gas (15.9%). In Nseleni, 13.2% of respondents used fuelwood, 6.6% used paraffin/ fuel oil/ kerosene and 9.2% used tank or LP gas for cooking. All respondents in Alton, Arboretum and Meer en See used electricity, while 1.6% of respondents from Aquadene/ Brackenham used tank or LP gas for cooking and 3.3% of the respondents from Empangeni Rail used tank or LP gas as their main source of energy for cooking. Figure 5.10 indicates that most households had multiple sources of energy for cooking, particularly in the lower income areas.

Figure 5.10: Other sources of energy used for cooking (Multiple responses, in %)



The other main sources of energy used for cooking was fuelwood (26.7%), paraffin/ fuel oil/ kerosene (13.6%) and tank or LP gas (5.6%) (Figure 5.10). A few households used electricity (4.6%) and solar energy (0.8%) as an additional source. All the respondents in Alton (100%), Aquadene/ Brackenham (98.4%), Arboretum (100%) and Meer en See (97%) did not use other energy sources for cooking. In the other communities a range of other sources were used. Specifically, in Empangeni Rail, 29.5% of the respondents used fuelwood, 14.8% used paraffin/ fuel oil/ kerosene and 8.2% used tank or LP gas. In Nseleni, 27.3% of the respondents used fuelwood, 17.1% used paraffin/ fuel oil/ kerosene, 9.2% used tank or LP gas and 1.3% used solar energy. In Umhlathuze, 54.3% of the respondents used fuelwood, 26.2% used paraffin/ fuel oil/ kerosene, 7.3% used tank or LP gas and 1.8 used solar energy. The use of cheaper fuels and natural resource-based fuels are clearly discernible in poorer communities, especially the rural areas.

Table 5.22: Location/ storage of energy source for cooking (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
In the yard	-	-	-	-	13.2	-	17.1	7.9
In the home (kitchen)	-	21.3	-	3.3	40.8	-	61.6	30.7
In the home (other than kitchen)	-	-	-	-	-	-	1.8	0.6
Outside the homestead/ yard	-	-	-	-	6.6	-	2.4	1.9
Not applicable (does not have to be stored such as electricity)	100	78.7	100	96.7	39.5	100	17.1	58.8

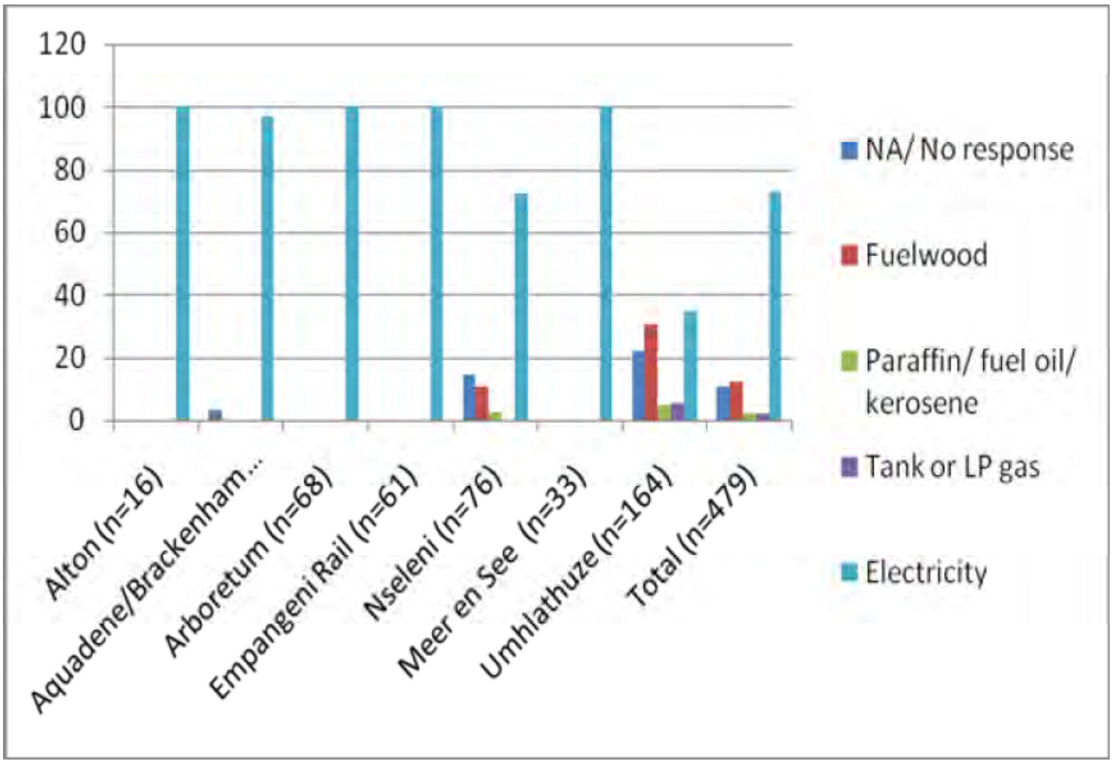
The energy source used for cooking was stored by 30.7% of the respondents from Aquadene/ Brackenham, Empangeni Rail, Nseleni and Umhlathuze in the home (kitchen), while 7.9% of the respondents indicated that they stored the energy source in the yard, 1.9% said that the energy source was located outside the homestead and 0.6% indicated that they stored the energy source in the home (room other than the kitchen) (Table 5.22). All respondents from Alton, Arboretum and Meer en See did not need to store the energy source as they used electricity exclusively.

Table 5.23: Place where energy source for cooking is used (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
N/A/ no response	25	3.3	5.9	3.3	-	-	-	2.5
Outside the home	-	-	-	-	6.6	-	11	4.8
In the kitchen	12.5	83.6	82.4	96.7	90.8	100	86.6	86
Throughout the home	62.5	13.1	11.8	-	2.6	-	2.4	6.7

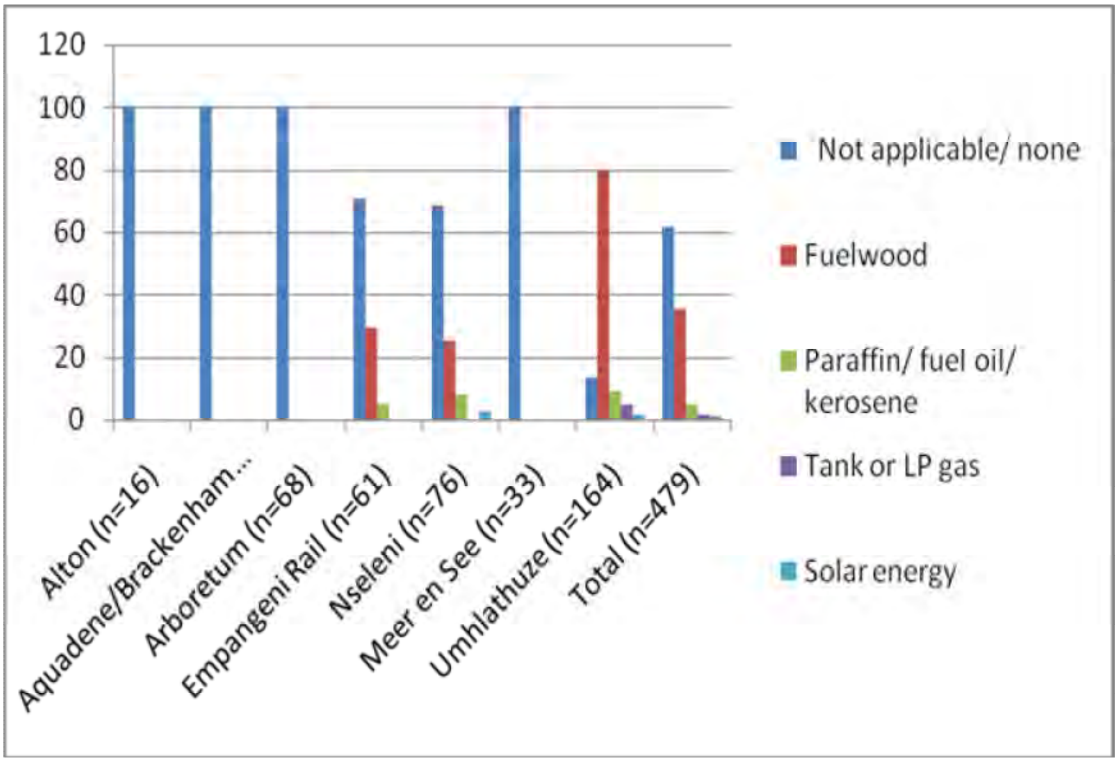
Eighty six percent of the respondents from all the study areas indicated that cooking using the source of energy was done in the kitchen inside the home, 4.6% indicated that they used the source of energy for cooking throughout the home and 4.8% of respondents said that they use the energy source for cooking outside the home (Table 5.23). No response/ not applicable was obtained from 2.5% of the respondents from Alton, Aquadene/ Brackenham, Arboretum and Empangeni Rail.

Figure 5.11: Main source of energy for heating (in %)



The main source of energy used by 72.9% of respondents from all study areas, excluding Umhlathuze, for heating was electricity. In Umhlathuze, 34.8% of respondents indicated that their main source of energy used for heating is electricity (Figure 5.11). Other sources of energy used for heating in Umhlathuze were fuelwood (30.5%), paraffin/ fuel oil/ kerosene (4.9%) and tank of LP gas (5.5%). In Nseleni, 10.5% of the respondents used fuelwood as the main source of heating and 2.6% used paraffin/ fuel oil/ kerosene. All respondents in Alton, Arboretum and Meer en See used electricity for heating. Some of the respondents (10.6% from Aquadene/ Brackenham, Nseleni and Umhlathuze) did not disclose their main source of energy that was used for heating, probable because they did not use energy for heating purposes.

Figure 5.12: Other sources of energy used for heating (Multiple responses, in %)



The other sources of energy used for heating was fuelwood (35.1%), paraffin/ fuel oil/ kerosene (5%), tank or LP gas (1.7%) and solar energy (1%) (Figure 5.12). All the respondents in Alton, Aquadene/ Brackenham, Arboretum and Meer en See did not use other energy sources for heating. In the other communities fuelwood (29.5%) and paraffin/ fuel oil/ kerosene (4.9%) was used in Empangeni Rail. In Nseleni, 25% of the respondents used fuelwood, 7.9% used paraffin/ fuel oil/ kerosene and 2.6% used solar energy. In Umhlathuze, 79.9% of the respondents used fuelwood, 9.1% used paraffin/ fuel oil/ kerosene, 4.9% used tank or LP gas and 1.8 used solar energy. Thus, similar trends are discernible to cooking.

Table 5.24: Location/ storage of energy source for heating (in %)

	A (n=16)	**A/B (n=61)**	**Ar (n=68)**	**ER (n=61)**	**N (n=76)**	**MS (n=33)**	**U (n=164)**	**Total (n=479)**
No response	25	9.8	11.8	3.3	17.1	-	22	14.4
In the yard	-	-	-	-	10.5	-	28.7	11.5
In the home (kitchen)	-	6.6	-	-	11.8	-	7.3	5.2
In the home (other than kitchen)	-	14.8	-	-	9.2	-	7.9	6.1
Outside the homestead/ yard	-	-	-	-	-	-	2.4	0.8
Not applicable (does not have to be stored such as electricity)	75	68.9	88.2	96.7	51.3	100	31.7	62

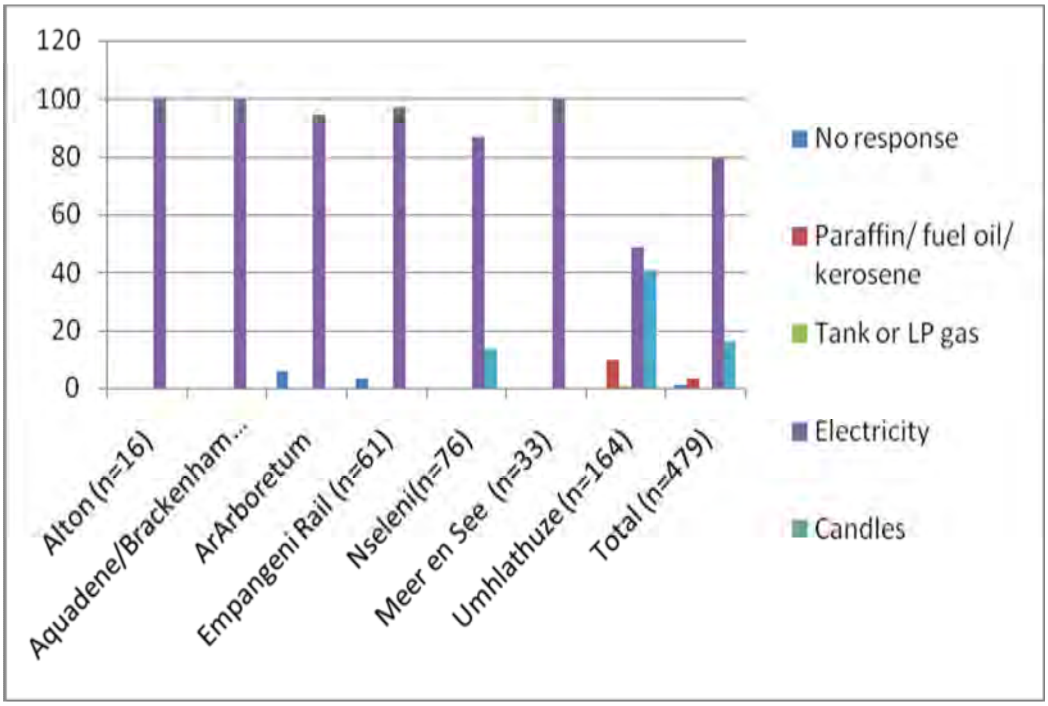
The energy source used for heating was stored by 11.5% of the respondents, from Nseleni (10.5%), and Umhlathuze (28.7%), in the yard (Table 5.24). Six percent of respondents indicated that they stored the source used for heating in the home (room other than the kitchen), while 5.2% of the respondents said that they stored the energy source in the kitchen. Only 0.8% of the respondents from Umhlathuze (2.4%) said that they stored the heating source in the yard. All respondents from Meer en See indicated that they did not need to store the energy source that is used for heating as they used electricity. No response was received from 14.4% of respondents. Not applicable was indicated by 62% of the respondents who used only electricity.

Table 5.25: Place where energy source for heating is used (in %)

	A (n=16)	**A/B (n=61)**	**Ar (n=68)**	**ER (n=61)**	**N (n=76)**	**MS (n=33)**	**U (n=164)**	**Total (n=479)**
N/A/ no response	25	6.6	5.9	3.3	17.1	-	22	13.2
Outside the home	-	-	-	-	-	-	28	9.6
In the kitchen	-	6.6	5.9	57.4	18.4	-	15.9	17.3
Throughout the home	75	86.9	88.2	39.3	64.5	100	34.1	59.9

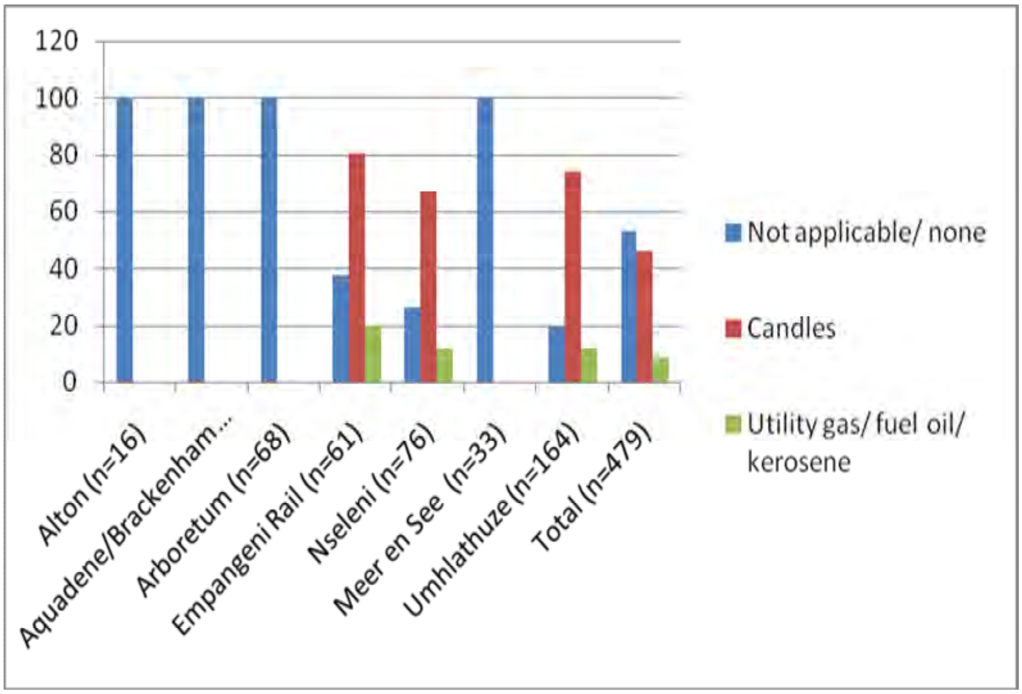
The energy source used for heating was used throughout the home by 59.9% of respondents, while 17.3% of the respondents indicated that they used the heating source only in the kitchen and 9.6% indicated that they used the heating source outside the home (Table 5.25). No response/ not applicable was obtained from 13.2% of the respondents from all the study areas except for Meer en See as all respondents in this area indicated that the energy source used for heating was used throughout the home.

Figure 5.13: Main source of energy for lighting (in %)



Electricity was the main source of energy that was used for lighting by 79.1% of the respondents from all study areas (excluding Umhlathuze where 48.8% of the respondents indicated that they used electricity) (Figure 5.13). Candles were indicated as the main source of lighting by 13.2% of respondents in Nseleni and 40.9% of respondents in Umhlathuze. Moreover, 9.8% of the respondents from Umhlathuze indicated that they used paraffin/ fuel oil/ kerosene as the main source of lighting, while 0.6% of the respondents from Umhlathuze said that they used tank or LP gas. A few respondents (1.3%), from Arboretum (5.9%) and Empangeni Rail (3.3%), did not provide a response for the main source of lighting used in the home.

Figure 5.14: Other sources of energy used for lighting (in %)



The other sources of energy used for lighting was candles (46.1%) fuelwood (35.1%) and paraffin/ fuel oil/ kerosene (Figure 5.14). All the respondents in Alton, Aquadene/ Brackenham, Arboretum and Meer en See did not use other energy sources for heating. In all other communities, fuelwood (80.3% in Empangeni Rail, 67.1% in Nseleni and 73.8% in Umhlathuze) and paraffin/ fuel oil/ kerosene (19.7% in Empangeni Rail, 11.8% in Nseleni and 11.6% in Umhlathuze) were used.

Madubansi and Shackleton (2006: 1) assert that the use of candles often results in the spread of unwanted fires, especially in poor communities. The choice of candles is again an indicator of affordability considerations since they are a cheap and easily available source of energy. The Chi-square test also revealed a statistically significant relationship between choice of secondary source used for lighting and employment (p=0.011). Thus, the choice of cheaper energy sources is linked to socio-economic status.

Table 5.26: Location/ storage of energy source used for lighting (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
No response	25	6.6	17.6	3.3	2.6	-	-	5
In the yard	-	-	-	-	-	-	0.6	0.2
In the home (kitchen)	-	3.3	-	-	6.6	-	14.6	6.5
In the home (other than kitchen)	-	13.1	-	-	19.7	-	39.6	18.4
Outside the homestead/ yard	-	-	-	-	-	-	1.2	0.4
Not applicable (does not have to be stored such as electricity)	75	77.0	82.4	96.7	71.1	100	43.9	69.5

The energy source used for lighting was stored by 18.4% of the respondents from Aquadene/ Brackenham (13.1%), Nseleni (19.7%) and Umhlathuze (39.6%) in the home (room other than the kitchen) (Table 5.26). A few respondents (6.5%) from these areas indicated that they store the source used for heating in the home (kitchen). The source used for lighting was stored in the yard by 0.2% of the respondents and outside the house/ yard by 0.4% of the respondents. All respondents from Meer en See indicated that they did not need to store the energy source that is used for lighting as they used electricity. No response was received from 5% of respondents and not applicable (does not need to be stored) was indicated by 69.5% of the respondents who used electricity solely.

Table 5.27: Place where energy source for lighting is used (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
N/A	25	3.3	11.8	3.3	2.6	-	-	3.8
Outside the home	-	-	-	-	-	-	1.2	0.4
In the kitchen	-	-	-	-	-	-	4.9	1.7
Throughout the home	75	96.7	88.2	96.7	97.4	100	93.9	94.2

The majority of respondents (94.2%) from all the study areas used the energy source stated in Table 5.27 above throughout the home, while in Umhlathuze, 1.7% of respondents indicated that they used the energy source in the kitchen and 0.4% indicated that the energy source was used outside the home. No responses/ not applicable were received from 3.8% of the respondents from all the study areas except for Umhlathuze and Meer en See.

The energy profile of the communities in Richards Bay indicates a heavy reliance on electricity (an unsustainable, non-renewable and relatively expensive energy option) for cooking, heating and lighting. Participants during the focus group discussions stated that this was because other options were not readily available and only poorer households used cheaper sources because they were forced to do so because of affordability issues. As indicated by Barnes *et al.* (2010), Casillas and Kammen (2010), Pachuri and Spreng (2011) and Sagar (2005), the use of multiple sources of energy (particularly non-renewable, traditional, cheaper options as is the case in some of the communities in Richards Bay) is a sign of energy poverty and reflects that while many households may have physical access to the electricity grid, they are unable to afford electricity and complement electricity use with cheaper energy options. While there are several renewable energy options available (such as solar energy and hydro energy), these are generally not available to households in Richards Bay.

During the focus group discussions, the main reasons for the lack of use of renewable energy in the communities were lack of awareness and knowledge about these options, high start up cost, concerns over maintenance and lack of clarity about the health impacts of these options. The latter concern is disconcerting since renewable energy sources are generally regarded as being healthier for people and the environment. From an air pollution and health perspective, they certainly are significantly less dangerous (if at all dangerous) to health and well-being than current reliance on fuel-based sources, especially fuelwood, gas and kerosene. The current sources are not only unsafe but also unsustainable. Of particular concern is that most of the unsafe and unhealthy energy sources are stored and used indoors, including cooking indoors. The health and safety concerns of storing non-renewable energy sources in the home are important to consider. It was also observed that many households in the poorer communities did not have good ventilation (often only a window per room) which was often kept closed because of odor and air pollution concerns from industrial pollutants (discussed later). The literature highlights the respiratory illnesses associated with indoor pollution and exacerbated by poor ventilation (Disenyana *et al*., 2010).

During the focus group discussions it also emerged that women were the main users of energy for cooking and heating since these activities are generally regarded as their responsibility at the household level. They are also generally responsible for collecting or purchasing and storing energy, where applicable (for example, fuelwood, kerosene, gas and candles). The results reflect findings emerging in the literature review that indicate that women are likely to be exposed more to indoor air pollutants from cooking, heating and lighting. Children are also more vulnerable because of greater susceptibility. It is also important to point out that women are generally responsible for collecting or purchasing energy (particularly fuelwood which is often harvested from open/ communal areas in the community). This is an additional burden on women in terms of their time, health impacts associated with transporting fuelwood (as discussed in relation to water collection earlier), safety and security concerns and exposure to pollutants. Sagar (2005) specifically states that the use of fuelwood, gas and kerosene are disconcerting since these sources have harmful health effects and cause the spread of unwanted fires in communities that use these sources which put women at risk. Furthermore, Ferrer-Martı´ *et al*. (2012) assert that alternate sources of energy (preferably renewable energy options) could result in major benefits for women since they are generally in charge of managing traditional energy sources. However, education pertaining to renewable energy sources will be needed since, as indicated by Sagar (2005), in some communities people are reluctant to switch from firewood to an alternative source because of food tastes, safety, and the variety of cooking methods that an open fire offers.

Chi-square tests showed a significant relationship between household size and sources of energy for cooking ($p=0.021$) and lighting ($p=0.033$). No significant relationship existed between household size and sources of energy for heating. These relationships were more acute in poorer communities. The results show that most cooking and heating have higher demands for energy at the household level than lighting and candles were often used to complement electricity in poorer households. It was found that larger households in communities used a greater variety of multiple sources (particularly fuelwood).

The reliance on electricity is unlikely to be sustained at high levels in poorer communities since the cost of electricity has been increasing dramatically in South Africa. The use of electricity also contributes to higher levels of poverty since poor household tend to spend a significant proportion of household income on electricity. As Kammen and Kirubi (2008) state, poor people spend the majority of their income on sources of energy and it is for this reason that energy poverty affects poor communities in developing countries more severely and more directly. If they cannot afford to purchase electricity and appropriate as well as affordable renewable energy options are not available, they will continue to use high polluting and unsafe fuel sources which are generally less expensive. Furthermore, it was observed during field visits and supported during the focus group discussions that some of the households in Umhlathuze, Empangeni Rail and Nseleni had illegal connections to electricity. This is a problem in South Africa and is indicative of the desperation that households have to access electricity, despite the practice being extremely dangerous and being a criminal offence. This practice results in these households and communities being exposed to hazardous and life-threatening ways of accessing energy.

5.5 Knowledge of Industries and Pollution in Richards Bay

The location of industries in relation to residential areas is deemed to be an important component of risk and level of exposure. Spatial aspects are also the main focus of the geography of health and relate to the place perspectives presented in the conceptual framework which underscores the importance of perception studies (Brody *et al.* 2004; Bickerstaff, 2004; Bickerstaff and Walker, 2001). Furthermore, it is a key concern in terms of the environmental justice framework which indicates that some populations (specifically the poor and Blacks) are more vulnerable to environmental risks and there are socio-economic inequalities in relation to who benefits and who loses from industrial air pollution (Bickerstaff and Walker, 2001; Bullard, 2004; Buzzelli, 2009; Chakraborty, 2006; Fisher *et al*., 2006; Marschall, 2008; Morello-Frosch and Lopez, 2006; Swyngedouw and Heynen, 2003; Sze and London, 2008). This section examines research findings in relation to respondents' knowledge of industries and pollution in Richards Bay.

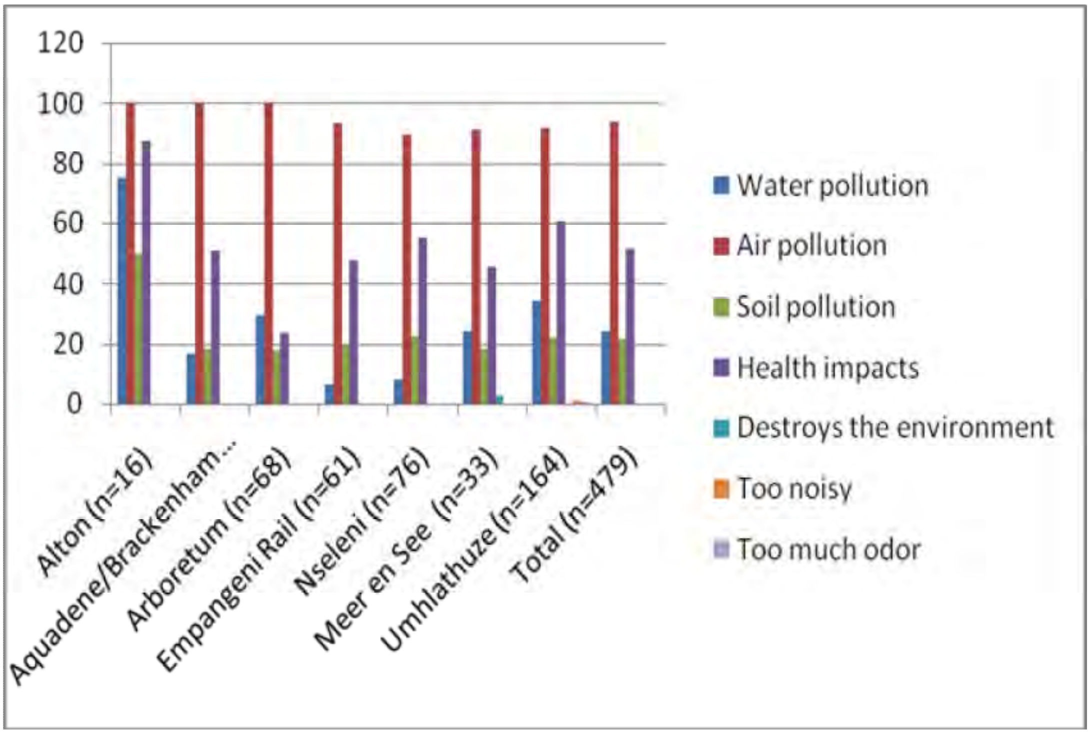
Table 5.28: Proximity of industries to respondent's residence (in %)

	A (n=16)	**A/B (n=61)**	**Ar (n=68)**	**ER (n=61)**	**N (n=76)**	**MS (n=33)**	**U (n=164)**	**Total (n=479)**
N/A / no response	-	14.7	-	-	15.8	-	-	4.4
<1 km	12.5	4.9	11.7	-	15.8	15.1	-	5.6
1-2 km	-	3.3	17.6	6.5	14.5	27.2	3	9
2-3 km	-	6.5	58.9	6.5	-	33.3	9.8	15.7
3-4 km	12.5	24.6	11.8	26.2	3.9	12.1	28	19.6
4-6 km	12.5	24.6	-	16.4	26.3	12.1	12.8	15
6-8 km	25	8.2	-	3.3	-	-	-	2.3
8-12 km	37.5	13.1	-	8.2	18.4	-	10.4	10.4
12-15 km	-	6.5	-	22.9	2.6	-	14	9
15-20 km		3.3	-	9.8	2.6	-	21.9	9.6

The above Table shows that 19.6% of respondents estimated that they lived approximately 3-4 km away from industries in Richards Bay: 28% from Umhlathuze, 26.2% from Empangeni Rail, 3.9% from Nseleni, 24.6% from Aquadene/ Brackenham, 12.5% from Alton, 11.8% from Arboretum and 12.1% from Meer en See. Almost 16% of the respondents felt that they lived 2-3 km away from the industries in Richards Bay. These respondents were from Arboretum (58.9%), Umhlathuze (9.8%), Meer en See (33.3%), Aquadene/ Brackenham (6.5%) and Empangeni Rail (6.5%). Some respondents (18.6%) from Empangeni Rail, Nseleni and Umhlathuze estimated that they lived between 12-20 km away from the industries in Richards Bay. A significant proportion of the respondents (27.7%) felt that they lived between 4-12 km. The respondents reside in close proximity to the industrial areas which was a deliberate sampling bias since only those communities that live in close proximity to the industries in Richard Bay were chosen. The RBCAA representative interviewed indicated that many of the major industries in the area resided in close proximity to a residential area in Richards Bay, Empangeni, Felixton and Nseleni. These areas coincide with locations that are considered to be the most polluted which are discussed later.

The results generally conform to the distance of the communities where the surveys were conducted from the main industrial area in Richards Bay. However, in some instances respondents overestimated the distance which indicates that people's understanding of distance differ from the actual distances. This is not unique to this study since participatory GIS and social mapping methodologies have shown how perceptions differ from reality. As indicated in the conceptual framework, it is important to focus on perceptions since people often make decisions and respond to perceived rather than real impacts. From a research point of view, given the discrepancies, triangulation and the use of mixed methods (as adopted in this study) becomes paramount to examine inconsistencies and clarify findings.

Figure 5.15: Problems associated with industries (Multiple responses, in %)



Ninety four percent of the total population that were interviewed reported air pollution as the main problem that is associated with industries in Richards Bay (Figure 5.15). Health impacts of pollutants from the industries manufacturing processes was reported by 51.4% of the respondents, while water pollution was reported by 24.2% of respondents and soil pollution was reported by 24.2% of the respondents from the study areas. Three percent of the respondents in Meer en See felt that industries in the area destroy the environment. In Umhlathuze, 1.2% of the respondents said that industries are too noisy, while 0.6% indicated that the industries cause too much odor. The RBCAA representative interviewed identified air and water pollution, negative impacts on public health and degradation and destruction of sensitive ecological and marine as the problems associated with the industries in Richards Bay.

Clearly, the main problems associated with industries are related to pollution, specifically air pollution. It is interesting to note that only close to half of the respondents associated industries in the area with health impacts yet the literature reveals a strong relationship between industries and negative health impacts. Some respondents do not appear to see the link between environmental pollution (since most identified some form including air and water pollution) and health impacts, possibly because they themselves may not suffer from any pollution-related ailments. The Chi-square test reveal that there is a significant relationship between the problems identified and location (p=0.042). This indicates that differences were discernible among the communities, specifically middle and upper income areas identified pollution problems more the lower income areas.

The next two Tables present the respondents' perceptions regarding the most and least polluted areas in Richards Bay. These are mapped as well and illustrated in Figure 5.18. The map also includes responses from the mental mapping exercise conducted during the focus group discussions.

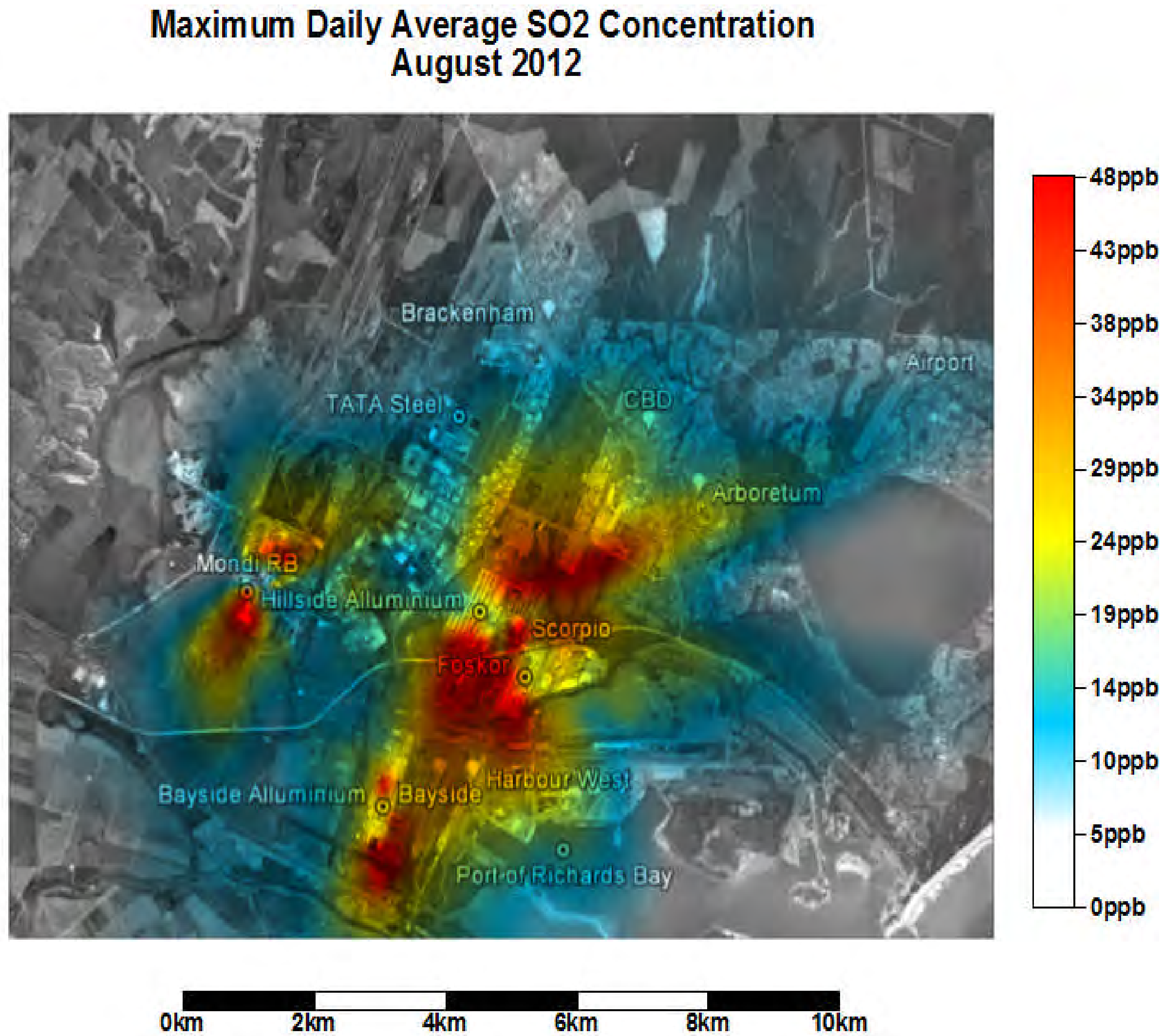
Table 5.29: Most polluted areas in Richards Bay (Multiple responses, in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
N/A / No response	-	3.3	-	6.6	3.3	24.2	7.9	6.3
All areas in Richards bay	12.5	21.3	-	16.4	5.3	-	9.1	9.2
Arboretum	-	6.6	11.8	9.8	3.9	3	3.7	6.4
Alton	12.5	9.8	35.3	-	2.6	24.2	14	13.6
Aquadene	62.5	32.8	35.3	-	5.3	15.2	13.4	17.7
Brackenham	37.5	13.1	41.1	3.3	6.6	33.3	34.7	24.4
Birdswood	-	-	-	3.3	-	-	1.8	1
Empangeni	-	-	-	3.3	-	-	4.9	2.1
Nseleni	50	13.1	5.9	-	32.9	-	25.6	18.2
Esikhawini	12.5	13.1	-	34.4	18.4	3	22	17.1
Felixton	-	-	5.9	3.3	-	-	-	1.3
Gobandlovu	-	1.6	-	19.7	38.2	-	12.2	12.9
Hillside	-	-	-	-	-	-	0.06	0.2
Mandlazini	-	-	-	29.5	15.8	-	9.1	9.4
Matshana	-	-	-	-	-	-	0.12	0.4
Kwambonambi	-	-	-	-	-	-	0.06	0.2
Meer en See	-	-	-	3.3	2.6	-	-	0.8
Mzingazi	-	-	-	3.3	-	-	-	0.4
Mkhobose	-	-	-	-	-	-	0.06	0.2
Ngwelezane	-	-	-	-	-	-	0.12	0.4
Port Dunford	-	-	-	-	3.9	-	-	0.6
Richards Bay harbor	-	3.3	23.5	-	-	6.1	0.06	4.4
Richards Bay town	-	6.6	-	-	5.2	6.1	1.8	2.7
Umhlathuze	-	-	-	-	-	-	13.4	4.6
Veldenvlei	-	-	-	3.3	-	-	-	0.4

The Table above illustrates the most polluted areas as perceived by the respondents. Areas perceived as the most polluted due to industries were Nseleni (18.2%), Aquadene (17.7%), Esikhawini (17.1%), Brackenham (24.4%), Alton (13.6%), Gobandlovu (12.9%), Empangeni (2.1%), Mandlazini (9.4%), Mathshana (0.4%), Kwambonambi (0.2%), Mkhobose (0.2%), Ngwelezane (0.4%) and Veldendvlei (0.4%). All areas were regarded as being the most polluted by 9.2% of the respondents. In addition respondents indicated that Richards Bay town is the most polluted (2.7%), Umhlathuze (4.6%), Meer en See (0.8%), Arboretum (6.4%) and Birdswood (1%). Other areas cited by respondents included Felixton (1.3%), Hillside Aluminum (0.2%), Mondi (1%) and areas in which the Richards Bay Harbor (4.4%) and Port Dunford (0.6%) are situated. All areas were regarded as being the most polluted by 9.2% of the respondents while 6.3% did not respond. The results show that the areas deemed to be the most polluted where generally in or in close proximity to the industrial area (shown on the map) or the port area. Port-related activities (especially the logistics components including transportation) are viewed as being high polluting sectors. It is interesting to note that those respondents who identified lower income areas (including nearby townships and rural areas) were generally from these areas or resided in similar low income areas. This could be attributed to broader dissatisfaction with these areas rather than pollution levels.

The RBCAA representative interviewed stated that the areas in the prevailing winds and closest to source are the most polluted generally in the area. The dosage map of SO_2 concentration during the month of August 2012 (Figure 5.16) was provided by the representation as an illustrative example of the concentration of pollutants in the industrial zone.

Figure 5.16: Maximum daily average concentration of SO_2 in August 2012 (RBCAA representative interviewed)



In Richards Bay, the RBCAA representative interviewed specifically stated that the residential areas of Arboretum Extension and the Central Business District which includes businesses, schools, a hospital and residential complexes were identified. In Felixton the areas of the village closest to the industries were seen to be the most polluted. The close association between industries and the most polluted areas was therefore further emphasized by the RBCAA representative interviewed.

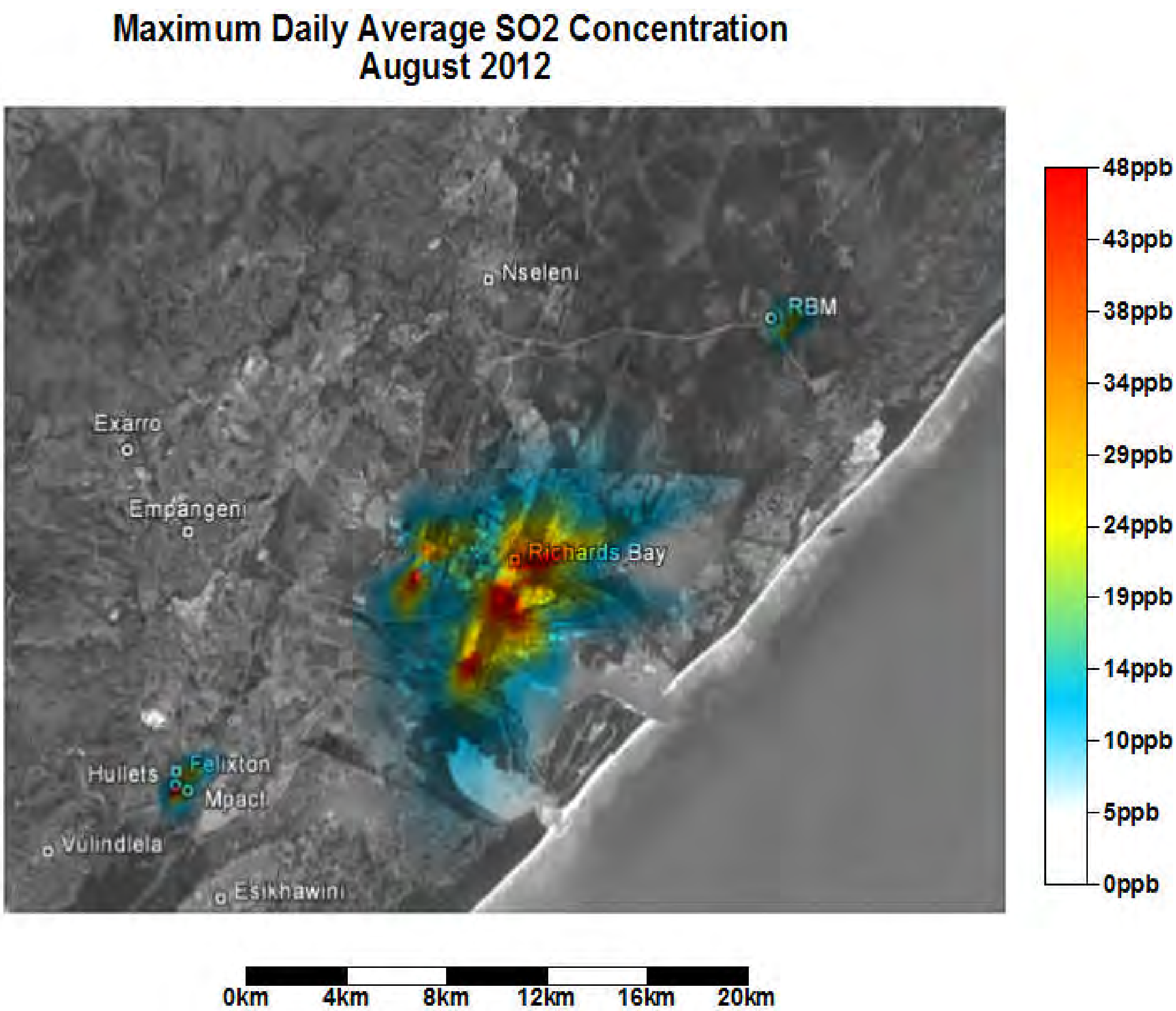
Table 5.30: Least polluted areas in Richards Bay (Multiple responses, in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
Alton	62.5	6.6	5.9	-	-	-	2.4	4.6
Arboretum	25	3.2	52.9	-	-	21.2	11	14
Birdswood	25	9.8	5.9	-	-	15.2	10.4	7.5
Bhiliya	-	3.2	-	-	-	-	1.8	1
Brackenham	-	3.2	-	-	-	-	-	0.4
Empangeni	-	8.2	5.9	6.6	17.1	6.1	11	9.6
Nseleni	-	3.2	-	8.2	14.5	6.1	2.4	5
Esikhawini	12.5	9.8	-	36.1	27.6	-	5.5	12.5
Gobandlovu	-	-	-	-	3.9	-	1.2	1.0
Hillside	-	-	-	-	-	-	1.2	0.4
Kuleka	-	-	-	-	-	-	0.6	0.2
Veldenvlei	-	-	-	-	2.6	-	-	0.4
Madlanzini	-	3.2	-	6.6	-	-	1.2	1.6
Matshana	-	-	-	-	-	-	1.8	0.8
Kwmbonambi	-	-	-	-	2.6	-	-	0.4
Meer en See	25	27.9	52.9	3.3	5.3	45.5	18.3	22.5
Umhlathuze	-	-	-	-	-	-	6.1	2.1
Mshekisane	-	1.6	-	-	-	-	1.2	0.6
Mtubatuba	-	3.2	-	-	2.6	-	-	0.8
Mtunzini	-	3.2	-	-	6.6	-	-	1.4
Ngwelezane	-	4.9	-	19.7	15.8	-	7.9	8.4
Port Dunford	-	3.2	11.8	-	7.9	9.1	19.5	10.6
Richards Bay Town	12.5	9.8	5.9	-	9.2	-	25	12.5

Table 5.30 displays perceptions regarding the least polluted areas as perceived by the respondents. Areas perceived as the least polluted were Meer en See (22.5%), Arboretum (14%), Richards Bay Town (12.5%), Esikhawini (12.5%), Port Dunford (10.6%), Aquadene (17.7%), Esikhawini (12.5%), Empangeni (9.6%), Ngwelezane (8.4%) and Birdswood (7.5%). Other areas included in the list are Alton (4.6%), areas outside Empangeni (0.2%), Bhiliya (1%), Brackenham (0.4%), Gobandlovu (1%), Nseleni (5%), Hillside (0.4%), Madlanzini (1.6%), Matshana (0.8%), Kwambonambi (0.4%), Mshekisane (0.6%), Kuleka (0.2%), Vlendenvlei (0.4%), Mtubatuba (0.8%), Mtunzini (1.4%) and Umhlathuze (2.1%). The results show that most areas identified as being least polluted were away from the industries and that responses differed considerably among and within communities about which areas were the least polluted. Middle/ upper income areas as well as areas in the periphery (including rural areas) were generally deemed to be the least polluted. The RBCAA representative interviewed stated that areas furthest away from industrial sources was the least polluted. Furthermore, because heavy industry is concentrated in Richards Bay, this means that the pollution load is significantly higher than other areas within uMhlathuze Municipality. While the representative indicated that the absence of industry in Empangeni would mean that this area is the least polluted, however, sugar cane burning is a significant

cause of pollution and Empangeni is likely to be affected by this. The August 2012 SO_2 concentration map at a larger scale provided by the RBCAA representative (Figure 5.17) showed that there was no discernable SO_2 concentration outside the main industrial zone and the industries located in Felixton. However, as further discussed next, several of the respondents identified these areas as the most polluted.

Figure 5.17: Maximum daily average concentration of SO_2 in August 2012 depicting a wider area (RBCAA representative interviewed)



The participatory mapping exercise conducted during the focus group discussion revealed that participants identified the industrial areas (including the port (and surrounds) as the most polluted areas. Areas outside Richards Bay were deemed to be the least polluted areas. Thus, similar trends emerged from the survey responses and focus group discussions. During the focus group discussion, one respondent highlighted that while the industries pollute the most, because of wind patterns nearby areas become the most polluted. This is also examined and the disease map generated as well as the air pollution and wind direction maps sourced from RBCAA indicate that there is no direct relationship between disease prevalence as discerned from the survey reporting, perceptions of the most and least polluted areas, and wind direction.

Figure 5.18 illustrates visually the most and least polluted areas as identified by the respondents. Two aspects are worth noting. Firstly, the most polluted areas coincide with the built up urban locations and the industrial zone as discussed in the previous chapter (Figure 4.3). Secondly, while some respondents perceive a specific location as the most polluted others see it as the least polluted. This issue was probed further during the focus group discussion. Participants stated that this could be attributed to what characteristics of a polluting industry most offends an individual which often differ from one person to another. For example, it was stated that some people may respond strongly to odors while others may find smoke emissions unacceptable. Additionally, some people may follow the monitoring reports and are aware of those industries that emit high levels of pollutants as monitored by the RBCAA, for example. The map also reveals that the middle/ upper income areas of Aquadene/ Brackenham, Arboretum, Alton and Meer en See where identified by some of the respondents as the most polluted areas, probably because of their location in close proximity to the main industrial zone. It is interesting to note that these areas were also seen by some to be the least polluted and during the focus group discussion the reason forwarded was that these are better off areas. Outlying areas (particularly those regarded as rural) had more locations that were viewed as being least polluted than most polluted.

Figure 5.18: Respondents perception of most and least polluted areas

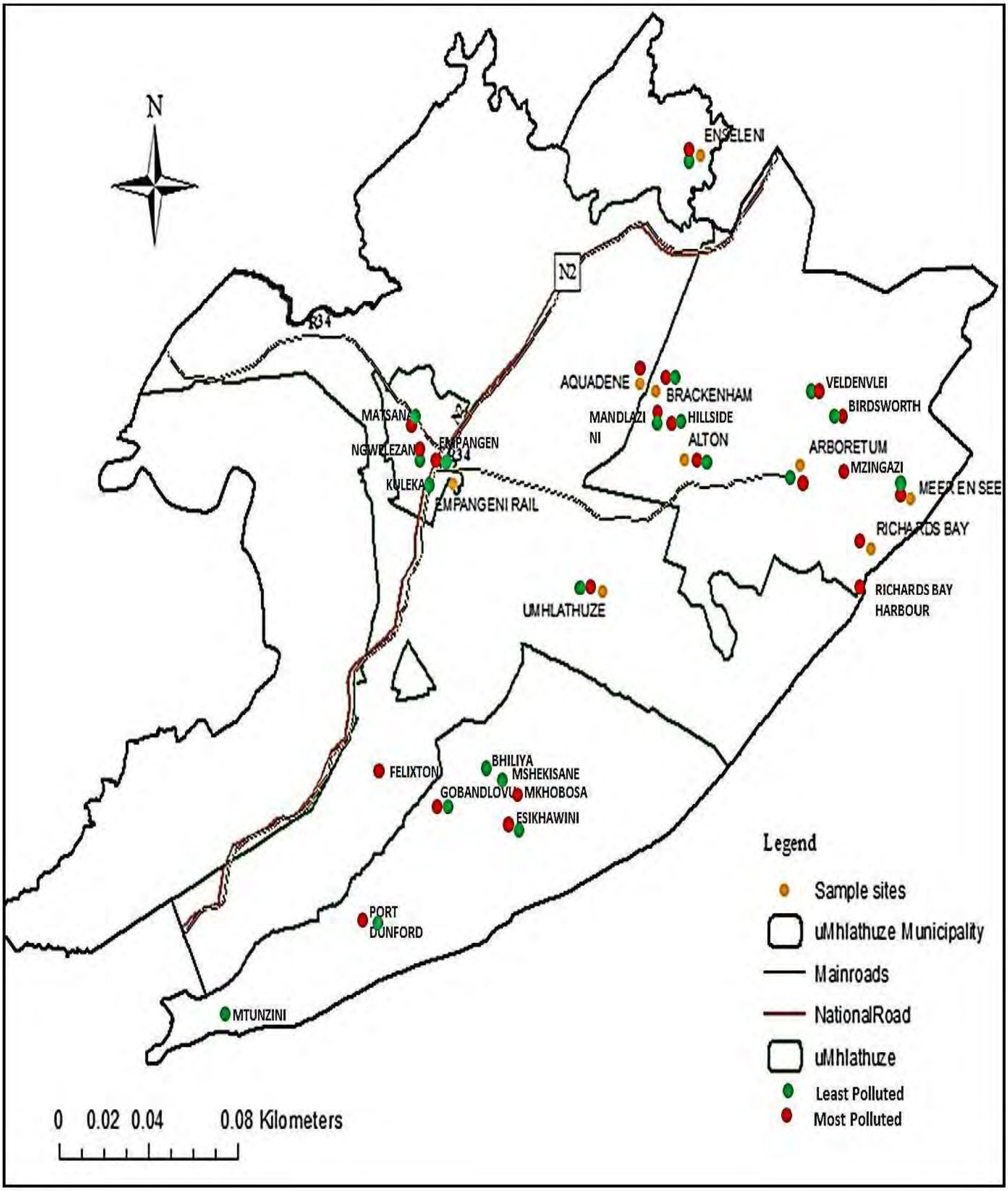


Table 5.31: Main source/s of pollution in Richards Bay (Multiple responses, in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
NA/ No Response	-	3.3	-	9.8	7.9	9.1	4.9	5.2
All Industries	-	-	17.6	-	-	6.1	-	2.9
All industries using coal and oil	-	-	-	-	-	-	0.6	0.2
Bayside Aluminum	25	3.3	29.4	-	-	36.4	12.2	12.1
Tongaat Hullett	-	-	11.8	1.6	3.9	18.2	2.4	4.6
Hillside Aluminum	-	-	-	-	-	6.1	-	0.4
Bayside Alusaf	50	11.5	41.2	-	9.2	12.1	11.6	15
BHP Billiton	50	11.5	11.8	-	-	3	3.7	6.3
FOSKOR	25	44.2	17.6	27.9	30.2	27.3	29.9	29.4
Richards Bay Coal Terminal	-	3.3	5.9	3.3	-	-	6.1	3.8
EXXARO	-	-	-	6.6	11.8	3	3.7	4.2
Mondi Felixton	-	-	11.8	3.3	3.9	-	4.9	4.4
Mondi Richards Bay	12.5	78.7	-	72.1	75	12.1	65.2	54.7
Port Net	-	3.3	-	-	2.6	-	11	4.6
Richards Bay Minerals	-	-	-	-	-	9.1	14.6	5.6
Tata Steel	50	11.5	5.9	-	5.3	-	7.3	7.3
Transnet	-	-	-	-	-	-	9.8	3.3
Tyre Coporation Richards Bay	-	3.3	11.8	3.3	-	12.1	7.3	5.8

The Table above shows the main sources of pollution in Richards Bay as perceived by the respondents. Of the total sampled population, 54.7% asserted that Mondi Richards Bay (54.7%), was the main source of pollution, 15% felt that Bayside Alusaf was the main source of pollution, 29.4% felt that Foskor was the main polluter, and 12.1% of respondents said that Bayside Aluminum was the main source of pollution in Richards Bay. These industries are generally clustered and the responses coincide with the previous findings regarding the locations that respondents viewed to be the most polluted. Some respondents (2.9%) suggested that all industries should be considered the main sources of pollution in Richards Bay, while 0.2% of respondents indicated that the main sources of pollution are industries that use coal and oil. Other listed sources of pollution by respondents in the study areas were Tongaat Hullett (4.6%), Hillside Aluminum (0.4%), BHP Billiton (6.3%), EXXARO (4.2%), Mondi Felixton (4.4%), Port Net (4.6%), Richards Bay Minerals (5.6%), Tata Steel (7.3%), Transnet (3.3%) and Tyre Corporation Richards Bay (5.8%). The RBCAA representative specifically identified Mondi as a significant source of odor complaints which are reported to cause nausea, headaches, sinus and respiratory problems. The BHP Billiton Hillside plant was also identified by the RBCAA representative which emits 10 561 tons per annum of SO_2 and is located only 0.6 km from the closest sensitive receptor (a pre-school). Foskor was the third industry named whose emissions from the plant caused burning of the eyes, nose and throat. The final industry identified was the Transnet Port Terminals which has significant dust generation from open stockpiles and ship loading activities. The representative stated that the responses were borne out of his/ her personal experiences and the symptoms described by people who logged complaints with the RBCAA.

The results shown in Table 5.31 indicates the respondents perception on the most polluted industries in Richards Bay, which also corresponds with the main sources of air pollution that was identified by the RBCAA (Table 4.1). Respondents were asked to provide reasons for why they chose a specific industry to be the main source of pollution in Richards Bay. Table 5.32 presents the results and indicates a range of responses.

Table 5.32: Reasons for opinion on which industries are the main source of pollution in Richards Bay (Multiple responses, in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
NA/ no response	100	42.6	58.8	26.2	34.2	63.6	57.9	50.1
Bad odors	-	36.1	-	36.1	34.2	6.1	14	19.8
Toxic gas emissions	-	6.6	-	9.8	-	-	5.5	4
Emission of gases	-	-	5.9	-	-	9.1	-	1.5
Sand / dust emissions	-	-	17.6	16.4	7.9	24.2	1.2	7.9
Chemical emissions	-	11.5	11.8	14.8	7.9	9.1	11	10.6
Smoke emissions	-	3.3	11.8	3.3	1.3	24.2	3	5.6
Death of employees	-	-	-	-	-	-	0.6	0.2
Flames	-	-	-	-	-	-	1.2	0.4
Large-scale production	-	-	-	6.6	-	-	8.5	3.8
Burn fossil fuels which pollute the atmosphere	-	-	5.9	-	-	-	-	0.8
Pollutes the air	-	6.6	5.9	3.3	15.8	3	3	5.4
Workers suffer from health problems	-	-	-	3.3	-	-	-	0.4

Reasons cited by respondents in Table 5.32 regarding why they perceived specific industries to be the main source of pollution in Richards Bay were the emissions of bad odors (19.8%), chemicals (10.6%), sand/ dust (7.9%), smoke (5.6%), toxic gas (4%) other gases (1.5%) and flames (0.4%). Respondents also stated that industries engage in large-scale production (3.8%), burn fossil fuels which pollute the atmosphere (0.8%), pollutes the air (5.4%) and workers suffer from health problems (0.4%). Death of employees was cited by 0.4% of respondents from Umhlathuze. No responses/ not applicable responses were received from 50.1% of respondents from all the study areas. This is a high response since most respondents identified most polluted areas and main sources of pollution in Richards Bay. The results clearly show that the main reasons forwarded by the respondents related to air pollution, both in terms of types of pollutants and the intensity/ scale. Health impacts on workers were also identified. Thus, there is a strong perception among communities in Richards Bay that industries contribute significantly to air pollution and that some pollute more than others.

As indicated in the literature, industries for local communities are seen to have costs and benefits (Bollen *et al.*, 2009; Buzzeli, 2007; Elliot *et al.*, 1999; Higginbotham *et al.*, 2010). To unpack this aspect further, respondents were asked to identify the advantages and disadvantages associated with industries in Richards Bay.

Table 5.33: Advantages of industries in Richards Bay (Multiple responses, in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
NA/ no response	-	-	-	4.9	3.9	-	6.7	3.5
None	12.5	11.5	5.9	6.6	25	-	36	19.8
Improves trade and business opportunities	50	3.3	-	-	-	-	1.2	2.5
Economic development within area	-	3.3	17.6	3.3	-	9.1	3	5
Improves income generating opportunities	-	3.3	-	-	-	-	-	0.4
Creates employment opportunities	75	85.2	82.4	88.5	71.1	93.9	51.8	71.8
Provides bursaries for students	-	6.6	-	6.6	-	-	-	1.7
Facilitates development in the area	-	3.3	17.6	-	-	18.2	2.4	5
Infrastructure development	-	-	-	3.3	-	21.2	-	1.9
Investment opportunities	25	6.6	-	-	-	-	-	1.7
Sponsorships for schools	-	6.6	-	13.1	11.8	-	7.3	6.9
Sponsorships for sport	-	4.9	-	3.3	-	-	2.4	1.9
Attracts people into the area	-	-	-	-	-	-	2.4	0.8
Improves services and facilities in the area	-	-	5.9	-	2.6	6.1	1.2	2.1
Training programs for the community	-	-	-	-	-	6.1	3	1.5
Subsidies	-	3.3	-	-	-	-	-	0.4
Close to work	-	-	-	-	-	-	1.2	0.4

The Table above shows the many advantages that respondents felt that industries have for the communities in Richards Bay. The majority of respondents (71.8%) from all the study areas listed above expressed that industries in Richards Bay creates employment opportunities for the local population while 19.8% felt that there were no advantages of having industries in the area. Other advantages of industries and opportunities provided by industries that were listed by respondents in Richards Bay include: improving trade and business opportunities (2.5%), provides economic development within the area (5%), improves income generating opportunities (0.4%), provides bursaries for students (1.7%), facilitates development in the area (5%), infrastructure development (1.9%), investment opportunities (1.7%), provides sponsorships for schools (6.9%), provides sponsorships for sports (1.9%), attracts people into the area (0.8%), improves services and facilities in the area (2.1%), provides training programs for the community (1.5%), provides subsidies (0.4%) and it is close to work (0.4%). No responses were received from 3.5% of the sample population. The RBCAA representative interviewed identified the main advantages of having industries in Richards Bay as uplifting disadvantage communities through social projects, job creation and the sponsorship of sporting events. The main aspects that emerge in relation to advantages of having industries in the area are:

- Economic benefits in relation to job creation, higher incomes and attracting investments into Richards Bay;
- Broader development impacts that relate to improved services, infrastructure and facilities; and
- Social responsibility benefits such as providing bursaries and sponsorships as well as supporting training programs.

The main advantages relate to job creation and the possibility of increased development in the area. This supports the literature that shows that employment opportunities and related economic benefits are deemed to be the key advantage associated with industry (Block and Whitehead, 1999; Enger *et al.*, 1986; Jaggernath, 2010; Morello-Frosch, 2002). However, given the unemployment rates presented earlier (specifically in lower income areas) it seems as if industries in Richards Bay are unable to create sufficient jobs to meet demands. Furthermore, as Jaggernath (2010) indicates, the lack of jobs to meet demand often creates conflicts in communities as residents compete for limited jobs and often become annoyed when people outside the area are employed.

Table 5.34: Disadvantages of industries in Richards Bay (Multiple responses, in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
NA/ no response	-	-	-	6.6	5.3	-	10.4	5.2
None	-	1.6	-	1.6	2.6	-	3.7	2.1
Health impacts	-	3.3	-	23	7.9	15.2	9.1	8.8
Air pollution	25	45.9	29.4	26.2	22.4	18.2	37.2	31.7
Pollution in general	87.5	23	64.7	9.8	21.1	30.3	17.1	27.6
Soil pollution	-	-	-	-	5.3	-	-	0.8
Water pollution	-	3.3	5.9	-	-	-	-	1.3
Pollution related illnesses	-	9.8	-	13.1	21.1	9.1	7.3	9.4
Bad odors	-	3.3	5.9	6.6	11.8	6.1	23.2	12.3
Congestion	57	6.6	17.6	-	-	30.3	14.6	12.9
Environmental degradation	-	-	-	3.3	-	15.2	2.4	2.3
Increase in Crime	12.5	-	-	-	-	-	1.2	0.8
Attracts too many people into the area	-	-	-	-	-	-	1.2	0.4
Displacement of people due to industries	-	-	-	6.6	-	-	0.6	1
Increase in foreign workers	-	-	-	-	-	-	8.5	2.9
Jobs are not given to the local people	-	13.1	-	3.3	10.5	-	5.5	5.6
Noise pollution	37.5	3.3	11.8	3.3	-	15.2	20.7	11.9
Temporary employment	-	3.3	-	-	-	-	-	0.4
Safety issues due to industries	-	6.6	-	-	3.9	-	2.4	2.3
Smoke emissions	-	-	-	-	-	-	1.2	0.4
Toxic gas emissions	-	-	-	-	-	-	0.6	0.2
Large consumers of electricity	-	-	-	-	5.3	-	-	0.8
Factories use land available for housing	-	-	-	-	-	-	2.4	0.8
Chemical hazards	-	-	5.9	-	-	-	-	0.8
Dirtying of the area	-	-	-	3.3	-	-	1.8	1
Industries too close to residents	12.5	-	-	-	-	-	-	0.4
Unemployment	-	-	-	-	-	-	2.4	0.8

Respondent's perceptions on the disadvantages that industries in Richards Bay have on communities are listed in Table 5.34 above. Air pollution was cited by 31.7% of the respondents from all the study areas, while 27.6% of respondents indicated that pollution in general was a major disadvantage. Twelve percent of the respondents from all the study areas except for Nseleni felt that noise pollution was a major disadvantage of industries in Richards Bay, 1.3% said that water pollution was a serious problem and 0.8% said that soil pollution was a major disadvantage. Health impacts and pollution related illnesses accounted for 18.2% of responses obtained from all the study areas with the exception of Alton and Arboretum. Other disadvantages associated with the industries in Richards Bay were related to the emissions of bad odors (12.3%), smoke (0.4%), toxic gases (0.2%), congestion (12.9%), environmental degradation (2.3%), safety issues (2.3%) and that industries pose chemical hazards (0.8%).

In addition, the disadvantages listed by the respondents included implications for the communities such as industries attract too many people into the area (0.4%), increases crime in the area (0.8%), jobs are not available to the local people (5.6%), increase in foreign workers (2.9%), creates temporary employment (0.4%) and results in unemployment (0.8%). Moreover, 1% of the respondents felt that industries dirty the area, 0.8% felt that industries consume too much of electricity, 0.8% said that industries use too much of land that could be used for housing in the area, 0.4% felt that industries are too close to residential areas and 0.8% felt that industries increase the crime rate in the area. Two percent of the respondents felt that industries cause no disadvantages to the communities in Richards Bay and 5.2% of respondents did not provide a response.

The main aspects that emerge in relation to disadvantages of having industries in the area are:

- Pollution impacts related specifically to air and water pollution as well as waste generated which was highlighted also by the RBCAA representative;
- Linked to above, concerns pertaining to environmental degradation as indicated by the RBCAA representative;
- Health impacts linked primarily to pollution which was also emphasized by the RBCAA representative;
- Congestion in the area;
- Employment issues pertaining to who gets jobs (perception that industries prefer to employ foreigners) and the types of jobs created (low paying and temporary); and
- Utilization of land by industries that displaces people and land available for homes.

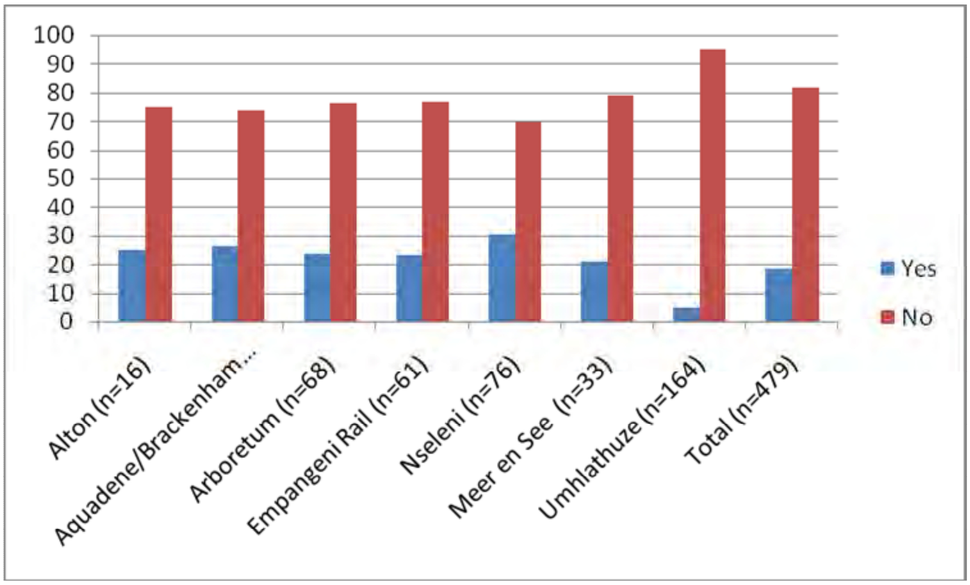
Generally, the main disadvantages related to pollution and negative health impacts which are similar to the responses presented above in relation to problems associated with industries in Richards Bay. The results again are similar to findings from other studies that show that the main disadvantages are in terms of pollution and quality of life issues, including health impacts. The RBCAA representative felt strongly that Richards Bay has reached capacity in terms of pollution load. He/ she argued that the authorities issue licenses in isolation, without taking into account the cumulative impacts, and felt that no further development of industries with emissions to air should be allowed until such time as the current pollution load is reduced. This, according the RBCAA representative interviewed, is supported by the Desired

State of the Environment Report which clearly states that air pollution levels have reached saturation point in Richards Bay.

5.6 Respondents Employment in Industries

As indicated in the previous section, the main advantage associated with industries is in relation to employment benefits. Earlier discussions also revealed that most respondents and members of households surveyed who were employed worked within the Richards Bay area. This section focuses specifically on employment in the industries in Richards Bay among the respondents interviewed.

Figure 5.19: Whether respondent or member of the household are currently employed at industries in Richards Bay (in %)



A total of 18.4% of respondents in the study areas indicated that either they or a member of the household work in an industry in Richards Bay (Figure 5.19): 25% in Alton, 26.2% in Aquadene/ Brackenham, 23.5% in Arboretum, 23% in Empangeni Rail, 30.3% in Nseleni and 21.2% in Meer en See. Only 4.9% of the respondents in Umhlathuze (a rural community) stated that they or a family member worked in an industry in Richards Bay. The results indicate that while close to a fifth of the households interviewed had at least one member who was employed in the industries in Richards Bay, this made up less than 20% of households who had members employed. Thus, the majority of the respondents retain jobs outside the industries in Richards Bay. In the South African context, therefore, industries do not appear to be a main job creator locally. This is also the case in the South Durban Basin area which is considered to be one of the most contested industrial areas in South Africa (Jaggernath, 2010; Visser, 2010). Thus, the notion that industries are the main job creators for locals should be reconsidered since this is often used to justify the existence of high polluting areas close to residential areas. The trade-off referred to in the literature applies to some of the households who benefits from jobs created by the industries in Richards Bay while all residents bear the costs of high levels of pollution. The finding that the majority of the households sampled do not have a member of the household working in a nearby industry indicates that there are often factors that influence the choice of residential location and could include place attachment as highlighted by Jaggernath (2010).

It is worth mentioning that this analysis only considers direct job benefits. Indirect jobs from the strong presence of the industries in Richards Bay could be linked to the service and entertainment sectors which also employs community members.

Table 5.35: Name of industry respondent or member of household is employed in (in %)

	A (n=4)	A/B (n=16)	Ar (n=16)	ER (n=14)	N (n=23)	MS (n=7)	U (n=8)	Total (n=88)
No response	-	12.5	-	-	-	-	-	2.3
Bayside Alusaf	-	12.5	-	-	-	14.3	-	3.4
Bell equipment	-	6.3	-	-	-	-	-	1.1
EXXARO	-	-	-	14.3	8.7	-	-	4.5
Foskor	-	12.5	50	-	-	28.6	-	13.7
Tyre Corporation	50	25	75	-	8.7	-	-	13.6
Tongaat Hullett	-	-	-	-	-	28.6	-	2.3
Mondi Richards Bay	-	-	-	28.6	13	-	50	12.5
LEOMAT Plant Hire		-	-	-	13	-	-	3.4
Port Net	-	-	-	14.3	-	28.6	-	4.5
Richards Bay Coal Terminal	-	-	25	14.3	-	-	-	6.8
Richards Bay Minerals	-	18.9	-	-	13	-	50	11.4
Richards Bay Harbor	-	-	-	-	8.7	-	-	2.3
Spoor Net	-	-	-	-	8.7	-	-	2.3
Tata Steel	-	12.5	-	-	-	-	-	2.3
Transnet	50	-	-	28.6	26.1	-	-	13.6

Among those respondents who indicated that they worked in an industry in Richards Bay, 13.7% worked at Foskor, 13.6% worked at Tyre Corporation Richards Bay, 12.5% worked at Mondi Richards Bay, 11.4% worked at Richards Bay Minerals and Richards Bay Coal Terminal (6.8%) (Table 5.35). Some of the respondents indicated that they work for Port Net (4.5%) and EXXARO (4.5%). In addition 2.3% of respondents indicated respectively that they worked at the Richards Bay Harbor, Spoor Net and Tata Steel, while 1.1% of the respondents from Aquadene/ Brackenham worked at Bell Equipment and 2.3% of the respondents did not indicate where they worked. There were no discernible patterns in terms of which industries members of the households interviewed worked in with a spread among a range of industries for all communities. However, the major industries seem to be the main job retainer.

Table 5.36: Number of years employed in industry (in %)

	A (n=4)	**A/B (n=16)**	**Ar (n=16)**	**ER (n=14)**	**N (n=23)**	**MS (n=7)**	**U (n=8)**	**Total (n=88)**
< 1year	-	12.5	-	28.6	-	-	-	6.8
1-4 years	50	25	25	28.6	43.5	-	75	34.1
5-10 years	-	43.8	75	-	17.4	100	25	36.4
11-15 years	-	12.5	-	28.6	13	-	-	10.2
16-20 years	-	6.3	-	-	-	-	-	1.1
21-25 years	-	-	-	14.3	-	-	-	2.3
26-30 years	-	-	-	-	8.7	-	-	2.3
31-35 years	50	-	-	-	17.4	-	-	6.8

Almost 7% of respondents indicated that they work in industries in Richards Bay between 31-35 years (50% in Alton and 17.4% in Nseleni), 4.6% of the respondents claimed that they have been employed at industries between 21-30 years (8.7% in Nseleni) and 1.1% (6.3% in Aquadene/ Brackenham) of the respondents worked in the industries between 16-20 years (Table 5.36). Approximately 10.2% of the respondents (12.5% in Aquadene/ Brackenham, 28.6% in Empangeni Rail and 13% in Nseleni) indicated that they have worked in the industries between 11-15 years, 36.4% (all in Meer en See) indicated that they have been employed in the industries between 5-10 years, 34.1% have been employed in the industries between 1-4 years (75% in Umhlathuze) and 4.5% of the respondents (28.6% in Empangeni Rail) said that they have been employed in the industries for >1 year. Most of the respondents (77.3%) stated that they or a member of the household was employed in the industry for less than 10 years (with 40.9% being employed for less than 5 years).

Table 5.37: Nature of employment at industry (in %)

	A (n=4)	A/B (n=16)	Ar (n=16)	ER (n=14)	N (n=23)	MS (n=7)	U (n=8)	Total (n=88)
No response	-	12.5	-	28.6	17.4	-	-	11.4
Administration/ clerical	-	-	25	14.3	-	-	-	6.8
Cleaner	-	-	-	-	8.9	-	25	4.5
Driver	50	-	-	-	21.7	-	-	8
Electrician	-	-	-	-	-	-	25	2.3
General laborer	-	-	-	14.3	34.8	-	50	15.9
Manager / supervisor	-	31.3	25	-	-	28.6	-	12.5
Technician	-	18.8	50	14.3	-	71.4	-	20.5
Sales	50	-	-	-	-	-	-	2.3
Safety officer	-	-	-	-	8.9	-	-	2.3
Operator	-	37.5	-	28.6	8.9	-	-	13.6

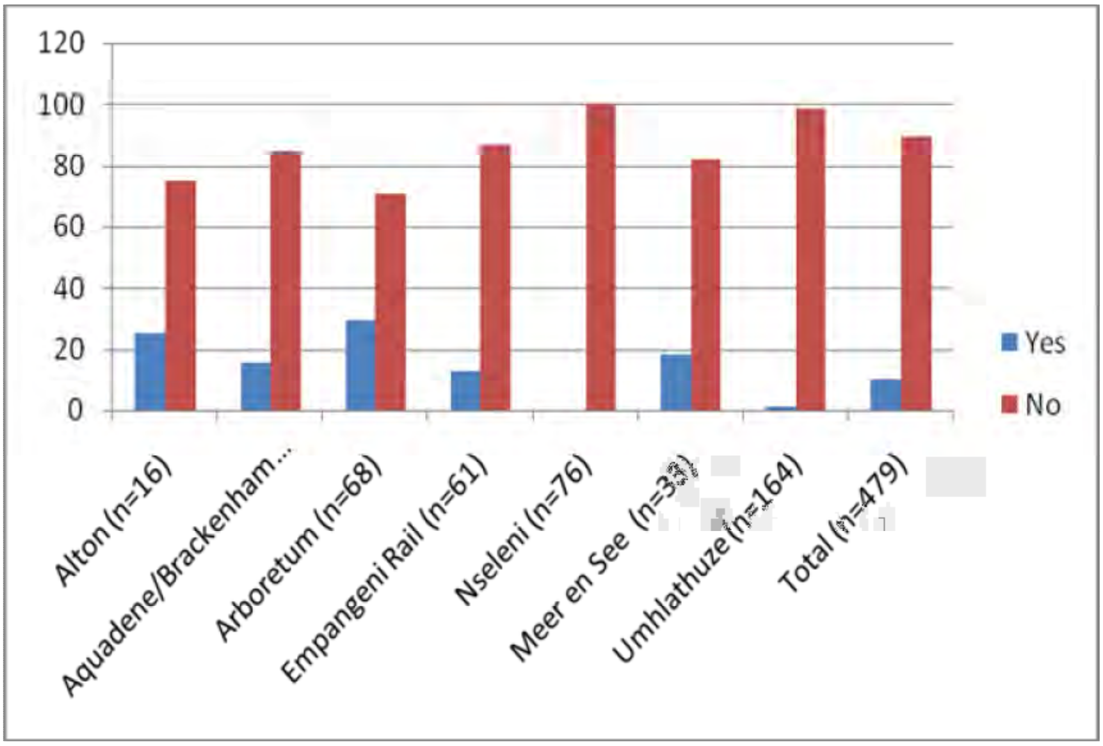
Table 5.37 indicates the nature of household members' in the industries. The Table indicates that 20.5% (18.8% from Aquadene/ Brackenham, 50% from Arboretum, 14.3% from Empangeni Rail and 71.4% from Meer en See) are technicians, while 15.9% (14.3% from Empangeni Rail, 34.8% from Nseleni and 50% from Umhlathuze) indicated that they are general laborers. The Table also indicates that 13.6% (37.5% from Aquadene/ Brackenham, 28.6% from Empangeni Rail and 8.9% from Nseleni) are operators and 12.5% are managers/ supervisors (31.3% from Aquadene/ Brackenham, 25% from Arboretum and 28.6% from Meer en See). Interestingly, 4.5% of the respondents indicated that they are cleaners. These respondents were from Nseleni (8.9%) and Umhlathuze (25%). Eight percent of the respondents were drivers (50% from Alton and 21.7% from Nseleni), while 6.8% were administration/ clerical workers (25% from Arboretum and 14.3% from Empangeni Rail). A few respondents (2.3% each) stated safety officers (8.9% from Nseleni), sales (50% in Alton) and electrician (25% in Umhlathuze). No responses were received from 11.4% of the respondents who indicated that they were employed by an industry in Richards Bay. The results indicate that locals worked in a range of different occupations but more when in lower paying jobs. Members from only a few of the households interviewed (12.5%), mainly from the middle/ upper income areas, held managerial/ supervisory positions which are generally higher paying jobs.

5.7 Knowledge of Organizations Dealing with Air Pollution in Richards Bay

Binder and Neumayer (2005), Canoton (2008), Scott and Barnett (2009) and Sparks (2006) are some of the researchers that underscore the importance of several types of organizations in addressing air pollution and health impacts at the local level. The main organizations/

institutions identified in the literature were civil society organizations, NGOs (especially environmental NGOs), government departments, industry and business organizations.

Figure 5.20: Respondents awareness of organizations addressing air pollution issues in the communities (in %)



A vast majority of the respondents (89.6%) from all the study areas (Figure 5.20) and the RBCAA representative interviewed said that they were unaware of any organization that were involved in addressing air pollution and health issues in Richards Bay. Only 10.4% of the sampled population from Alton (25%), Aquadene/ Brackenham (15.5%), Arboretum (29.4%), Empangeni Rail (13.1%), Meer en See (18.2%) and Umhlathuze (1.2%) indicated that they were aware of such organizations in Richards Bay. Much fewer respondents were aware of organizations in lower income areas (the rural community in Umhlathuze in particular) than in middle/ upper income areas.

Table 5.38: Name of organization aware of (in %)

	A (n=4)	A/B (n=9)	Ar (n=20)	ER (n=8)	MS (n=6)	U (n=2)	Total (n=49)
NA/ No response	-	44.4	-	25	-	-	12.2
Department of Environmental Affairs	-	33.3	-	25	-	-	7.1
Labor court	-	-	-	25	-	-	4.1
Mondi	-	-	-	25	-	-	4.1
Municipality	-	-	-	-	33.3	100	8.2
RBCAA	100	22.2	100	25	66.7	-	61.2

Among the 10.4% of the respondents who indicated that they were aware of organizations that address air pollution and health related issues, most (6.2%) identified RBCAA which is a NGO operating in the area (all respondents from Alton and Arboretum, 66,7% from Meer en See, 25% from Empangeni Rail and 22.2% from Aquadene/ Brackenham) (Table 5.38). A few identified government departments including the Department of Environmental Affairs (33.3% from Aquadene/ Brackenham and 35% from Empangeni Rail), the municipality (all in Umhlathuze and 33.3% in Meer en See) and the labor court (25% in Empangeni Rail). The only industry that was identified was Mondi by 4.1% of the respondents, all from Empangeni Rail. It is interesting to note that almost none of the respondents from the lower income areas were aware of RBCAA, the main organization in the area. This organization focuses on consistent monitoring of air pollution in Richards Bay and should make more effort to raise awareness of the work of the NGO in poorer communities.

Table 5.39: Nature of involvement of organization (in %)

	A (n=4)	A/B (n=9)	Ar (n=20)	ER (n=8)	MS (n=6)	UV (n=2)	Total (n=49)
No response	50	33.3	20	-	-	100	22.4
Building awareness on air pollution impacts and control	-	-	-	50	-	-	8.2
Building awareness on the health impacts of air pollution	50	-	-	-	-	-	4.1
Work related problems	-	-	-	50	-	-	8.2
Regulation and monitoring of pollution	-	66.7	80	-	100	-	57.1

Of the 10.4% of respondents who were aware of organizations that address air pollution and health related issues, 57.1% indicated that these organizations (mainly referring to RBCAA) were involved in the regulation and monitoring of pollution, 8.2% each said that these organizations address work related problems as well as build awareness on air pollution impacts and in controlling pollution (Table 5.39). A few respondents (4.1%) stated that the organizations build awareness on the health impacts of air pollution. No responses on the nature of the involvement of these organizations were obtained from 22.4% of respondents.

This may suggest that 22.4% of the respondents were unaware of what exactly these organizations do.

The results are dissimilar to the South Durban Basin area where several organizations and alliances are active (Jaggernath, 2010; Scott and Barnett, 2009; Sparks, 2006). The results generally indicate that there is a strong need for greater awareness campaigns in Richards Bay by various organizations in the area. Research discussed in the literature review clearly indicates that civil society and locally-based organizations play a significant role in raising awareness about environmental issues (including air pollution and health impacts) and they are key to lobby for change. As Scott and Barnett (2009) state from experiences in the South Durban Basin, civil society-driven organizations in particular can reframe pollution issues, expose pollution problems and offenders, and be persuasive to effect change.

5.8 Air Pollution and Health Implications

A key aspect of this study is on health impacts in relation to specific illnesses that were prevalent in the community. The analysis in this section examines various types of illnesses that were common (and how these are linked to air pollution), the main causes of the illnesses affecting household members, which specific group in the household is most affected, consultation with a health practitioner and frequency of treatment. The section then specifically discusses respiratory illnesses that are highlighted in the literature as being associated with air pollution: coughing, wheezing, chest illness and asthma.

5.8.1 Community and household level health issues

The percentage of households that had at least one member who suffered from established illnesses are presented in the Table below. This was done mainly to ascertain the types of illnesses prevalence in the communities amongst sampled households. Only 8.8% of the household interviewed (35.3% in Arboretum, 2.6% in Nseleni and 48.5% in Meer en See) indicated that neither the respondent nor household members had specific ailments. The responses indicate that this was almost exclusively (with a few exceptions in Nseleni) in the middle/ upper income areas of Arboretum and Meer en See).

Table 5.40: If respondent or a member of the household has specific ailments (Multiple responses, in % - yes responses only)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
None	-	-	35.3	-	2.6	48.5	-	8.8
Allergies	87.5	44.3	23.5	29.5	21.1	21.2	30.5	30.9
Eczema	37.5	-	11.8	6.6	-	-	11.6	7.7
Hay fever	37.5	26.2	11.8	6.6	2.6	3	1.8	8.4
Asthmatic bronchitis/ asthma	37.5	19.7	5.9	19.7	19.7	-	26.2	19.2
Reactive airway disease	-	-	-	3.3	2.6	3	1.8	1.7
Wheezing	12.5	23	5.9	32.8	31.6	18.2	31.7	25.5
Coughing	75	34.4	38.2	8.2	9.2	51.5	33.5	29.8
Breathing difficulties	-	-	2.9	6.6	-	6.1	2.4	2.5
Colds/ flus	-	6.6	-	-	-	-	-	0.8
Cardiac illnesses	-	6.6	-	-	-	-	-	0.8
High blood pressure	-	-	-	-	3.9	-	-	0.6
Diabetes	-	-	-	-	3.9	-	-	0.6
Sinus	-	9.8	-	6.6	2.6	-	0.6	2.7
Chest pains	12.5	9.8	11.5	29.5	27.6	6.1	19.5	18.4
Shortness of breath	-	-	2.9	3.3	-	-	1.2	1.3
HIV/ AIDS	-	-	-	-	2.6	-	-	0.4

Table 5.40 displays a list of common diseases (identified from the literature review) that affects household members in communities situated in close proximity to industrial areas. The table indicates that 30.9% of this study respondents reported that allergies were common in the household, 29.8% identified coughing, 25.5% reported wheezing, 18.4% stated chest pains and 17.7% reported that a member/s of the household have asthmatic bronchitis/ asthma. Allergies accounted for 87.5% of the responses in Alton, 44.3% in Aquadene/ Brackenham, 23.5% in Arboretum, 29.5% in Empangeni Rail, 21.1% in Nseleni, 21.2% in Meer en See and 30.5% in Umhlathuze. Coughing was identified by 75% of the respondents in Alton, 34.4% in Aquadene/ Brackenham, 38.2% in Arboretum, 8.2% in Empangeni Rail, 9.2% in Nseleni, 51.5% in Meer en See and 33.5% in Umhlathuze. Twenty five percent of respondents in Umhlathuze indicated that a member/s of the household had asthmatic bronchitis/ asthma, 37.5% in Alton, 16.4% in Aquadene/ Brackenham, 5.9% in Arboretum, 19.7% in Empangeni Rail and 15.8% in Nseleni. Chest pains were reported by 29.5% of the respondents in Empangeni Rail, 27.6% in Nseleni, 19.5% in Umhlathuze, 12.5% in Alton, 11.5% in Aboretum, 9.8% in Aquadene/ Brackenham and 6.1% in Meer en See. Wheezing was reported by 32.8% of the respondents in Empangeni Rail, 31.7% Umhlathuze, 31.6% in Nseleni, 23% in Aquadene/ Brackenham, 18.2%s in Meer en See, 12.5% in Alton and 5.9% in Arboretum. Other health problems listed by the respondents were eczema (7.7%), hay fever (8.4%), reactive airway disease (1.7%), asthma (1.5%), breathing difficulties (2.5%),

colds/ flus (0.8%), cardiac illnesses (0.8%), high blood pressure (0.6%), diabetes (0.6%), sinus (2.7%), shortness of breath (1.3%) and HIV/AIDS (0.4%).

Table 5.41: Number of household members who have illnesses (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
None	-	-	35.3	-	2.6	48.5	-	8.8
One	87.5	85.2	55.9	50	46.1	39.4	50	54.1
Two	12.5	11.5	7.3	50.8	40.8	12.1	45.7	25.9
Three	-	3.3	1.5	6.6	7.9	-	2.4	3.5
Four	-	-	-	1.6	2.6	-	1.8	1.3
Average	**1.1**	**1.2**	**0.8**	**1.6**	**1.6**	**0.6**	**1.6**	**1.2**

The average number of household members who had illnesses was 1.2 and ranged from none to 4 (Table 5.41). The highest average of 1.6 was in all the lower income areas (Empangeni Rail, Nseleni and Umhlathuze). The lowest averages were in Arboretum (0.8) and Meer en See (0.6). Most of the respondents stated 1 household member was ill (54.1%), specifically 87.5% in Alton, 85.2% in Aquadene/ Brackenham, 55.9% in Arboretum, 50% in Empangeni Rail, 46.1% in Nseleni, 39.4% in Meer en See and 50% in Umhlathuze. Close to a quarter of the respondents (25.9%) stated that 2 household members were ill (12.5% in Alton, 11.5% in Aquadene/ Brackenham, 7.3% in Arboretum, 50.8% in Empangeni Rail, 40.8% in Nseleni, 12.1% in Meer en See and 45.7% in Umhlathuze). Three household members being ill were indicated by 3.5% of the respondents (3.3% in Aquadene/ Brackenham, 1.5% in Arboretum, 6.6% in Empangeni Rail, 7.9% in Nseleni and 2.4% in Umhlathuze). A few respondents (1.3%) stated that four household members were ill (1.6% in Empangeni Rail, 2.6% in Nseleni and 1.8% in Umhlathuze). In addition to more members of the household being ill in lower income areas, there were also households which had more persons residing together. This could be linked to overcrowding which, as indicated earlier, also contributes to poor health conditions.

Moodley (2002) states that the state of health or ill health in communities or amongst individuals is the result of numerous factors and these are time and context related. It is important to examine which factors community members think contribute to the poor health conditions to ascertain which are beyond their control and which are behavior related. Table 5.42 presents the causes of the present health conditions in the household as perceived by the respondents.

Table 5.42: Perceived causes of present health conditions (Multiple responses, in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
No response	-	-	11.8	-	-	27.3	-	3.5
Pets	75	45.9	11.8	9.8	13.2	6.1	11	17.5
Dust	75	42.6	64.7	77	38.2	42.4	28	45.5
Pollen, trees, fresh cut grass	75	24.6	35.3	13.1	13.2	27.3	10.4	19.8
Cigarette smoking	75	39.3	5.9	32.8	30.3	15.2	20.1	25.3
Industrial smoke	87.5	55.7	70.6	63.9	65.8	36.4	46.3	57.0
Being physically active	-	16.4	-	9.8	9.2	9.1	7.3	7.9
Colds or flu	50	26.2	23.5	19.7	13.2	21.2	23.8	22.5
Certain types of food	-	8.2	-	3.3	5.3	6.1	14	7.5
Change of weather	62.5	23	35.3	32.8	13.2	3	37.8	29.4
Mold and mildew	12.5	-	5.9	9.8	-	3	20.1	9.6
Sprays of strong smells (perfumes, colognes, domestic cleaning agents, etc.)	75	41	5.9	13.1	5.3	-	31.1	21.7
HIV positive	-	-	-	-	-	-	1.2	0.4

More than half of the respondents (57%) indicated that industrial smoke was the cause of their present health conditions: 87.5% in Alton, 55.7% in Aquadene/ Brackenham, 70.6% in Arboretum, 63.9% in Empangeni Rail, 65.8% in Nseleni, 36.4% in Meer en See and 46.3% in Umhlathuze. Close to half the respondents (45.5%) identified dust as a source: 75% in Alton, 42.6% in Aquadene/ Brackenham, 64.7% in Arboretum, 77% in Empangeni Rail, 38.2% in Nseleni, 42.4% in Meer en See and 28% in Umhlathuze. Other prominent causes identified were:

- Change of weather (29.4%): 62.5% in Alton, 23% in Aquadene/ Brackenham, 35.3% in Arboretum, 32.8% in Empangeni Rail, 13.2% in Nseleni, 3% in Meer en See and 37.8% in Umhlathuze
- Cigarette smoking (25.3%): 75% in Alton, 39.3% in Aquadene/ Brackenham, 5.9% in Arboretum, 32.8% in Empangeni Rail, 30.3% in Nseleni, 15.2% in Meer en See and 20.1 % in Umhlathuze.
- Colds or flu (22.5%): 50% in Alton, 26.2% in Aquadene/ Brackenham, 23.5% in Arboretum, 19.7% in Empangeni Rail, 13.2% in Nseleni, 21.2% in Meer en See and 23.8% in Umhlathuze.
- Pollen, trees, fresh cut grass (19.8%): 75% in Alton, 24.6% in Aquadene/ Brackenham, 35.3% in Arboretum, 13.1% in Empangeni Rail, 13.2% in Nseleni, 27.3% in Meer en See and % in 10.4 Umhlathuze.

- Sprays of strong smells (perfumes, colognes, domestic cleaning agents, etc.) (21.7%): 75% in Alton, 41% in Aquadene/ Brackenham, 5.9% in Arboretum, 13.1% in Empangeni Rail, 5.3% in Nseleni and 31.1% in Umhlathuze
- Pets (17.5%): 75% in Alton, 45.9% in Aquadene/ Brackenham, 11.8% in Arboretum, 9.8% in Empangeni Rail, 13.2 % in Nseleni, 6.1% in Meer en See and 11% in Umhlathuze.

Some of the respondents stated mold and mildew (9.6%), being physically active (7.9%) and certain types of food (7.5%). A few (3.5%) from Arboretum and Meer en See did not respond and one respondent in Umhlathuze stated being HIV positive.

There is no discernible pattern emerging in relation to the responses. However, more respondents living in middle/ upper income areas identified causes. This could be attributed to greater awareness. As indicated earlier, these communities also had a higher level of awareness about organizations, specifically RBCAA that shares information about pollution. It is interesting to note that although this study indicates that socio-economic conditions (particularly aspects such as poverty, racism, gender inequality, etc.) contribute significantly to health conditions at the household level, none of the respondents identified these aspects. The focus was on environmental aspects and may be attributed to how the question was asked. Care should be taken in future research to ensure that socio-economic factors are included in surveys in a more succinct manner.

When this aspect was raised during the focus group discussion, the participants identified broader socio-economic as well as environmental causes during a ranking exercise conducted. Tables 5.43 and 5.44 below present the ranking matrix and results, respectively. Industrial was ranked 1 and reflects the survey respondents' perceptions that industrial pollution was the main cause of health problems among households in Richards Bay. This resonates with the literature that air pollution is a serious problem in Richards Bay. Poor facilities and infrastructure was ranked second and indicates the importance that community members place on proper and adequate facilities and infrastructure. Poverty/ unemployment and poor housing was ranked three. The links between socio-economic deprivation (housing condition being strongly related to economic status) is regarded as important in terms of health issues in a community. Housing condition, as illustrated earlier creates exposure conditions that initiate or exacerbate illnesses. Poverty is directly linked to socio-economic vulnerabilities. Indoor pollution (specifically the use of fuelwood, paraffin and gas which are often used among the poor) was ranked 5. Again, the combination of outdoor pollution and indoor pollution in some communities emerge as a double jeopardy for the poor. Change of weather was ranked 6. It is interesting to note that during the focus group discussions climate change and negative health impacts in particular were underscored. This is supported by several researchers including Bollen *et al*. (2009), Oudinet *et al*. (2006), Rive (2010) and Yoon and Lee (2003). Cigarette smoking (discussed later in greater detail) was ranked 7. Dust (which is linked to pollution and weather patterns) was ranked 8. Water pollution, poor health facilities and mold and mildew were ranked 9 while lack of education and inadequate nutrition were the least ranked (12) causes.

Table 5.43: Ranking matrix

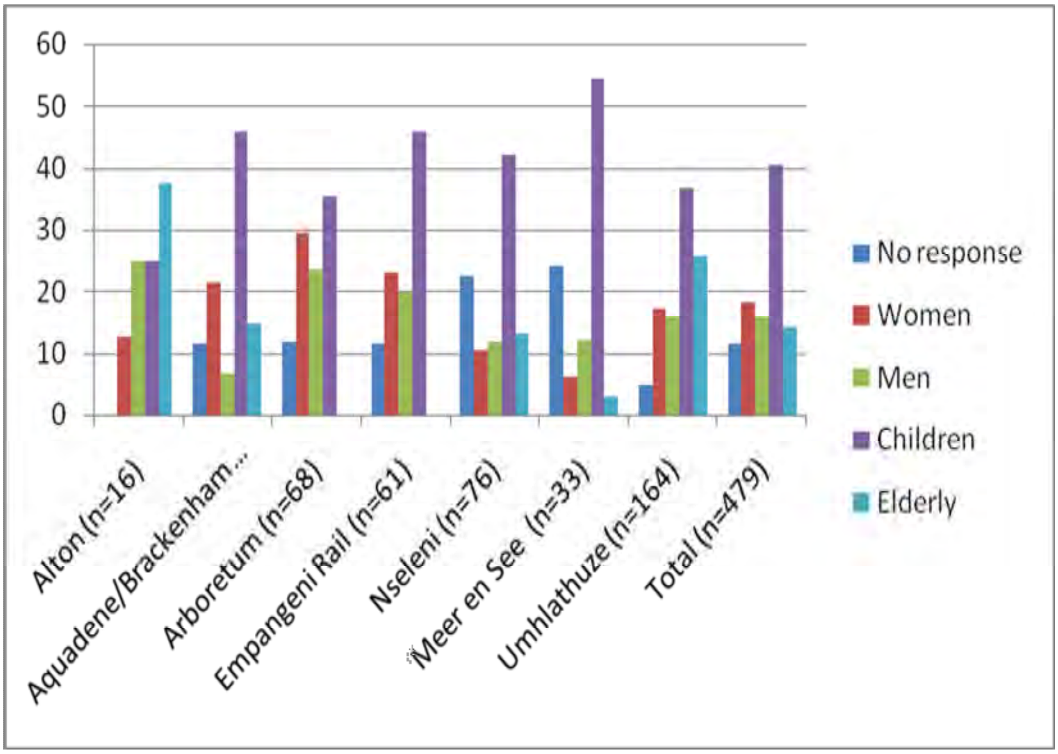
	IP	D	WP	P/U	IN	PFI	PHC	PHF	MM	LE	FPG	CS	CW
IP		IP	IP	IP	IP	IP	IP	IP	IP	IP	IP	IP	IP
D			WP	P/U	D	PFI	PHC	D	MM	D	FPG	CS	D
WP				P/U	WP	PFI	PHC	PHF	MM	WP	FPG	CS	CW
P/U					P/U	PFI	PHC	P/U	P/U	P/U	P/U	P/U	P/U
IN						PFI	PHC	PHF	MM	IN	FPG	CS	CW
PFI							PFI	PFI	PFI	PFI	PFI	PFI	CW
PHC								PHF	PHC	PHC	PHC	PHC	PHC
PHF									FPG	FPG	FPG	CS	CW
MM										MM	FPG	CS	CW
LE											FPG	LE	CW
FPG												FPG	FPG
CS													CW
CW													

Table 5.44: Scoring of ranking exercise

Causes	Code	Frequency	Rank
Industrial pollution	IP	12	**1**
Dust	D	4	**8**
Water pollution	WP	3	**9**
Poverty/ unemployment	P/U	9	**3**
Inadequate nutrition	IN	1	**12**
Poor facilities and infrastructure (water, sanitation, etc.)	PFI	10	**2**
Poor housing conditions	PHC	9	**3**
Poor health facilities	PHF	3	**9**
Mold and mildew	MM	3	**9**
Lack of education	LE	1	**12**
Use of fuelwood, paraffin, gas (indoor pollution)	FPG	8	**5**
Cigarette smoking	CS	5	**7**
Change of weather	CW	7	**6**

It is important to note that participants underscored that there were underlying causes that tend to worsen the health conditions of community members. For example, they reiterated what is a key assertion in the literature that poverty makes groups more vulnerable to be exposed to air pollution. This is also linked to the discourse on environmental justice and racism presented in the conceptual framework.

Figure 5.21: Mostly affected by health condition (in%)



Children were identified by 40.5% of the respondents to be the most affected members of the household by the stated health condition, while women accounted for 18.2% of the responses, men were reported by the respondents as being mostly affected by 15.7% of respondents and about 14.2% of the respondents said that the elderly were mostly affected by the stated health condition (Figure 5.21). In all the study areas the majority of the respondents indicated that children were mostly affected (25% in Alton, 45.9% in Aquadene/ Brackenham, 35.3% in Arboretum, 45.9% in Empangeni Rail, 42.1% in Nseleni, 54.5% in Meer en See and 36.6% in Umhlathuze). Almost 12% of the respondents did not indicate who in the household was mostly affected by the stated health condition. The responses support the literature that women and children are the most vulnerable (Braveman, 2008; Brulle and Pellow, 2006; Higginbotham *et al.*, 2010; Jin *et al.*, 2006; Larson and Rosen, 2002; Sze and London, 2008).

Table 5.45: Source of treatment for health conditions (Multiple responses, in %)

	A (n=16)	**A/B (n=61)**	**Ar (n=68)**	**ER (n=61)**	**E (n=76)**	**MS (n=33)**	**UV (n=164)**	**Total (n=479)**
Private doctor	100	98.4	58.8	47.5	27.6	81.8	39	53.7
Local clinic	12.5	13.1	35.3	29.5	63.2	24.2	34.8	34.4
Private hospital	25	11.5	17.6	19.7	-	42.4	9.8	13.6
State hospital	-	-	5.9	3.3	17.1	-	20.7	11.1
Traditional healer	-	-	-	-	2.6	-	4.9	2.1

Slightly more than half of the respondents (53.7%) from all the study areas seek medical treatment from a private doctor (100% in Alton, 98.4% in Aquadene/ Brackenham, 58.8% in Arboretum, 47.5% in Empangeni Rail, 27.6% in Nseleni, 81.8% in Meer en See and 39% in Umhlathuze) (Table 5.45). The local clinic is the source of treatment for health conditions by 34.4% of the respondents from all the study areas (12.5% in Alton, 13.1% in Aquadene/ Brackenham, 35.3% in Arboretum, 29.5% in Empangeni Rail, 63.2% in Nseleni, 24.2% in Meer en See and 34.8% in Umhlathuze), while 13.6% used the private hospital (25% in Alton, 11.5% in Aquadene/ Brackenham, 17.6% in Arboretum, 19.7% in Empangeni Rail, 42.4% in Meer en See and 9.8% in Umhlathuze) and 11.1% of the respondents sought treatment from the state hospital (5.9% in Arboretum, 3.3% in Empangeni Rail, 17.1% in Nseleni and 20.7% in Umhlathuze). A few of the respondents (1.7%) sought treatment from a traditional healer (2.6% in Nseleni and 4.9% in Umhlathuze). The responses indicate that the economically better off communities (Alton, Aquadene/ Brackenham, Arboretum and Meer en See) used the private, more expensive health care sector while generally households in lower income areas tend to rely on public or traditional health care facilities. Moodley (2002) illustrates the inequalities in health care facilities and services in South Africa, particularly in terms of quality.

Table 5.46: Frequency of treatment for health conditions (Multiple responses, in %)

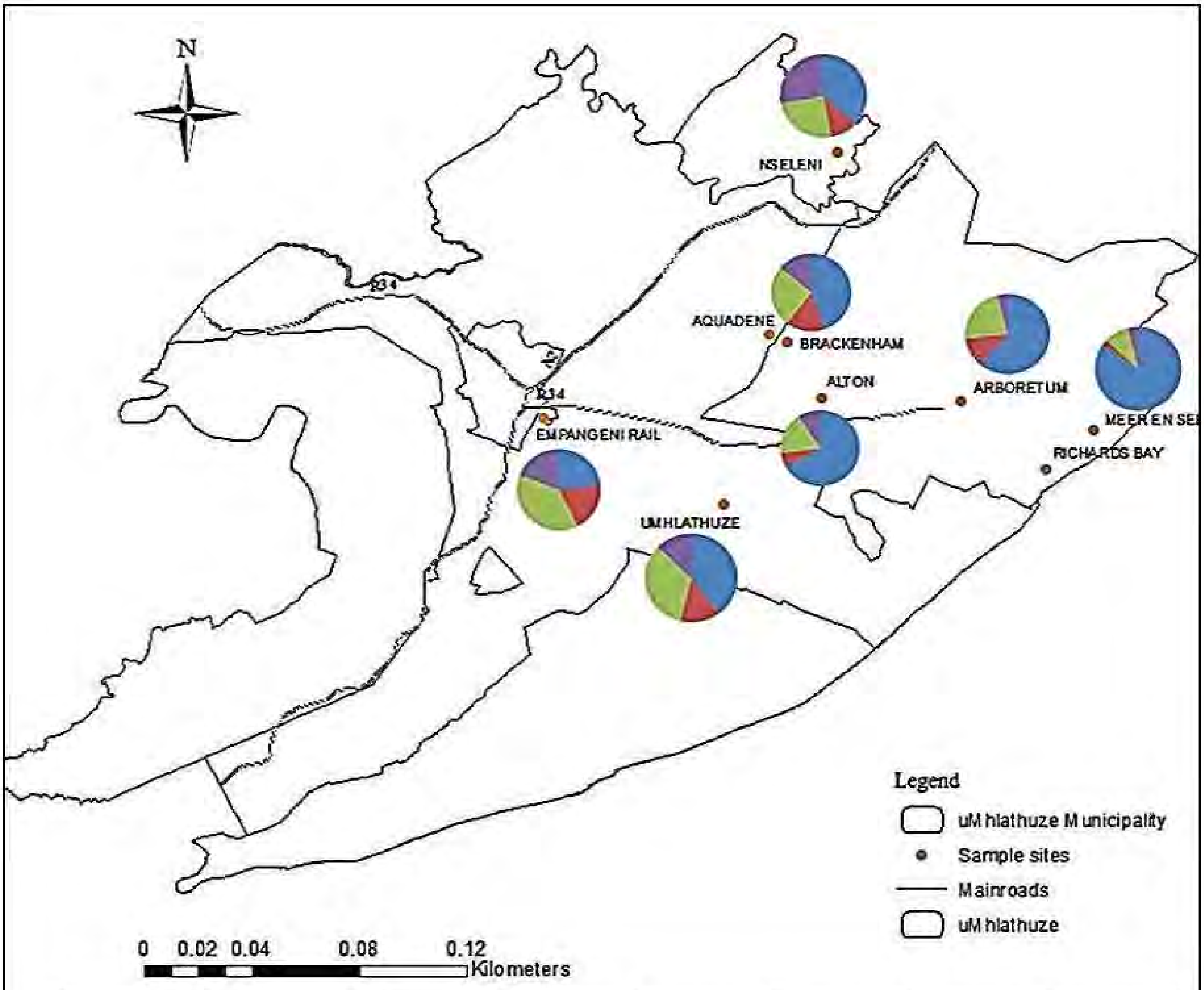
	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
Weekly	12.5	4.9	-	3.3	6.6	-	26.8	11.7
Monthly	25	34.4	17.6	49.2	60.5	15.2	37.2	37.4
6 monthly	75	42.6	47.1	29.5	7.9	27.3	24.4	29.9
Yearly	12.5	18	5.9	9.8	23.7	9.1	11.6	13.2
Every 2 months	-	-	-	8.2	-	-	-	1
Occasionally	-	-	-	-	-	6.1	0.6	0.6
Seasonally	-	-	11.8	-	-	-	-	1.7
Sometimes	-	-	5.9	-	2.6	33.3	-	3.5
Only when sick	-	-	17.6	-	2.6	9.1	1.8	4.2

The frequency of treatment for health conditions by a member/s of the respondents' household is displayed in Table 5.46. Most respondents (37.4%) reported that the member/s of the household need to source treatment monthly, while 29.9% said treatment is sourced on a six monthly basis, 13.2% said that the treatment was sourced yearly and 11.7% of the respondents reported that the member/s of the household sourced treatment weekly. Only 1% of the respondents indicated that treatment was sourced every 2 months. The respondents also indicated that treatment for the health condition was sourced occasionally (0.6%), seasonally (1.7%), and sometimes (3.5%). Treatment for the health condition was reported by 4.2% of the respondents to be sourced only when sick. Most households from all communities use health care facilities on a monthly or half-yearly basis.

5.8.2 Selected health ailments related to air pollution and the respiratory system

The ailments that are discussed in this section are coughing, wheezing, chest illness and asthma. Figure 5.22 spatially shows the prevalence of these health conditions amongst the sampled population.

Figure 5.22: Main health condition in the household (Multiple responses, in % - yes responses only)



	Alton (n=54)	Aquadene/ Brackenham (n=280)	Arboretum (n=169)	Empangeni Rail (n=298)	Nseleni (n=361)	Meer en See (n=109)	Umhlathuze (n=672)
Coughing	81.5	22.9	37.9	8.1	13.9	65.1	24
Wheezing	7.4	7.9	7.1	6.7	3.9	1.8	8.3
Chest pains	22.2	13.2	14.2	13.4	9.4	7.3	20.1
Asthma	11.1	7.1	2.4	6.7	10.5	2.8	7.7

Among the respiratory illnesses examined, most respondents (24.6%) indicated that a household member experienced coughing (81.5% in Alton, 22.9% in Aquadene/ Brackenham, 37.9% in Arboretum, 8.1% in Empangeni Rail, 13.9% in Nseleni, 65.1% in Meer en See and 24% in Umhlathuze). This was followed by chest pains (14.9%) (22.2% in Alton, 13.2% in Aquadene/ Brackenham, 14.2% in Arboretum, 13.4% in Empangeni Rail, 9.4% in Nseleni, 7.3% in Meer en See and 20.1% in Umhlathuze). Fewer households (7.7%) indicated wheezing (7.4% in Alton, 7.9% in Aquadene/ Brackenham, 7.1% in Arboretum, 6.7% in Empangeni Rail, 3.9% in Nseleni, 1.8% in Meer en See and 8.3% in Umhlathuze). The least responses (7.4%) were for asthma (11.1% in Alton, 7.1% in Aquadene/ Brackenham, 2.4% in Arboretum, 6.7% in Empangeni Rail, 10.5% in Nseleni, 2.8% in Meer en See and 7.7% in Umhlathuze). There were significant differences among the communities which could not be explained by economic status or distance from main polluting industries alone. This suggests that other factors are at play that impact on the health status of individuals in relation to respiratory illnesses. These differences will be discussed further later. However, it is important to note that the map reveals that coughing correlated with the closeness to the industrial zone.

Table 5.47: Number of years household members experiencing cough (Multiple responses, in %)

	A (n=44)	**A/B (n=64)**	**Ar (n=64)**	**ER (n=24)**	**N (n=50)**	**MS (n=71)**	**U (n=161)**	**Total (n=478)**
No response or N/A	31.8	18.7	14	8.3	20	22.5	23.6	21.1
Don’t know	13.6	6.2	-	-	-	-	7.4	4.6
>year	4.5	17.1	23.4	33.3	24	19.7	15.5	18.2
1-2years	-	7.8	25	29.1	14	16.9	13.6	14.4
3-4years	13.6	15.6	18.7	16.6	20	9.8	16.7	15.8
4-5 years	4.5	14	6.2	-	8	2.8	8.6	7.3
6-7years	-	6.2	6.2	-	-	5.6	-	3.3
8-9years	31.8	9.3	-	-	-	12.6	1.2	6.4
10-14 years	-	-	6.2	8.3	4	2.8	4.3	3.9
15-20 years	-	1.5	-	-	6	7.0	4.9	3.5
40 years	-	3.1	-	4.1	-	-	3.7	1.8

As mentioned previously, 478 household members experience symptoms of coughing. The data indicates (Table 5.47) that household members have been experiencing the symptoms for less than 1 year (18.2%), 1-2 years (14.4%), 3-4 years (15.8%), 4-5 years (7.3%), 6-7 years (3.3%) 8-9 years (6.4%) and 10 -14 years (3.9%). A small percentage of respondents (3.5%) indicated that the affected household member/ s have been affected with coughing for duration of 15-20 years, while 1.8% of the household members were affected with coughing for 40 years. Few respondents (4.6%) did not know how long the affected household member/s has/ have been affected by the cough.

Table 5.48: Whether household members cough on most days of the week for a period of 3 months (in %)

	A (n=44)	A/B (n=64)	Ar (n=64)	ER (n=24)	E (n=50)	MS (n=71)	UV (n=161)	Total (n=478)
Yes	90.9	71.8	18.7	70.8	64	22.5	77.6	60.3
No	9.1	28.1	81.3	29.1	36	77.4	22.3	39.7

Almost 60% of household members cough on most days of the week for a period of 3 months, while 39.7% did not cough on most days during the same period. Table 5.48 also shows that the majority of household members from Umhlathuze (77.6%), Nseleni (64%), Empangeni rail (70.8%), Aquadene/ Brackenham (71.8%) and Alton (90.9%) coughed on most days of the week for a period of 3 months. Respondents in Arboretum (81.3%) and Meer en See (77.4%) did not cough frequently, although most respondents indicated that at least one household member coughs in these areas.

Table 5.49: Frequency of wheezing attacks (in %)

	A (n=4)	A/B (n=22)	Ar (n=12)	ER (n=20)	N (n=14)	MS (n=2)	U (n=56)	Total (n=130)
No response	-	27.2	-	10	-	-	25	16.9
Once a day	75	18.1	66.8	35	57.1	-	23.2	33.0
Several times a month	25	27.2	33.2	30	42.8	100	32.1	33.0
During season change	-	27.2	-	15	-	-	12.5	12.3
After sport	-	-	-	10	-	-	3.5	3.0
After smoking	-	-	-	-	-	-	3.5	1.5

Wheezing attacks were reported by 33% of respondents as occurring once a day and several times a month respectively, while 12.3% of the respondents indicated that the wheezing attacks occur only during season change (Table 5.49). A small percentage of respondents indicated that their wheezing attacks after sport (3%) and after smoking (1.5%). These respondents were from Umhlathuze (7%) and Empangeni Rail (10%). No responses on the frequency of attacks was received from 16.9% of the respondents. All respondents in Meer en See indicated that they wheeze several times a month.

Table 5.50: Whether household members require medication for wheezing attacks (in %)

	A (n=4)	A/B (n=22)	Ar (n=12)	ER (n=20)	E (n=14)	MS (n=2)	UV (n=56)	Total (n=130)
NA/ No response	-	27.2	-	-	21.4	-	7.1	10
Yes	100	54.5	100	70	57.2	100	80.3	74.6
No	-	18.1	-	30	21.4	-	12.5	15.4

The majority of the respondents (74.6%) indicated that medication was required to alleviate the wheezing attacks of the affected household member/s, while 15.4% of the respondents namely from Umhlathuze (12.5%), Nseleni (21.4%), Empangeni rail (30%) and Aquadene/ Brackenham (18.1%) indicated that the affected household member/s did not require any medicine (Table 5.40). Ten percent of the respondents did not indicate if the affected household member/s required any medication for their wheezing attacks.

Table 5.51: Whether household members were hospitalized for chest pains (in %)

	A (n=12)	A/B (n=37)	Ar (n=22)	ER (n=40)	N (n=34)	MS (n=8)	U (n=135)	Total (n=288)
No response	-	5.5	-	35	17.6	-	-	7.6
Yes	58.3	45.9	59.1	40	14.7	-	20	29.5
No	41.7	48.6	40.9	25	67.6	100	80	62.9

Of the total number of respondents who indicated that a member/s of the household has chest pains (n=288), the majority of respondents from all the study areas (62.9%) reported that the member/s was hospitalized as a result of the chest pains, while 29.5% said that the member/s did not need hospitalization (Table 5.51). More than 7% of respondents did not indicate if the member/s were hospitalized for chest pains.

Table 5.52: At what age did asthma begin (in %)

	A (n=6)	A/B (n=20)	Ar (n=4)	ER (n=20)	N (n=38)	MS (n=3)	U (n=52)	Total (n=143)
0-5 years	50	45	100	35	34.2	-	52	44.0
6-10 years	16.7	30	-	20	23.6	100	27	25.8
11-15 years	-	10	-	15	21.0	-	11.5	13.8
16- 20 years	33.3	-	-	-	7.8	-	5.7	5.5
> 20 years	-	15	-	30	13.1	-	3.8	11

Asthma was reported by 69.8% of the respondents as having started for the affected household member/s under the age of 10 years old (Table 5.52). Forty four percent of respondents indicated that the asthma started below the age of 5 years while 25.8% of the respondents reported that the asthma began between the ages 6-10 years old. Almost 14% of the respondents indicated that the asthma began for the household member/s between the ages 11-15 years. A small percentage of the respondents reported the asthma to have started between the ages 16-20 years, while 11% of the respondents indicated that asthma started for the affected member/s of the household after the age of 20 years. This relates to the literature which highlights that asthma commonly affects young children.

Table 5.53: Does household member/s still have asthma (in %)

	A (n=6)	A/B (n=20)	Ar (n=4)	ER (n=20)	E (n=38)	MS (n=3)	UV (n=52)	Total (n=143)
Yes	83.3	85	100	80	68.4	100	73.0	79.5
No	1.7	15	-	20	31.6	-	15.3	20.4

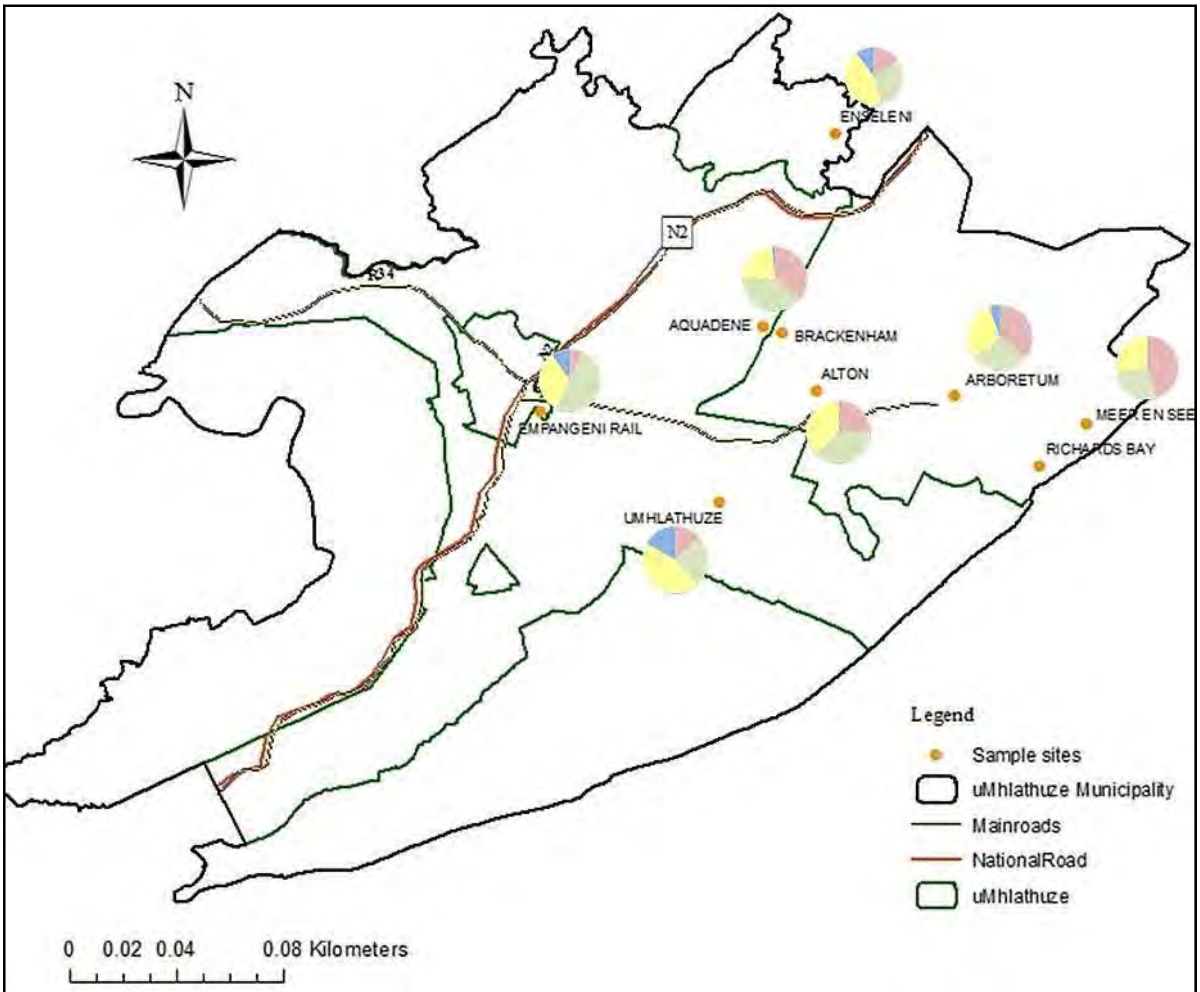
Almost 80% of the respondents who indicated that a household member experienced asthma attacks reported that the affected household member/s still have asthma and the remaining 20.4% of respondents reported that they do not suffer from asthma anymore (Table 5.53).

Table 5.54: Whether household member/s take medication for asthma (in %)

	A (n=6)	A/B (n=20)	Ar (n=4)	ER (n=20)	E (n=38)	MS (n=3)	UV (n=52)	Total (n=137)
Yes	83.3	85	100	80	68.4	100	73.0	79.5
No	1.7	15	-	20	31.6	-	15.3	20.4

A large percentage of the respondents from all the study areas (79.5%) who indicated that a household member experienced asthma reported that the household member/s take medication to alleviate or control their asthmatic condition, while 20.4% of the respondents indicated that the member/s did not take medication for the asthma (Table 5.54). These respondents were from Alton (1.7%), Aquadene/ Brackenham (15%), Nseleni (31.6%), Umhlathuze (15.3%) and Empangeni Rail (20%).

Figure 5.23: Perceptions of respondents of general health status of household (in%)



	Alton (n=16)	Aquadene/ Brackenham (n=61)	Arboretum (n=68)	Empangeni Rail (n=61)	Nseleni (n=76)	Meer en See (n=33)	Umhlathuze (n=164)
Excellent	25	36.1	35.3	6.6	15.8	45.5	13.4
Good	37.5	39.3	29.4	50.8	30.3	27.3	25
Satisfactory	37.5	23	29.4	32.8	43.4	27.3	44.5
Poor	-	1.6	5.9	9.8	10.5	-	17.1

The general health status of the respondents is displayed in Figure 5.23. Most of the respondents felt that their health status was excellent (21.5%: 25% in Alton, 36.1% in Aquadene/ Brackenham, 35.3% in Arboretum, 6.6% in Empangeni Rail, 15.8% in Nseleni, 45.5% in Meer en See and 13.4% in Umhlathuze) or good (32.2%: 37.5% in Alton, 39.3% in Aquadene/ Brackenham, 29.4% in Arboretum, 50.8% in Empangeni Rail, 30.3% in Nseleni, 27.3% in Meer en See and 25% in Umhlathuze) with more respondents from the middle/ upper income areas than the lower income areas. A significant proportion of the respondents

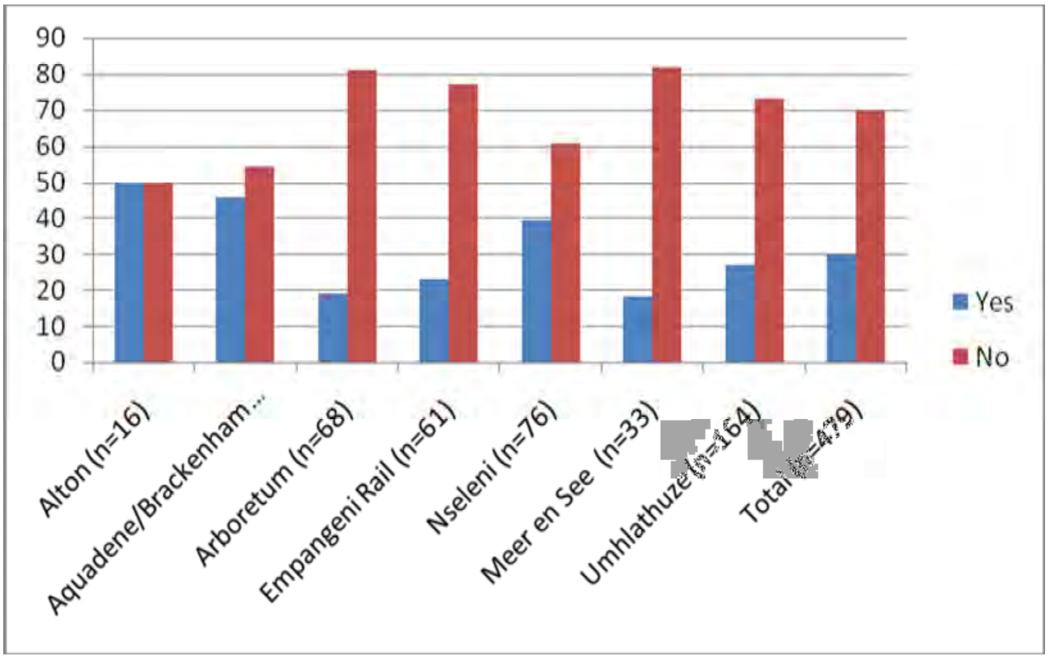
(36.5%: 37.5% in Alton, 23% in Aquadene/ Brackenham, 29.4% in Arboretum, 32.8% in Empangeni Rail,43.4 % in Nseleni, 27.3% in Meer en See and 44.5% in Umhlathuze) felt that they had a satisfactory health status. Some of the respondents (9.8%) from Aquadene/ Brackenham (1.6%), Arboretum (5.9%), Empangeni Rail (9.8%), Nseleni (10.5%) and Umhlathuze (17.15) felt that their state of health was poor. These responses are interesting since there appears to be a level of satisfaction with general health status yet there are high concerns about air pollution and other health hazards as well as relatively high prevalence of illnesses in the communities under study. This could be linked to feelings of place attachment, as indicated by Jaggernath (2010), where people living in polluted areas such as the South Durban Area express satisfaction with aspects of their lives.

The differences between household level prevalence of selected ailments (coughing, wheezing, asthma and chest pains) and the prevalence of diseases amongst all household members presented in Table 5.40 can be attributed to two aspects:

- The number of household members afflicted with an illness: This implies that in some households more members experience respiratory related problems while in others there were few or none. This was particularly noticeable in relation to coughing were household members in the middle/ upper income groups in Alton and Meer en See specifically experienced considerably higher prevalence of coughing. This could be as a result of their residing in close proximity to the main polluting industries. Coughing is largely in this case a symptom of air pollution irritation and not necessarily indicative of serious illnesses since there is generally a lower prevalence of illnesses these communities. Also, at the sampled population level, these communities have lower prevalence in relation to wheezing, asthma and chest pains.
- The differences could also be indicative of the lack of understanding of diseases within the communities, particularly among lower income groups who may not have access to health care facilities. They may, for example, have members suffering from asthma as well as wheezing but they see it simply as difficulty in breathing. It is therefore imperative that environmental and health education be improved as well as programs be put into place to diagnose the health conditions of people living in areas such as Richards Bay that have high air pollution levels. This is particularly important in relation to children because proper diagnosis and health care can reduce the severity and length of ailments thereby improving quality of life.

The literature (Birch *et al*., 2000; Larsen and Rosen, 2002; Mestl, 2006; Mestle *et al*., 2007; Neidell, 2004) and results from this study indicate that cigarette smoking is a serious health concern in the household. Cigarette smoking is a key indoor polluter. Figure 5.22 indicates whether a member of the household smokes in the home.

Figure 5.24: Whether member/s of the household smokes in the home (in %)



The majority of respondents from all the households within all the study areas (70.1%) specified that member/s of the household do not smoke in the home (Figure 5.24). However, 29.9% of the respondents, also from all the study areas, reported that member/s of the household smoke in the home. This is a significant number of households since smoking does not only affect the health of the smoker but those around them through secondary smoking.

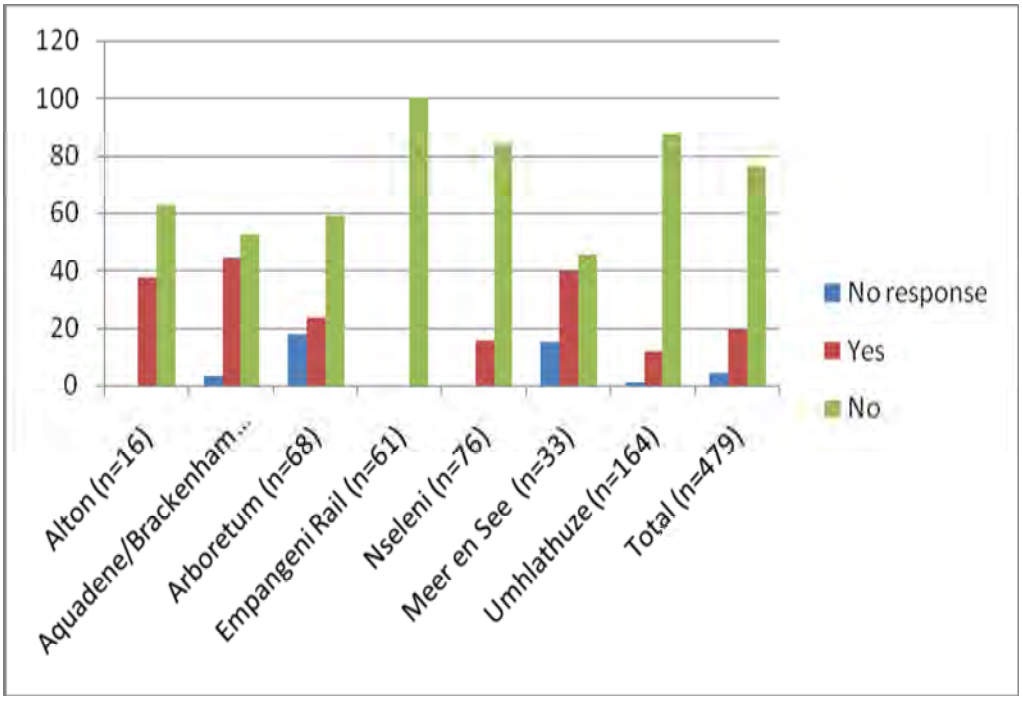
Table 5.55: Number of people who smoke in the home (in %)

	A (n=8)	**A/B (n=28)**	**Ar (n=12)**	**ER (n=14)**	**N (n=30)**	**MS (n=6)**	**U (n=44)**	**Total (n=142)**
1	75	46.4	100	71.4	80	83.3	79.5	73.9
2	25	35.7	-	28.6	13.3	16.7	20.5	21.1
3	-	17.9	-	-	-	-	-	3.5
4	-	7.1	-	-	-	-	-	1.4
7	-	-	-	-	6.7	-	-	1.4
Average	**1.3**	**2**	**1**	**1.3**	**1.5**	**1.2**	**1.2**	**1.4**

The average number of persons who smoked in the household was 1.4 (1.3 in Alton, 2 in Aquadene/ Brackenham,1 % in Arboretum, 1,3% in Empangeni Rail, 1.5% in Nseleni, 1.2%

in Meer en See and 1.2% in Umhlathuze) and ranged from 1 to 7 (Table 5.55). Ninety five percent of the respondents from all the study areas in Richards Bay who reported that member/s of the household smoke stated that one (73.9%: 75% in Alton, 46.4% in Aquadene/ Brackenham, 100% in Arboretum, 71.4% in Empangeni Rail, 80% in Nseleni, 83.3% in Meer en See and 79.5% in Umhlathuze) or two (21.1%: 25% in Alton, 35.7% in Aquadene/ Brackenham, 28.6% in Empangeni Rail, 13.3% in Nseleni, 16.7% in Meer en See and 20.5% in Umhlathuze) members of the household smoke within the home. Twenty five percent of the respondents in Aquadene/ Brackenham reported that there are 3-4 members that smoke within the home and 6.7% of respondents in Nseleni reported that 7 members of the household smoke within the home. Cigarette smoking is a worrying trend in all communities.

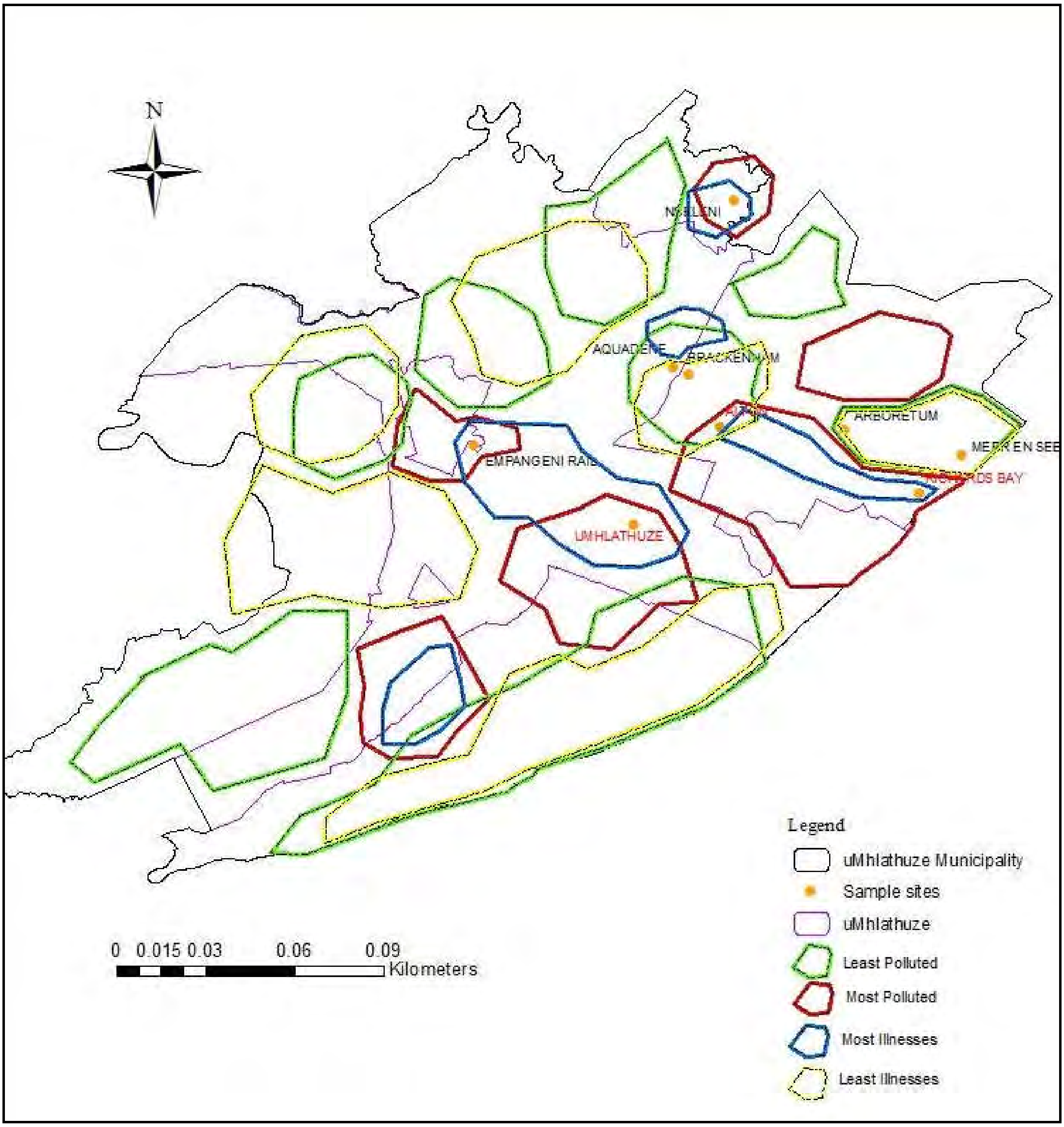
Figure 5.25: Whether pets live in the home (in %)



Pets also emerge in the literature and even in terms of the perceived cause of health problems in the communities as a concern. A small percentage of respondents (19.4%) said that they have pets that live within the home, while 76% of the respondents said that they do not have pets that live in the home and 4.4% did not indicate if they have a pet that lives in the home or not (Figure 5.25).

The issue of the prevalence of diseases was also addressed during the focus group discussion. More specifically, participants were asked to indicate least and most polluted areas as well as areas that had high and low illness prevalence rates. The resultant map is presented in Figure 5.26.

Figure 5.26: Participatory mapping of pollution and illnesses

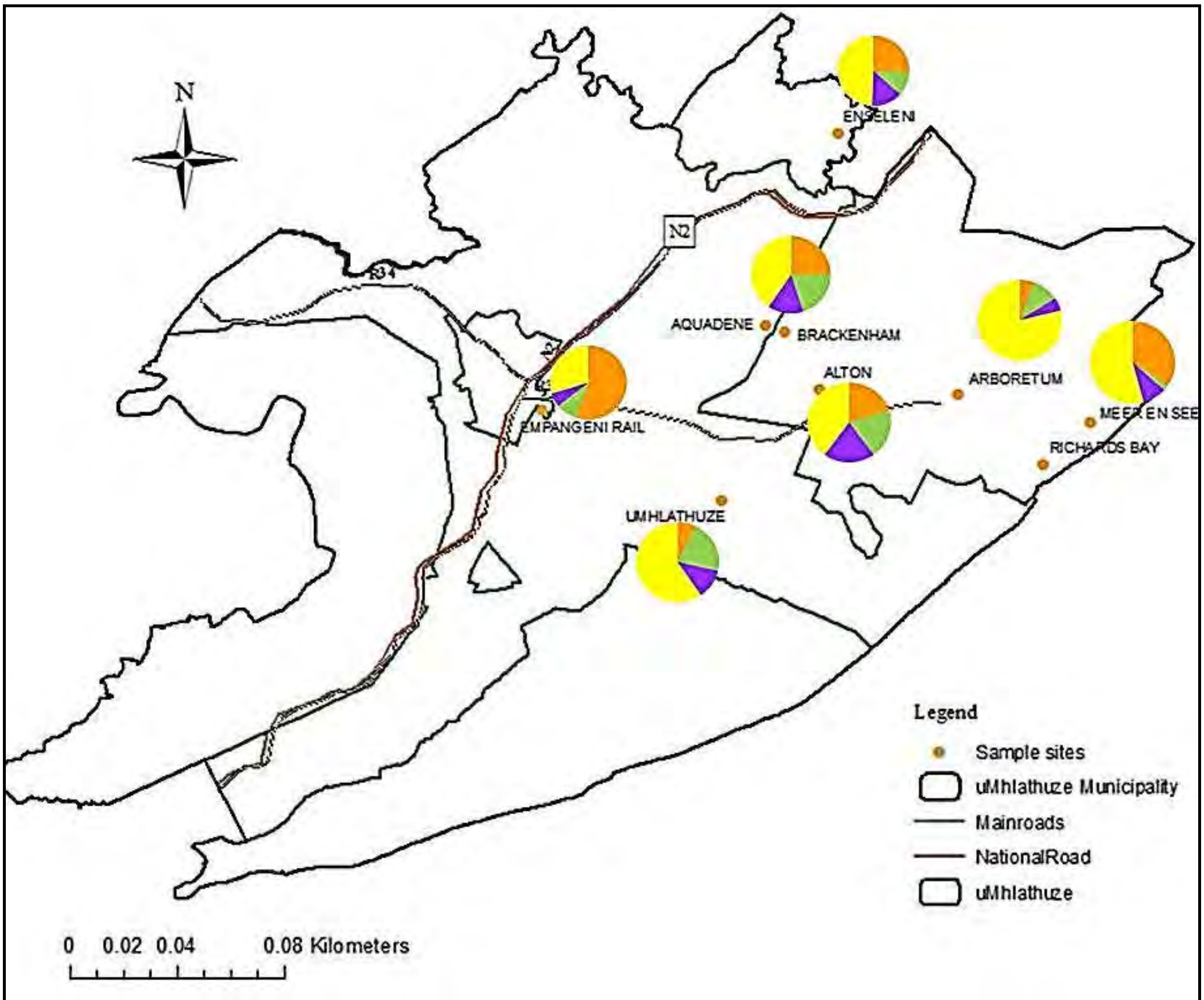


The map shows that once again most polluted areas are within or in close proximity to the industrial zone as well as the built environments of Empangeni as well as the mining area to the north. The least polluted areas were in the periphery (particularly with rural areas) and in the communities deemed to be middle/ upper income areas. In terms of perceptions regarding illnesses, the most prevalent areas were clearly seen to be in the lower income areas and within or close to the industrial zone. Interestingly, care was taken to ensure that the most illnesses did not cover Alton, Arboretum or Meer en See (the middle/ upper income areas). The least illnesses were in these areas together with the least populated areas. Once again, there is overlap in relation to both the most and least polluted as well as areas with the most and least illnesses. The results reinforce the importance of considering perceptions and indicate that even during focus groups, which tend to be consensus-orientated, differences emerged.

5.9 Household Coping Strategies: Air Pollution and Health Implications

As indicated in the literature review chapter, research reveals that households and communities in general utilize a range of strategies to deal with air pollution and health impacts (Bevc *et al.*, 2007; Hunter *et al.*, 2003; Larson and Rosen, 2002; Makri and Stilianalis, 2008; Smith and Mehta, 2000). These strategies relate to socio-economic and political aspects as well as attempts to change environmental conditions within the household and in the area. Respondents were asked to indicate whether they employed the control measures listed in Figure 5.27.

Figure 5.27: Control measures employed for household health conditions (Multiple responses, in %)



	Alton (n=16)	Aquadene/ Brackenham (n=61)	Arboretum (n=68)	Empangeni Rail (n=61)	Nseleni (n=76)	Meer en See (n=33)	Umhlatuze (n=164)
Removed visible mold growth	37.5	36.1	5.9	60.7	26.3	9.1	25
Removed pets from the home	37.5	29.5	11.8	9.8	11.8	27.3	1.8
Changed cigarette smoking rules in the home	37.5	21.3	5.9	6.6	14.5	15.2	6.7
Attempted to control/ remove insects / cockroaches	75	59	88.2	32.8	51.3	75.8	39.6

Some of the respondents (7.1%), in Alton (12.5%) and Umhlathuze (19.5%), did not provide a response. More than half of the respondents (53.7%) stated that the household attempted to control or remove insects or cockroaches (75% in Alton, 59% in Aquadene/ Brackenham, 88.2% in Arboretum, 32.8% in Empangeni Rail, 51.3% in Nseleni, 75.8% in Meer en See and 39.6% in Umhlathuze). The second most utilized control measure among the households interviewed was the removal of visible mold growth (27.8%: 37.5% in Alton, 36.1% in Aquadene/ Brackenham, 5.9% in Arboretum, 60.7% in Empangeni Rail, 26.3% in Nseleni, 9.1% in Meer en See and 25% in Umhlathuze). This was followed by removal of pets from the home (12.3%: 37.5% in Alton, 29.5% in Aquadene/ Brackenham, 11.8% in Arboretum, 9.8% in Empangeni Rail, 11.8% in Nseleni, 27.3% in Meer en See and1.8 % in Umhlathuze) and changing cigarette smoking rules in the home (11.3%: 37.5% in Alton, 21.3% in Aquadene/ Brackenham, 5.9% in Arboretum, 6.6% in Empangeni Rail, 14.5% in Nseleni, 15.2% in Meer en See and 6.7% in Umhlathuze). The results indicate that generally more households from the middle/ upper income areas used the control or removal of insects than those from lower income areas, possibly because of affordability constraints. The removal of visible mold growth was more prominent in the lower income communities which could be attributed to mold being more of a problem because of poorer housing conditions.

Table 5.56: Whether control measure alleviated the health condition (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	E (n=76)	MS (n=33)	UV (n=164)	Total (n=479)
NA	12.5	-	-	-	-	6.7	27.6	9.1
Yes	75	57.4	88.2	42.6	46.2	73.3	25.2	50.8
No	12.5	42.6	11.8	57.4	53.8	20	47.2	40

Close to half of the respondents (50.8%: 74% in Alton, 57.4% in Aquadene/ Brackenham, 88.2% in Arboretum, 42.6% in Empangeni Rail, 46.2% in Nseleni, 73.3% in Meer en See and 25.2% in Umhlathuze) indicated that the control measure used helped to alleviate the health condition, while 40% (12.5% in Alton, 42.6% in Aquadene/ Brackenham, 11.8% in Arboretum, 57.4% in Empangeni Rail, 53.8% in Nseleni, 20% in Meer en See and 47.2% in Umhlathuze) indicated that it did (Table 5.56). Some of the respondents (9.1%) from Aquadene/ Brackenham (12.5%), Meer en See (6.7%) and Umhlathuze (27.6%) did not indicate whether the control measure used in the household did/ did not help to alleviate the health condition. More respondents in the middle and upper income areas believed that the control measure/s used was/ were effective than the lower income area.

In addition to the control measures discussed, respondents were asked about the coping strategies that they use to deal with air pollution. The results presented in Table 5.57 show that six different coping strategies were used.

Table 5.57: Coping strategies used to deal with air pollution (Multiple responses, in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
None	25	24.6	19.1	68.9	59.2	9.1	74.4	50.9
Closing windows and doors	37.5	29.5	27.9	21.3	17.1	15.2	20.1	22.3
Leaving the home temporarily	12.5	43.7	7.5	1.6	-	12.1	1.8	4.6
Cooking outdoors rather than indoors	-	-	-	8.2	3.9	-	7.3	4.2
Using renewable energy sources such as solar energy	12.5	13.1	10.3	1.6	-	6.1	1.2	4.6
Purchasing better appliances such as stoves	31.3	37.7	27.9	-	1.3	39.4	-	12.7
Report industry to NGOs such as RBCAA or government organizations	18.8	27.9	17.6	-	1.3	45.5	-	10

Among the households that adopted a coping strategy, the most prominent was closing windows and doors (22.3% of most respondents: 37.5% in Alton, 29.5% in Aquadene/ Brackenham, 27.9% in Arboretum, 21.3% in Empangeni Rail, 17.1% in Nseleni, 15.2% in Meer en See and 20.1% in Umhlathuze). Some of the respondents, mainly in the middle and upper income areas, stated purchasing better appliances (12.7%: 31.3% in Alton, 37.7% in Aquadene/ Brackenham, 27.9% in Arboretum, 1.3% in Nseleni and 39.4% in Meer en See) and reporting industries (10%: 18.8% in Alton, 27.9% in Aquadene/ Brackenham, 17.6% in Arboretum, 1.3% in Nseleni and 45.5% in Meer en See). Fewer respondents identified using renewable energy sources (4.6%: 12.5% in Alton, 13.1% in Aquadene/ Brackenham, 10.3% in Arboretum, 1.6% in Empangeni Rail, 6.1% in Meer en See and 1.2% in Umhlathuze) Additionally, 4.5% of the respondents in the lower income areas stated that they cooked indoors (8.2% in Empangeni Rail, 3.9% in Nseleni and 7.3% in Umhlathuze). Slightly more than half of the respondents (50.9%) mainly in the lower income areas on Empangeni Rail (68.9%), Nseleni (59.2%) and Umhlathuze (74.4%) indicated that they did not adopt any coping strategies to deal with air pollution. This could be attributed to fewer options being available (for example, purchasing better appliances which is linked to affordability) and not being aware of organizations that could assist as indicated earlier. In any event, this is a worrying result since it indicates that most households in poorer areas do not or are unable to adopt coping strategies to deal with air pollution. This again reinforces the need for air pollution and health related education programs in these areas.

The responses support Makri and Stilianalis' (2008) assertion that the coping strategies adopted are linked to environmental, social, political or other factors which also influence exposure levels. The coping strategies identified by the survey respondents were also supported during the focus group discussion. Participants also stated the closing of windows, leaving the home temporarily and using masks were generally done when there was high levels of odor and air pollution. It is important to note that closing windows and doors can increase indoor pollution (particularly if fossil and biomass-based fuels are being used in the house such as wood, paraffin and gas). It was also highlighted that some people have moved out of the area because of persistent air pollution problems. This aspect was also included in the survey and is discussed next.

Table 5.58: Whether household considered moving out of the area (in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	E (n=76)	MS (n=33)	UV (n=164)	Total (n=479)
Yes	50	26.2	-	26.2	48.7	12.1	42.7	31.7
No	50	73.8	100	73.8	51.3	87.9	57.3	68.3

More than 31.1% of the respondents from all the study areas (50% in Alton, 26.2% in Aquadene/ Brackenham, 26.2% in Empangeni Rail, 48.7% in Nseleni, 12.1% in Meer en See and 42.7% in Umhlathuze), excluding Arboretum, reported that they considered moving out of the area and 68.3% indicated that they have not considered moving out of the area (Table 5.58). All respondents in Arboretum said that they have not considered moving out of the area.

Table 5.59: Reasons for wanting to move out of the area (Multiple responses, in %)

	A (n=8)	A/B (n=16)	ER (n=16)	N (n=37)	MS (n=4)	U (n=70)	Total (n=151)
Health impacts from industrial chemical	50	18.8	75	45.9	-	75.7	58.9
Environmental impacts	25	12.5	50	29.7	-	55.7	41.1
Work related	25	-	-	21.6	50	61.4	36.4
Personal reasons	75	68.8	-	56.8	50	71.4	59.6

Of the total number of respondents who indicated that they have considered moving out of the area, 58.9% (50% in Alton, 18.8% in Aquadene/ Brackenham, 75% in Empangeni Rail, 45.9% in Nseleni and 75.7% in Umhlathuze) said that they considered moving because of the health impacts that are associated with industrial chemicals and 41.1% (25% in Alton, 12.5% in Aquadene/ Brackenham, 50% in Empangeni Rail, 29.7% in Nseleni and 55.7% in Umhlathuze) said that they considered moving out of the area due to a range of environmental impacts (Table 5.59). Other reasons cited by respondents were that they considered moving out of the area due to personal reasons (59.6%: 75% in Alton, 68.8% in Aquadene/ Brackenham, 56.8% in Nseleni, 50% in Meer en See and 71.4% in Umhlathuze) and for work related reasons (36.4%: 25% in Alton, 21.6% in Nseleni, 50% in Meer en See and 61.4% in Umhlathuze). The results indicate that the main reasons for wanting to move out of the area related to environmental issues.

The results also reveal that whole middle/ upper income households are able to adopt adaptation strategies (such as purchasing better appliances), poorer households rely almost exclusively on coping or survivalist strategies (closing doors and windows as well as cooking outdoors), that is, no long-term changes to change or anticipate conditions. The latter residents are unable to adapt but rather merely cope. The environmental justice literature in particular calls for effective mitigation strategies to minimize air pollution impacts, it is clear that for poorer households their socio-economic positions do not allow them to adopt long-term adaptation strategies. Of concern is that even most households in the middle/ upper income areas (although to a lesser extent) do not appear to be adapting.

5.10 Challenges Households and Communities Face

At the end of the survey, respondents were asked to share their perceptions about the challenges that their households face compared to the community in general. This was done to establish where common problems/ challenges existed and what the differences were. Table 5.58 indicates the household challenges identified by the respondents.

Table 5.60: Household challenges (Multiple response, in %)

	A (n=16)	A/B (n=61)	Ar (n=68)	ER (n=61)	N (n=76)	MS (n=33)	U (n=164)	Total (n=479)
None	37.5	50.8	23.5	27.9	22.4	48.5	18.3	34.8
Air pollution	12.5	3.3	5.9	13.1	6.6	-	1.2	4.8
Overcrowding	-	-	-	3.3	11.8	-	7.3	4.8
Asthma	-	3.3	-	-	-	-	-	0.4
Crime	25	-	5.9	6.6	-	-	1.8	3.1
Poverty	-	-	11.8	3.3	6.6	-	11	6.9
Lack of education	-	-	-	-	-	9.1	-	0.6
Health implications	-	6.6	11.8	9.8	13.2	15.2	11.6	10.9
High cost of living	-	8.2	5.9	9.8	11.8	-	5.5	6.9
Insufficient security	-	1.6	-	-	-	-	-	0.2
Lack of basic services, e.g. electricity, water, sanitation	-	-	-	-	2.6	-	21.3	7.7
Lack of income	-	3.3	23.5	23	18.4	-	38.4	22.8
Old age	-	-	11.8	-	-	9.1	-	2.3
Loss of parents	-	3.3	2.9	-	-	-	-	0.8
Lack of employment opportunities	-	-	5.9	-	-	12.1	-	1.7
Poor housing	-	-	-	-	-	-	3	1
Lack of living space	-	-	-	-	-	-	7.3	2.5
Soil pollution	-	-	-	3.3	-	-	0.6	0.6
Water pollution	-	-	-	-	-	-	0.6	0.2
Lack of savings	-	6.6	-	6.6	6.6	-	7.3	5.2
Noise pollution	**25**	3.3	2.9	-	-	-	-	1.7
Chest illness	-	-	-	-	-	-	1.2	0.4
Children’s health	-	-	-	-	-	-	2.4	0.8
Hijackings	-	1.6	-	-	-	-	-	0.2
Traffic congestion	**37.5**	6.6	-	-	-	-	-	2.1
Unemployment	-	-	-	-	6.6	-	4.3	2.5

A range of household challenges that were listed by respondents from all the study areas are presented in Table 5.60 above. The Table indicates that 22.8% of the respondents felt that the main challenge facing the household is a lack of income (38.4% in Umhlathuze, 18.4% in Nseleni, 23% in Empangeni Rail, 23.5% in Arboretum and 3.3% in Aquadene/ Brackenham). Almost 11% of the respondents from all the study areas excluding Alton felt that households are subjected to health implications, while 7.7% said that main challenges facing the household was a lack of basic services such as electricity, water and sanitation. Poverty and the high cost of living was identified by 6.9% of respondents, while air pollution and overcrowding were reported as challenges that households in Richards Bay were subjected to by 4.8% of respondents. A few respondents from Umhlathuze (7.3%), Nseleni (6.6%), Empangeni Rail (6.6%) and Aquadene/ Brackenham said that challenges facing the households include a lack of savings. The Table also shows that respondents felt that crime (3.1%), lack of living space (2.5%), unemployment (2.5%), lack of employment opportunities (1.7%), insufficient security (0.2%), lack of education (0.6%), poor housing (1%), traffic congestion (2.1%) and hijackings (0.2%) were also household challenges. Asthma, chest illnesses and children's health were also listed as challenges by 1.6% of the respondents. Water, soil and noise pollution accounted for 2.5% of the responses. In addition 2.3% of the respondents felt that old age was a challenge facing households and 0.8% felt that loss of parents also posed a challenge to households in Richards Bay.

Table 5.61: Community challenges (Multiple response, in %)

	A (n=16)	**A/B (n=61)**	**Ar (n=68)**	**ER (n=61)**	**N (n=76)**	**MS (n=33)**	**U (n=164)**	**Total (n=479)**
None	-	29.5	29.4	6.6	6.6	-	6.7	12.1
Don't know	-	-	29.4	-	-	30.3	0.6	6.5
Crime	50	29.5	17.6	29.5	38.2	21.2	45.1	34.6
Unemployment	12.5	3.3	5.9	13.1	7.9	-	27.4	14
Health issues	12.5	3.3	-	3.3	-	-	13.4	5.8
Poor living standards	-	-	11.8	-	5.3	9.1	3.7	4.4
Lack of basic services, electricity, water, sanitation	-	3.3	-	-	5.3	-	16.5	6.9
Shortage of living space	-	-	-	3.3	2.6	-	4.3	2.3
Bad odors	-	-	-	-	5.3	-	3	1.9
Asthma	-	-	-	-	-	-	1.2	0.4
Drug abuse	-	6.6	-	6.6	14.5	9.1	2.4	5.4
Dust	-	6.6	-	3.3	3.9	-	1.2	2.3
No democracy	-	-	-	-	-	6.1		0.4
HIV/ AIDS	-	-	-	-	2.6	-	0.6	0.6
House break-ins	-	-	-	3.3	-	-	4.9	2.1
Lack of security	-	3.3	-	16.4	6.6	6.1	1.8	4.6
Insufficient infrastructure, e.g. transport facilities	12.5	-	-	3.3	10.5	-	17.7	8.6
Lack of medical facilities	-	-	-	-	11.8	-	0.6	2.1
Noise pollution	25	8.2	-		5.3	-		2.7
Air pollution	87.5	29.5	8.8	23	23.7	15.2	23.2	21.5
Traffic congestion	50	13.1	5.9	-	-	3	1.2	4.8
Soil pollution	-	6.6	-	6.6	15.8	-	0.6	4.4
Shortage of recreational facilities	6.3	-	-	3.3	-	-		0.6
Conflicts in community	-	-	-	-	-	-	1.2	0.4
Poverty	-	4.9	-	4.9	-	-	25	9.8
Poor street lighting	-	-	-	3.3	-	-		0.4
Overcrowding	-	-	-	-	-	-	1.8	0.6
Increase in foreign workers	-	-	-	-	-	-	2.4	0.8
Tuberculosis	-	-	-	-	-	-	0.6	0.2

Table 5.61 above presents a range of community challenges that were indicated by the respondents from all the study areas in Richards Bay. Approximately a third of the respondents (34.6%) from all the study areas (50% in Alton, 29.5% in Aquadene/ Brackenham, 17.6% in Arboretum, 29.5% in Empangeni Rail, 38.2% in Nseleni, 21.2% in Meer en See and 45.1% in Umhlathuze) reported that crime was a community challenge,

while 21.5% indicated air pollution as a challenge (87.5% in Alton, 29.5% in Aquadene/ Brackenham, 8.8% in Arboretum, 23% in Empangeni Rail, 23.7% in Nseleni, 15.2% in Meer en See and 23.2% in Umhlathuze). Among the other main problems identified, 5.8% reported health issues, 14% stated unemployment was a challenge in the community, 9.8% said that poverty was rife in the communities and 8.8% stated that the lack of infrastructure and transport facilities were challenges to the communities in Richards Bay. Other challenges identified in the Table above include poor living standards (4.4%), shortage of living space (2.3%), house break-ins (2.1%), lack of security (4.6%), bad odors from industries (1.9%), dust (2.3%), shortage of recreational facilities (0.6%), overcrowding (0.6%), conflicts in communities (0.4%), increase in foreign workers (0.8%), poor street lighting (0.4%) and no democracy (0.4%). Noise pollution and soil pollution were reported by 7.1% of respondents. Respondents also indicated that a lack of medical facilities (2.1%) and health conditions such as asthma (0.4%), HIV/AIDS (0.6%), and Tuberculosis (0.2%) were community challenges, while 6.5% of respondents did not know of any community challenges and 12.1% of the respondents said there were no community challenges.

The responses indicate that similar problems were identified at the community and household levels, although the number differed. Particularly, higher proportions found crime and air pollution to be a problem in the community than in the home. The main problems identified related to:

- Social issues (related to crime, poverty, education levels, etc.)
- Economic aspects (related to unemployment, high cost of living, etc.)
- Infrastructural issues (related to transport, lack of basic services, recreational facilities, etc.)
- Environmental concerns (related to water, air and soil pollution)
- Health issues

More problems and higher responses were generally discernible in the lower income areas which reinforce the literature that the poor are vulnerable to a range of problems. It is also important to note that the challenges raised are interconnected. The RBCAA representative stated that the challenges facing local communities in Richards Bay is that rural communities only focus on job creation and are not aware of the impacts of industrial pollution on their health and the environment while urban communities only speak out when it directly affects them. There is thus a lack of education in terms of environmental rights which is typical of South Africa generally where there are high levels of complacency. According to the RBCAA representative interviewed, the Authorities tasked with protecting the health of South Africans and the environment are unqualified and/ or lack the capacity to implement regulations which results in communities being left to protect themselves. This situation is untenable and needs to change.

5.11 Conclusion

This chapter presented the analysis and discussion of the results collected from the households surveyed, the focus group discussion conducted and the interview with the RBCAA representative. The socio-economic profile emanating from this study reflects the general profile of the community as described in the Richards Bay Industrial Development Zone Staus Quo Report (2010). The discussion also integrated the relevant literature and incorporated spatial data. Overall, there were differences as well as similarities in responses between the case study community sites and the focus group participants as well as the RBCAA representative interviewed. The findings clearly reveal that while there are air pollution and health impacts in Richards Bay, these are interconnected to a range of other variables. The results also indicate the importance of considering the perceptions and concerns of respondents.

This study focused specifically on locations that were in close proximity to the Richards Bay industries. It is important that further studies be conducted to compare the perceptions of those residents who live close to industries with perceptions of residents who live further away from industrial areas. The next chapter provides the summary and the recommendations emanating from this research endeavor.

CHAPTER SIX

SUMMARY OF RESULTS, RECOMMENDATIONS AND CONCLUSION

6.1 Introduction

This research was undertaken in KwaZulu-Natal, in the Richards Bay area. Fieldwork was conducted in the following sampled communities of Richards Bay and surroundings: Alton, Aquadene/ Brackenham, Arboretum, Empangeni Rail, Meer en See, Nseleni and the Umhlatuze. The Richards Bay area formed an ideal research base to conduct socio-economic studies and evaluations on how pollution impacts on the health of individuals and communities because of the proximity of industries to the diversity of communities that including formal and informal households. The question that was raised at the inception of this thesis was whether pollution from the nearby industries had an adverse effect on the health status of the population or were there other underlying influences that had an impact? In studies of this nature it is difficult to find any one causal factor that has an impact on peoples' health. However, from the primary and secondary data obtained and the multi-conceptual framework adopted for this study, this concluding chapter addresses these questions and formulates suitable conclusions in the context of the research undertaken.

Chapter two of this research provided a suitable theoretical framework drawing from political ecology and political economy, place and environmental justice perspectives. It also reflects on the colonial and apartheid history of South Africa, which denied poor Black communities the right to basic infrastructure such as roads. Consequently, the post-apartheid era is plagued with tremendous financial problems and backlogs in rural road maintenance and delivery, the lack of local capacity and an integrated approach to planning and implementation.

The research methodologies and approaches used in the study are highlighted in chapter four. The underlying foundation for the primary data analyzed in Chapter five of the research was facilitated through the use of quantitative techniques, specifically the implementation of household questionnaires that was undertaken in seven selected communities in Richards Bay and spatial mapping as well as the outcomes of qualitative approaches such as the focus group discussion and key informant interview. This chapter concludes the study with a discussion on some evaluations made during the course of the research, and thereafter forwards a set of recommendations to be considered in order to improve the quality of life of communities, their knowledge on air pollution from industries and the associated health impacts, increase the knowledge of communities on indoor air pollution and health impacts, and forward some suggestions on policies to curb pollution so that communities bordering industries could be protected to some extent. The study concludes with some final comments. The next section briefly summarizes the key findings of this research undertaking.

6.2 Summary of the Key Research Findings

The main findings of the research are summarized in relation to the objectives presented in Chapter one. The summary clearly indicates that the objectives were achieved and the research questions that emanated from the objectives (presented in Chapter four) were addressed.

6.2.1 Socio-economic and demographic profile of the respondents

The Group Areas Act that was imposed in South Africa during apartheid continues to reflect many imbalances today, which is evident in the distribution of racial and economic groups. Communities tend to reflect historical racial groups, specifically Whites (generally located in the upper income areas), Indians and Coloreds (generally located in the middle and lower income areas) and Africans (generally located in the lower income areas). In keeping with the economic status of the communities, the data collected from the respondents from the communities in Richards Bay and the surrounding areas showed that the lower income areas (Nseleni, Empangeni Rail and Umhlathuze) and the middle income areas (Aquadene/ Brackenham and Arboretum) have a more youthful population with a significant number being children, while the upper income areas (Alton and Meer en See) have a more elderly population. A similar trend was also found in relation to household size. The household size of the communities, on average, was 4.8 with the communities with the higher average household sizes being in the lower to middle income areas. This research finding is supported by the 2011 South African Census data (Statistics South Africa, 2012). The consequences of this youthful population growth with increases in air pollution levels present serious health challenges for the communities that reside in close proximity to industries in Richards Bay.

The majority of respondents surveyed in this study were males who are generally deemed the head of households in most communities in South Africa. However, the results of this study show that a considerable number of the population in the surveyed households were females (in the majority) and children. Females were found to dominate in the lower income areas, namely, Nseleni, Umhlathuze and Empangeni Rail. This could be related to the absence of males in the household who may have migrated for employment in the urban centers in other regions of South Africa or have passed on as result of HIV/AIDS and/ or other illnesses. The focus group discussions raised concerns that despite there being numerous industries in the area, there is inadequate job creation and as a result even young women are also migrating to the larger urban areas in search of work, especially in the domestic sector. This is also shown by Hunter (2010) who indicates that women from poor communities often tend to seek jobs in the domestic sector or sex industry which make them extremely vulnerable. Several authors (Braveman, 2006; Brulle and Pellow, 2006; Higginbotham *et al.*, 2010; Sze and London, 2008 and others) state that it is generally women and children who are most vulnerable to air pollution and the associated health implications.

In regards to the marital status of respondents, the study found that the majority of the respondents were married in the middle to upper income areas, while less than half of the respondents were married in the lower income areas, specifically Nseleni and Umhlathuze. It was also found that there were a higher proportion of single and widowed households in the lower income areas which may be an indicator of higher levels of poverty and vulnerability. The findings also show that higher income jobs were mostly in the middle/ upper income areas while lesser paying jobs were confined to the lower income areas.

The focus group discussions also pointed out that while there were remittance and grants for the elderly, children from poorer households, HIV/AIDS and disability grants provided in South Africa, there was no grants/ assistance/ compensation that are available for individuals suffering from air pollution ailments which has been shown to be carcinogenic in some cases. The study found that the income levels were higher in the middle/ upper income areas than the lower income areas. Lower earning respondents were located mostly in the lower status areas which were classified as predominantly African populated areas as per the historical race classification and apartheid segregated areas. The focus group discussion also highlighted this when respondents stated that many households in Richards Bay engage in multiple livelihood generating incomes to diversify incomes due to the limited formal, full-time job opportunities available and low paying jobs. The economic status of households is extremely important in relation to air pollution and health issues since numerous studies have shown that socio-economic inequalities impact on health outcomes which are mainly linked to levels of economic deprivation and poverty which appear to be key predictors of adverse health conditions experienced within a population and that the poorer segments in society are subjected to a disproportionate share of negative environmental impacts (particularly in relation to air pollution) and have higher levels of exposures to pollutants.

According to the literature reviewed during this study, consideration of the level of education is critically important when addressing health issues in general and air pollution issues specifically. Employment statuses and access to health care facilities influences employment statuses and income levels. In keeping with the socio-economic classification of Richards Bay, the study found that higher levels of educations were found in middle/ upper income areas compared to lower income areas. These areas are predominantly African populated and as previously highlighted have been denied access to basic services and opportunities.

Block and Whitehead (1999) state that even where there are negative environmental and health consequences, people make tradeoffs to be closer to job opportunities and support job creation, even when there are negative environmental and health consequences. An interesting finding from the study, in relation to this statement, was that most respondents work within the Richards Bay area, which supports the literature that industrial areas tend to create job opportunities for locals (Cubin and Pedregon, 2008; Jaggernath, 2010; Pulido, 2000). However consideration should also be given to the types of jobs created and the working conditions that have serious and long-term health impacts. Also, it is important to note that the focus group discussion pointed out that the jobs that are available in Richards Bay are generally low paying and that not enough jobs are being created by industries in the area for the local people.

6.2.2 Respondent's perceptions, issues and concerns relating to health and industries

The study attempted to examine the various types of illnesses that are common (and how these linked to air pollution), the main causes of the illnesses affecting household members, which specific group in the household is most affected, consultation with a health practitioner and frequency of treatment. A key focus area in the study survey instrument was placed on respiratory health given its close association with air pollution impacts. It was evident from the study that households had at least one member who suffered from an established illness. However, it was also found that only a small proportion of respondents from Arboretum, Nseleni and Meer en See and some other members in the household had specific ailments. This was most common in the middle/ upper income areas with a few exceptions in Nseleni. There were a range of health illnesses that respondents reported that they or a family member/s experienced in the household. More members of the household that experienced illnesses were found to live in lower income areas where households had more persons residing together. This could be linked to overcrowding which, as indicated earlier, contributes to poor health conditions.

In examining factors community members think contribute to the poor health conditions to ascertain which are beyond their control and which are behavior related, it was found that more than half of the respondents (57%) indicated that industrial smoke was the cause of their present health conditions. Other stated reasons were wide ranging and therefore there was no discernible pattern that emerged in relation to the causes for poor health experienced by the affected household member. However, the data did show that more respondents living in middle/ upper income areas identified causes. It is interesting to note that although this study indicates that socio-economic conditions (particularly aspects such as poverty, racism, gender inequality, etc.) contribute considerably to health conditions at the household level, none of the respondents identified these aspects. Respondents placed more focus on environmental aspects.

During the focus group discussions, participants identified broader socio-economic as well as environmental causes during a ranking exercise: industrial was ranked 1 and underscores the findings from the survey where more than half the respondents perceived that industrial pollution was the main cause of health problems among households in Richards Bay. Poor facilities and infrastructure was ranked second which indicated the importance that community members place on proper and adequate facilities and infrastructure. Poverty/ unemployment and poor housing were ranked three. The links between socio-economic deprivation (housing conditions being strongly related to economic status) is regarded as important in terms of health issues in a community. Poverty is directly linked to socio-economic vulnerabilities.

Children were found in this study to be the most affected in the households. More women were also noted to be affected in the households than men and the elderly. The responses support the literature that women and children are the most vulnerable (Braveman, 2006; Brulle and Pellow, 2006; Higginbotham *et al.*, 2010; Jin *et al.*, 2006; Larson and Rosen, 2002; Sze and Lond, 2008).

With regards to health care, the findings from the study show that the economically better off communities (Alton, Aquadene/ Brackenham, Arboretum and Meer en See) used the private, more expensive health care sector while generally households in lower income areas tend to rely on public or traditional health care facilities. Most households from all the communities use health care facilities on a monthly or half-yearly basis

An interesting finding was that most respondents rate their general health status as either excellent, good (more respondents from the middle/ upper income areas than the lower income areas) or satisfactory (more respondents from Umhlathuze). Despite there being high concerns about air pollution and other health hazards as well as relatively high prevalence of illnesses in the communities, the study found that respondent's level of satisfaction with general health status is relatively high. This could be linked to feelings of place attachment, as indicated by Jaggernath (2010) where people living in polluted areas such as the South Durban Area express satisfaction with aspects of their lives.

6.2.3 Knowledge and perceptions of Industries in Richards Bay

The study findings indicate that the distances reported by respondents conform to the distance of the communities where the surveys were conducted from the main industrial area in Richards Bay. It was also evident that some respondents overestimated the distance which may suggest that respondents understanding of distance differ from the actual distances.

With regards to the main sources of pollution in Richards Bay, the study found that a large majority of the respondents reported air pollution as the main problem that is associated with industries in Richards Bay while the health impacts of pollutants from the industries manufacturing processes was the second main cause. The reason for the health impacts associated with air pollution not being equally important to environmental pollution may be because respondents do not see the link between environmental pollution and health impacts, possibly because they are not affected from any pollution-related ailments. This showed that the differences were discernible because the middle and upper income areas identified pollution problems more the lower income areas.

It was clearly evident from this study that the areas deemed to be the most polluted were generally in or in close proximity to the industrial area or the port area. Lower income areas tendered to be most polluted, according to respondents residing in these areas or who lived in in similar low income areas. This could be attributed to broader dissatisfaction with these areas rather than pollution levels. It was also found that most areas identified as being least polluted were away from the industries and that responses differed considerably among and within communities about which areas were the least polluted. Middle/ upper income areas as well as areas in the periphery (including rural areas) were generally deemed to be the least polluted.

6.2.4 Indoor air pollutants and housing conditions of respondents

The conditions in which people live are significantly important when examining the health status of communities as housing and environmental conditions influence people's health and well-being as shown by Morello-Frosch and Lopez (2006), Macintyre *et al*. (2002) and Day (2007). The majority of respondents in this study were found to be living in dwellings/ households made from dwellings constructed with brick and asbestos, brick and zinc, stone and other traditional materials which is indicative of housing in the poorer communities who live in informal dwellings/ households and may be a causal contributing factor of the poor health status of these communities.

Furthermore, the number of rooms in dwellings/ households are important considerations in health impact studies as crowding facilitates the spread of respiratory infection and exacerbates these ailments which are strongly linked to air pollution as indicated in the literature review chapter (Aldridge, 1993; Surjadi, 1993). The study revealed that most respondents in the lower income areas had fewer rooms and those with larger number of rooms can be confusing in rural and peri-urban areas since some properties have homesteads with multiple resident structures for more than one family. In addition, more respondents who resided in lower income areas did not feel that the dwelling/ housing catered for their needs. The study also indicated that suggestions to improving the dwelling/ household related directly to the quality of the homes and general living standards/ quality of life issues with some environmental issues that relate to health, including improved ventilation and cleaning the surrounding residential environments. The unsuitability of the dwelling/ household for all weather types were also generally higher in the lower income areas which corresponds with the quality of the dwelling/ household and levels of poverty.

As highlighted in Chapter Five, the availability of proper services such as access to water and sanitation and energy sources, at the household level, has an impact on health. Numerous authors have highlighted that lack of access to piped water and proper sanitation impacts on communities as household members are more likely to be prone to illness and disease (Butala *et al.* 2010; Hubbard *et al.* 2011; Mara, 2003; Moodley, 2002; Whittington *et al.* 2012). The study found that a large majority of respondents have access to sources of tap water. However, a few respondents from the more rural areas (Nseleni and Umhlathuze) reported that they did not have access to a tap and used other sources such as a river/ stream. The focus group discussion raised concerns that water collected from a communal tap, stand pipes and communal boreholes can become contaminated because of exposure to airborne pollutants or improper transportation of the water, including the containers that are used to transport and store water. Additionally, many households in the communities mentioned that multiple sources of water supply such as rivers/ streams and rainwater are used despite tap water being their main source. Participants also indicated that most households in the areas use these available sources if taps break (which is experienced regularly in relation to communal taps) or when water supply is disrupted. It was also found that some households use sources such as rivers/ streams and rain water for drinking when the available taps break-down. Thus, poorer communities are exposed to the possibility of air pollution-related water supply contamination due to the emission of particles from industries that settle in open (natural) water sources. In relation to sanitation, the study found that those vulnerable to unhygienic conditions with inadequate sanitation facilities were only in Nseleni and Umhlathuze. Respondents from these communities were found to be using sources such as a septic tank, a drainage system, manual disposal, the bush or other nearby facility. The lack of proper sanitation facilities in these communities can lead to the spread of infectious diseases, especially under conditions of household overcrowding and improper building structures. Moreover, the manual disposal of waste (burying) and use of nearby bushes by some of the respondents are particularly disconcerting as these become the breeding ground for pests. In addition, the environment, land and water can be polluted by the unsightly presence of waste that is not properly disposed.

Indoor air pollution from the type of energy sources used as sources of cooking, lighting and heating, such as fuelwood, paraffin, gas and candles, and behavioral characteristics such as smoking and pets living in households, have been found to impact on health (Karekezi and Kithyoma, 2002; Sagar, 2005). The study included some of these aspects in the household surveys that relate to air pollution and health impacts, such as sources of cooking, lighting and heating and behavioral factors such as smoking and pets within the household to determine whether these factors had any health impacts. The energy profile of the communities in Richards Bay indicates a heavy reliance on electricity (an unsustainable, non-renewable and relatively expensive energy option) for cooking, heating and lighting. The study showed that most households, including those whose main source of energy was electricity, used multiple sources of energy for cooking, particularly in the lower income areas. These included electricity, fuelwood, paraffin/ fuel oil/ kerosene, tank or LP gas, and solar energy. It was also found during the focus group discussion that these lower cost options was used because other options, such as renewable energy (solar energy and hydro energy) were not readily available and mostly poorer households used cheaper sources because they were forced to do so due to issues of affordability.

Participants indicated that the main reasons for the lack of use of renewable energy in the communities were related to a lack of awareness and knowledge about these options, high start-up costs, concerns over maintenance and lack of clarity about the health impacts of these options. The health and safety concerns of storing non-renewable energy sources in the home are important to consider. The literature highlights the respiratory illnesses associated with indoor pollution which is exacerbated by poor ventilation (Disenyana *et al*., 2010). It was also observed in this study that many households in the poorer communities did not have good ventilation, and often having only one window per room that was generally kept closed because of odor and air pollution concerns from industrial pollutants, thus increasing the risk of illnesses.

During the focus group discussion it also emerged that women were the main users of energy for cooking and heating since these activities are generally regarded as their responsibility at the household level. They are also generally responsible for collecting or purchasing and storing energy, where applicable (for example, fuelwood, kerosene, gas and candles) which is an additional burden on women in terms of their time, health impacts associated with transporting fuelwood, safety and security concerns and exposure to pollutants. No significant relationship was found between household size and sources of energy for heating. These relationships were more acute in poorer communities. The results show that most cooking and heating have higher demands for energy at the household level than lighting and candles which were often used to complement electricity in poorer households. The study also observed during the field visits that some of the households in Umhlathuze, Empangeni Rail and Nseleni had illegal connections to electricity. This was also supported during the focus group discussion. The reliance on electricity is unlikely to be sustained at high levels in poorer communities due to cost and affordability.

In relation to indoor air pollution and behavioral factors, the literature (Birch *et al*., 2000; Larsen and Rosen, 2002; Mestl, 2006; Mestle *et al*., 2007; Neidell, 2004) and results from this study indicate that cigarette smoking is a serious health concern in the household. The study found that cigarette smoking is a worrying trend in all communities as 29.9% of the respondents reported that a member/s of the household smoke in the home. This is a significant number of households since smoking does not only affect the health of the smoker but those around them through secondary smoking. During the focus group discussion, cigarette smoking was ranked 7^{th} in the list of concerns. Pets also emerged in the literature and even in terms of the perceived cause of health problems in the communities researched. However, the study found that only a small percentage of the households keep pets in the home.

6.2.5 Coping strategies that households use to deal with health problems

The results from this study indicate that generally more households from the middle/ upper income areas used control or removal of insects and cockroaches than those from lower income areas, possibly because of affordability constraints. The removal of visible mold growth was more prominent in the lower income communities which could be attributed to mold being more of a problem because of poorer housing conditions. The findings also show that other measures such as removal of pets and changing smoking rules in the home were applied by respondents. When asked if the control measures were effective, more respondents in the middle and upper income areas believed that the control measure/s used was/ were effective compared to the lower income area.

Makri and Stilianalis' (2008) assert that coping strategies adopted by households are linked to environmental, social, political or other factors, which also influence exposure levels. The study showed that the most prominent coping strategy used was closing windows and doors. Some of the respondents stated that purchasing better appliances, mainly in the middle and upper income areas, is used as a strategy. Fewer respondents identified using renewable energy sources. The study also found that respondents in the lower income areas coped by cooking indoors and slightly more than half of the respondents in the lower income areas did not adopt any coping strategies to deal with air pollution. This is a worrying result since it indicates that most households in poorer areas do not or are unable to adopt coping strategies to deal with air pollution. This again reinforces the need for air pollution and health related education programs in these areas.

During the focus group discussion, participants indicated that the closing of windows, leaving the home temporarily and using masks when there were high levels of odor and air pollution are additional coping strategies. However, it is important to note that closing windows and doors can increase indoor pollution (particularly if fossil and biomass-based fuels are being used in the house such as wood, paraffin and gas). It was also highlighted that some people have moved out of the area because of persistent air pollution problems. The results also showed that the main reasons for wanting to move out of the area related to environmental issues.

6.2.6 Community perceptions of industries in the area: advantages and disadvantages

The study found that respondents perceived industries in the Richards Bay have costs and benefits for local communities. The findings indicate that the majority of respondents felt that industries creates the following benefits: economic in relation to job creation, higher incomes and attracting investments into Richards Bay; broader development impacts that relate to improved services, infrastructure and facilities; and social responsibility benefits such as providing bursaries and sponsorships as well as supporting training programs.

The main advantages that industries in Richards Bay have for communities were found in this study to relate to job creation and the possibility of increased development in the area. This supports the literature that shows that employment opportunities and related economic benefits are deemed to be the key advantage associated with industry (Block and Whitehead, 1999; Enger *et al.*, 1986; Jaggernath, 2010; Morello-Frosch, 2002). However, given the unemployment rates presented earlier (specifically in lower income areas) it seems as if industries in Richards Bay are unable to create sufficient jobs to meet demands. The lack of jobs to meet demand often creates conflicts in communities as residents compete for limited jobs and often become annoyed when people outside the area are employed (Jaggernath, 2010). However, despite this perception of advantages of industries and employment opportunities created by industries, only about a fifth of the households interviewed had at least one member who was employed in the industries in Richards Bay, generally in the lower paying jobs. It was also evident that members from only a few of the households interviewed, mainly from the middle/ upper income areas, held managerial/ supervisory positions which are generally higher paying jobs.

Disadvantages that were found to be related to industries in Richards Bay, as perceived by the respondents, relate mostly to air pollution and pollution in general. The main aspects relating to the disadvantages of industries in Richards Bay that emerged in the study include pollution impacts related specifically to air and water pollution as well as waste generated; concerns pertaining to environmental degradation caused by air and water pollution; health impacts linked primarily to pollution; traffic congestion in the area; employment issues pertaining to who gets jobs (perception that industries prefer to employ foreigners) and the types of jobs created (low paying and temporary); and utilization of land by industries that displaces people and land available for homes. The lack of employment opportunities in the industries in Richards Bay is supported by the finding in this study that the majority of the respondents are employed outside the industries in Richards Bay. Therefore, industries do not appear to be a main job creator locally. This is also the case in the South Durban Basin area which is considered to be one the most contested industrial areas in South Africa (Jaggernath, 2010; Visser, 2010).

6.2.7 Spatial distributions/ patterns of specific health problems experienced by households

In relation to respiratory illnesses and air pollution, the study found that many household members were affected by asthma, wheezing, chest pains or coughing or a combination of these illnesses. The majority of respondents from all the study areas (62.9%) reported that the member/s was/ were hospitalized as a result of the chest pains. Asthma was found in the study to affect mostly children younger than 10 years with a higher percentage being children less than 5 years old. This also relates to the literature that it is usually children who are mostly affected by asthma due to their susceptibility to respiratory illnesses which can result from the chronic exposure to air pollution as well as indoor pollution such as cigarette smoke, pets, poor ventilation and energy sources used for cooking. Children less than 5 years are more likely to cling on to their mothers when they are preparing food using hazardous sources of energy that emit air pollutants. A large majority of the affected population still rely on the use of medication to control or alleviate their respiratory symptoms.

6.2.8 Perceptions regarding which industries are the main air polluters in the area using participatory GIS

The participatory mapping exercise conducted during the focus group discussion revealed that participants identified the industrial areas (including the port and surrounds) as the most polluted areas. Areas outside Richards Bay were considered to be the least polluted areas. Thus, similar trends emerged from the survey responses and focus group discussion. During the focus group discussion, one respondent highlighted that while the industries pollute the most, because of wind patterns nearby areas become the most polluted. This aspect was also examined. In addition, the prevalence of different illnesses in relation to the sampled communities was examined and a disease map was generated in addition to the air pollution maps sourced from RBCAA. The map clearly indicates that there is no direct relationship between disease prevalence as discerned from the survey reporting, perceptions of the most and least polluted areas, and wind direction. In the light of the preceding discussion, the following section makes some recommendations emanating from the present study.

6.3 Recommendations Emanating from the Study

In addition to the recommendations that were provided during the course of this research, this section highlights and elaborates on some of the more important ones and also provides further recommendations. Again, the discussion is guided by the research objectives of the study.

6.3.1 Socio-economic and demographics

The government should design programs that facilitate the improvement of socio-economic standards of the poor, especially in the rural communities. Education level has been theorized as being directly linked to access to health care facilities and that the differences in education levels and employment opportunities among communities (which is evident in Richards Bay) create and reinforce social disadvantage which results in increased vulnerability (Cubbin and Pedgregon, 2008). A key limitation of the inclusion of education levels in understanding the relationships between health and air pollution is the exclusive focus on tracking formal educational levels. There is no focus in any of the literature reviewed on the relationship between health and air pollution literacy levels. It is important that future research examine how community members access and engage with information about health and air pollution levels. Specifically, there are different attempts to educate people about air pollution in communities. This was found not only to be the case in Richards Bay but in other areas as well, for example, the South Durban Basin (Jaggernath, 2010). The effectiveness of these environmental education attempts should be critically examined to inform future projects. Individuals also derive information from a range of other sources such as the media, friends and relatives. Overall, it is important to note that focusing on formal educational is insufficient and our understanding of education needs to be broadened and incorporated into research processes so that communities affected can benefit from the findings. Additionally, more research needs to be undertaken to determine the most appropriate method to use to communicate the information that may be able to assist communities in their interpretation and understanding of health implications that are associated with air pollution from both indoor and outdoor sources.

The higher proportion of single and widowed respondents in the lower income areas is indicative of higher levels of poverty and vulnerability. Despite the number of industries in

Richards Bay, inadequate job creation was found to be a serious problem in lower income areas because males are forced to leave their homes to secure employment in other urban centers and, more recently, young women have also been migrating to the larger urban areas in search of work. When jobs were available in the industries, they are usually lower waged and labor intensive employment, especially among those from the lower status communities. This could relate to educational levels because respondents in the lower income areas are predominantly African populations who were denied access to education during apartheid. As mentioned previously, due to apartheid and the segregation of the South African population into pockets of Bantustan groups, these areas were denied/ provided with limited opportunities for employment, education and services such as health care, water supply, proper sanitation. A possible solution to addressing these imbalances in Richards Bay is for industries to recognize that local communities have developed or natured their own set of skills informally, which may be of value to industry. Thus industry should create more job opportunities for the local communities and provide benefits and incentives for unrecognized skills that individuals have that are generally classified as 'unskilled labor'. In addition, industries should provide skills training on a wider scale and increase these training programs in lower income communities in order to equip the local populations with skills that are necessary to the industries. By providing employment, the quality of life of individuals and communities will improve through better living conditions and this will tend to improve health status.

An interesting finding during the study was that while there are several types of grants available to address the needs of the indigent in South Africa, they do not include an assistance or compensation for individuals suffering from air pollution ailments although research indicates that in some cases they can be extremely debilitating and are also carcinogenic. The study recommends that the national, provincial and local government health departments in South Africa consider other ailments such as the severe cases of respiratory illnesses in communities that are associated with industries and hold industries responsible. A form of health tax should be paid based on the severity of pollution levels and this should be used to compensate the surrounding communities for any form of respiratory illnesses prevalent.

In terms of income, the poor suffer the brunt of disproportionate shares of the economic burdens of any environmental regulations that unduly increase prices of housing, energy and fuels, appliances, etc. In order to achieve environmental justice, the costs imposed by environmental regulations need to match the benefits for everyone. The researcher also recommends that further research be conducted that investigates and compares the socio-economic and spatial characteristics of communities situated at or in close proximity to industries with those of communities that are situated further away from industries in relation to the above issues.

6.3.2 Concerns relating to health

The health impacts of outdoor air pollution have been explored in the literature review conducted during this study. Industries were perceived by respondents as the main sources of air pollution relating to health implications because industries emit large concentrations of pollutant and toxic gasses into the atmosphere. In the light of this, it is important that communities situated near to industries and in surrounding areas be advised to minimize outdoor activity during days with high pollution or smog levels. Industries should also circulate a schedule to communities indicating days when harmful gases will be emitted into the atmosphere and provide recommendations/ coping strategies that should be practiced. Individuals who are choosing new residential locations need to consider the health impacts related to areas close to industries and thus should opt for sites that are remote from chemical manufacturing plants, industries that emit high concentrations of pollutants that have found to be harmful to health and from areas with heavy traffic.

Advocating and supporting for the control of air pollution should be increased from general practitioners, community nurses, health departments, and patients as members of large health organizations. Practitioner and health facilities in communities should therefore become familiar with current exposure guidelines for pollutants considered to be risks for inducing or exacerbating asthma and other respiratory diseases so that proper treatment of patients could be undertaken.

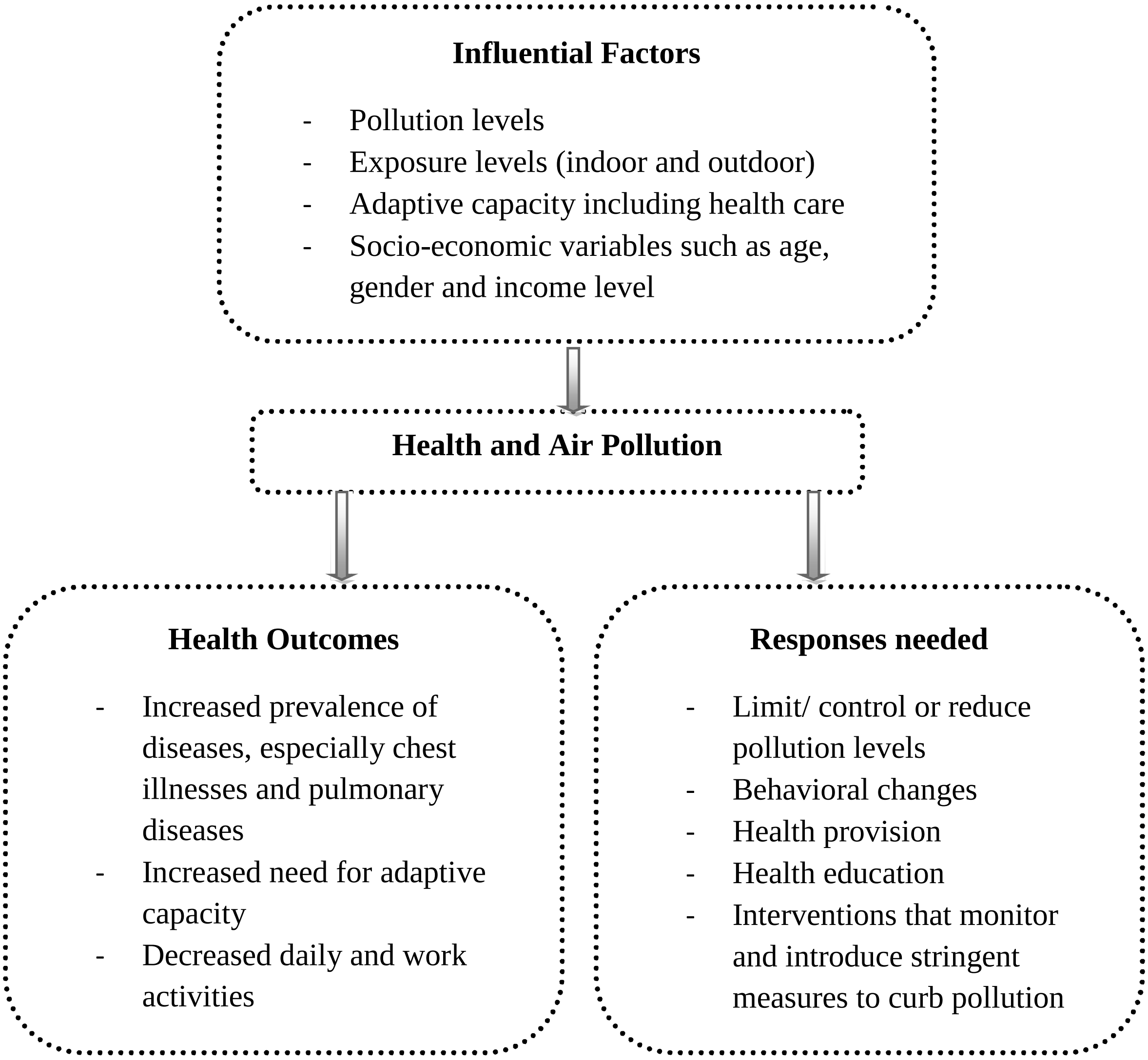
Furthermore, health promotion strategies and the sharing of information should be in place from the health departments and other partners to educate communities on common illnesses that are community specific. Industries, health promotion professionals, government agencies, environmental protection agencies and general practitioners should be involved in the design of health promotion strategies. Information such as that provided by this research should contribute to the development of health promotion and educational programs.

A strong relationship between the researchers/ health impact investigators and community is necessary to help inform communities on the connections between risk factors and health outcomes. It is therefore necessary that community involvement be formalized in any processes that will possibly have an impact on the health of local communities. Community participation is essential in every stage of this process.

Another important aspect to consider is the control measures that are employed by individual household members to prevent, alleviate, or control the impacts of air pollution on their health. The data findings of this study indicate that the most prominent strategy that is used by individuals and household members are closing windows and doors. Individuals and household members need to be more active in the measures that they employ and take more control in preventing air pollution and the associated health impacts. For example, instead of smoking or cooking indoors, individuals and household members should smoke or cook outdoors.

In addition to the recommendations made above, Environmental Management Programs (EMPs) and Environmental Impact Assessments (EIAs) need to integrate health impact assessments as a compulsory regulatory requirement. The inclusion of health impact assessments in EMPs and EIAs will strengthen the power to determine whether a new project is viable or not, will cause harm to human health, increase morbidity or facilitate the development of new illnesses and they can influence industrial designs, developments and operations in specific locations.

Figure 6.1: Socio-economic and health variables



Socio-economic indices such as age, gender and income and health indicators such as the prevalence of illnesses directly influence the health impacts and outcomes that emanate from exposure to indoor and outdoor air pollution. Figure 6.1 shows the influential factors of poor health in relation to air pollution as well as the potential health outcomes. The researcher therefore recommends that socio-economic indices and health indicators be considered as having a two-fold relationship or link that directly influences each other and should thus be investigated collectively and not as separate components. A more critical and comprehensive understanding will also inform responses as indicated in Figure 6.1.

6.3.3 Knowledge and perceptions of industries in Richards Bay, including advantages and disadvantages of industries

Perceptions of industries in this research were found to differ as respondents felt that industries have a range of advantages (benefits) and disadvantages for communities in Richards Bay and the surrounding areas. The following recommendations are suggested in order to educate communities about industries:

- The improvement of communication and partnership strategies among various stakeholders and the communities; especially encourage community participation in environmental health studies that are related to the development of industries and industrial processes. Community involvement can help address communities' concerns as the community will be able to ask questions in relation to their concerns and thus challenge any negative impacts that may be identified. Community participation requires that the communities be involved at all stages of the industrial process, development or upgrades. These include stages of the proposed design, identification of possible impacts, impact assessments, implementation and further monitoring and evaluation.
- Resource materials such as reports, articles, brochures and newsletters and information brochures written by research investigators with tangible information on advantages and disadvantages, benefits and negative factors that are identified as being associated with industries need to be made available to all communities, accessible through such avenues as libraries, health centers, clinics, schools, and community centers.
- Community consultation and feedback is also an important method of involving communities in the multiple stages of industrial development, processes and upgrades. Such initiatives will provide multiple benefits including cooperation of participants, access to knowledge, enhanced understanding of the results and related health issues, and improved community perceptions on the impact of industrial air pollution on health. This process will ensure that health issues are clear to communities and that they are aware that health concerns are embraced in planning and decision-making processes at all levels of government and the private sector.

6.3.4 Indoor air pollutants and housing conditions of respondents

Poorer communities in South Africa often have informal dwellings and/ or alternate combination materials in terms of dwelling types as shown by Thomas *et al*. (1999). The relatively high percentage of brick homes in lower income areas is also reflective of the housing delivery development projects in post-apartheid South Africa to provide housing to the poor and provide *in situ* upgrading of informal homes. An important consideration is that most of the suggestions forwarded in the study relate to conditions in the home that influence environmental quality of the dwelling that can affect health. While government has recognized the need for housing delivery to the poor, consideration needs to be given to actually helping poor communities maintain the households and thus upgrades/ improvements to the housing provided to the poor are necessary in housing development projects.

With regard to access to water and sanitation, most respondents had access to tap water and proper toilet facilities. However, it was noted that some respondents are still using communal sources or rivers and streams which may be exposed to pollution emitted into the air and settles into the water or discharged directly into the water sources from industries. The research also indicated that most respondents had access to toilet facilities, however, some respondents from the lower income areas were forced to use the nearby bushes – which may become a breeding site for infectious diseases. Considerable attention needs to be given to addressing the water and sanitation issues as key priorities for preventative health interventions (Whittington *et al.*, 2012). In low income areas there is exposure to a range of conditions including air and water pollution as indicated in this study. From the literature review it was clearly evident that health issues are interrelated and it is often impossible to determine causality when there is evidence of multiple factors. This study therefore supports the assertion by Moodley (2002) that health issues need to be considered holistically and an integrated health promotion and intervention framework should be developed rather than focusing on singular aspects such as air pollution or poor nutrition. The conditions combine to make some communities and/ or individuals more vulnerable than others. The differentiation of the impacts needs to be understood so that resources can be directed to those who need it the most.

The energy profile of the communities in Richards Bay indicates a heavy reliance on electricity (an unsustainable, non-renewable and relatively expensive energy option) for cooking, heating and lighting. However, there are households (mostly in the lower income communities) that use electricity and other sources such as fuelwood, candles and paraffin/ kerosene. As indicated by Barnes *et al.* (2010), Casillas and Kammen (2010), Pachuri and Spreng (2011) and Sagar (2005), the use of multiple sources of energy (particularly non-renewable, traditional, cheaper options as is the case in some of the communities in Richards Bay) is a sign of energy poverty and reflects that while many households may have physical access to the electricity grid, they are unable to afford electricity and complement electricity use with cheaper energy options. While there are several renewable energy options available (such as solar energy, hydro energy and thermal power), these are generally not available to households in Richards Bay. As part of the governments housing delivery projects, the inclusion of renewal energy options such as solar energy should be considered. In other words, the possibility of installing systems such as solar water heating should be investigated more and invested in by the government for poor households.

Furthermore, the focus group discussion held during this study identified a lack of use of renewable energy in the communities due to a lack of awareness and knowledge, high start-up costs, concerns over maintenance and lack of clarity about the health impacts. These options are generally less harmful to health and well-being than current reliance on fuel-based sources, especially fuelwood, gas and kerosene. This study supports the recommendation made by Sagar (2005) that education pertaining to renewable energy sources is definitely needed in communities to make them aware that an alternative source of energy is more healthier and may decrease the potential for respiratory illnesses and morbidity which are caused by pollutants from sources such as fuelwood. Other recommendations related to indoor pollution emanating from this study are:

- Improvement of household ventilation to allow free air exchange and to reduce the concentration of particulate matter indoors.
- Improved stoves that are well-designed, well-built, and well-maintained that can reliably lower indoor air pollutants from cooking. The South African government should facilitate the transition to cleaner household fuels and also include programs to promote the use of improved stoves and educate communities on ways to mitigate health risks that are associated with indoor biomass combustion.
- Policies that befit the poor should be implemented to reduce the upfront cash costs of new appliances (such as improved stoves or LPG bottles) or of obtaining electricity

connections, that provide innovative credit, offer low-cost service connections for electricity and LPG and spread connection costs over a long period to reduce monthly outlay. As stated by Bell *et al*. (2005), many air pollution control technologies, such as more technologically advanced indoor cooking stoves, are expensive. Thus the facilitation and subsidization of cleaner household technologies from the government is necessary in lower income communities.

- The study found that more children below 5 years have respiratory illnesses such as asthma. Household awareness, especially for mothers who cook near children, should be created by environmental and health agencies and non-governmental agencies involved in pollution and health impacts informing them of the dangers of exposing children to pollutions emitted from cooking. This can be done by forming women social clubs and other basic health care programs in communities.
- In addition, the Ministry of Health in South Africa should advocate the relief or exemption of taxes on natural gas since the health cost imposed on the economy due to biomass utilization by lower income communities in South Africa is high.

6.3.5 Coping strategies that households use to deal with health problems

As indicated earlier currently, most respondents (especially in lower income areas) adopt simple survivalist strategies to cope with air pollution and health impacts. The respondents in lower income areas are generally unable as a result of socio-economic status to invest in longer term adaption strategies such as purchasing appliances, procuring better health care and even feeling that they have an option to relocate. Of particular concern is that generally, even in middle and upper income areas, households are adopting reactive strategies rather than being in a position to be proactive to find long-term solutions to address air pollution and health impacts in Richards Bay. This, unfortunately, is also the scope of organizations such as RBCAA that focus mainly on monitoring and reporting issues rather than finding sustainable solutions. To this end, it is essential that all stakeholders get together to develop a long-term strategy to build socio-economic and political capacity within the communities to be better equipped to cope with and adapt to air pollution and the related health impacts. It may be worthwhile to also consider technological solutions where appropriate to further reduce industrial air pollutants as well as indoor air pollutants that are particularly hazardous to low income households. One possible strategy is to make available renewable and clean energy that is accessible and inexpensive for low income communities. As discussed earlier, solar energy may be a viable option. The burden should not be on the poor who appear to be bearing the brunt of air pollution impacts although they reap the least benefits. The industries in the areas should increase their corporate social responsibility programs, to enhance households to cope better with air pollution. Additionally, as stated earlier, in relation to individuals and communities interpretation and understanding of air pollution and health implications, further research needs to be conducted to determine the most appropriate method to use to communicate information that may be able to assist communities better understand pollution and health implications as well as how to cope with the impacts and how they can be involved or contribute to control measures.

6.3.6 Spatial distributions/ patterns of specific health problems experienced by households

This research shows that the theoretical perspectives linked to landscape ecology and health impacts identified by Curtis (2004 cited in Day, 2007) is discernible. Specifically, an ecological landscape is evident since there is a clear spatial distribution of physical environmental risk factors (especially in relation to the location of industries in the area and the existence of indoor pollution which tend to be concentrated in specific communities) as well as the distribution of medical conditions which emerged from the disease mapping exercise undertaken. A materialist landscape is also noticeable with respondents identifying a range of perceived advantages and disadvantages in Richards Bay. Air pollution-related concerns are the main disadvantages while the key advantage is employment opportunities which, ironically, are linked to the industries in the area. In terms of the latter, landscapes of consumption are evident where the local communities are employed in the area and many of the activities (including the industries) consume environmental resources to respond to demands. There are also landscapes of social control as evident by the organizations in the area that address air pollution and health issues. This scenario is very difficult to change, especially in terms of relocating industries. It is easier to move communities that are impacted by pollution away from industries or put in place measures that would restrict air pollution so that communities are not impacted. If communities are moved, subsidized transportation should be provided for those employed so that they are not disadvantaged. NGOs and other organizations in the areas that address air pollution and health issues should work more closely with communities and not just report on pollution and health issues but rally for behavioral change of industries and government departments in terms of air pollution and health matters. The interests of all communities in the area should be protected, not only the elite. Those who are the most vulnerable should be the priority.

The lack of clarity in understanding of the prevalence and identification of which ailments are afflicting households is reflective of the problems associated with surveys, where self-reporting is the main mechanism to collect data. However, they are useful to show trends and were sufficient for this study were the main focus was on socio-economic and spatial linkages. It is recommended that future surveys more clearly explain specific ailments rather than rely on open-ended questions. Particularly, where literacy levels and access to formal health care facilities are lower, it is possible that the ailment experienced is not diagnosed and therefore not reported. Additionally, ailments such as coughing should be disaggregated further to ascertain whether the coughing occurs during colds and flus or independently to colds and flus. In terms of the former, coughing is a symptom of having a cold or a flu. This will help to establish whether seasonal weather changes (not addressed directly in this study) may be affecting or aggravating air pollution related ailments.

6.3.7 Other recommendations in relation to outdoor air pollution and health impacts

This research did not investigate the health impacts that are associated with air pollution from the increase in transportation in Richards Bay. However, a few respondents highlighted that a major disadvantage of industries in the area was increased traffic due to the transportation of manufacturing goods and materials to and from the industries from other areas. It is therefore recommended that further investigations be carried out in relation to the health impacts of transportation in Richards Bay.

This study clearly indicates that local level research in relation to air pollution unearths the role that humans can play as sensors and information sources. To some extent, the RBCAA is adopting this approach by encouraging people to monitor air pollution incidents. However, as the results reveal this is confined to middle/ and upper income areas. Several techniques are now available, including crowd sourcing techniques using various types of social media. Various researchers (Faulkner *et al*., 2011; Mun *et al*. 2009; Sakaki *et al*., 2010) show that applications of social media are being developed to detect earthquakes, monitor traffic and detect accidents, map pollution and monitor public health. Existing monitoring processes should include these technologies in Richards Bay.

6.4 Concluding remarks

The conceptual framework used in this study contributes substantially to a greater understanding of the differential health impacts on communities in relation to air pollution. It provided an integrated approach to guide the study that included an examination of historical processes and spatial dimensions in relation to who is most likely to be impacted. The focus on perceptions and experiences emerged as being critically important since it underscores social issues pertaining to air pollution studies which often tend to be neglected. Furthermore, the spatial and mapping aspect ensured that different scales of analyzes were incorporated. Also, the political economy perspective linked to the environmental justice framework integrates several themes relating to air pollution and health impacts. These included the demographic profile and socio-economic status of households, health problems experienced, household livelihood strategies, access to health services and facilities, coping strategies adopted, social perceptions and environmental considerations.

The thesis clearly reveals the complex socio-economic, environmental and spatial dynamics that are influencing air pollution and health impacts. It is clearly evident that health issues in the context of widespread air pollution concerns is a social, political and environmental issue that requires urgent attention. The findings of this study are relevant to both formulating strategies to address air pollution and health impacts as well as inform the development of appropriate policies. This latter requires a rethinking of current policies as highlighted in the recommendations section of this chapter. Case study, in-depth analyzes are important to consider in the setting of priorities that are context sensitive and in the policy development process. This study contributes to the socio-economic and spatial knowledge that currently exists on health impacts of air pollution.

Air pollution and health impacts remains a major concern in many parts of the world, especially in areas of high levels of industrial development such as Richards Bay. High levels of indoor and outdoor air pollution cause acute and chronic health problems. This research supports the findings of other scholars who show that the poor and vulnerable are most likely to bear the brunt of negative impacts. The ‘triple jeopardy’ experienced by the poor especially cannot continue. All stakeholders need to work together to find sustainable options to deal with air pollution problems that continue to afflict many.

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APPENDIX ONE
COMMUNITY HEALTH QUESTIONNAIRE
AIR POLLUTION AND HEALTH IMPACT STUDY

A. Socio-Economic and Demographic Characteristics of Respondents

1. Name of community______________________

3. Family Member Characteristics
3.1 Family Composition

Family Members	Age 1	Sex 2	M/ status 3	M/ income 4	Employment status 5	Education. 6	Place of employment 7
Person 1							
Person 2							
Person 3							
Person 4							
Person 5							
Person 6							
Other (specify)							

Codes:

2.Age
1.5-14
2.15-24
3.25-34
4.35-44
5.45-54
6.55-64
7.65-74
75+

3.Sex
1.Male
2.Female

4.Marital Status
1.Currently Married
2.Single (Never married)
3.Widowed
4.Divorced
5.Separated
6.Abandoned
7.SingleParent

5.Income
1. <300
2. 300-499
3. 500-699
4. 700-899
5. 900-1099
6. 1100-1299
7. 1300-1499
8. 1500-1699
9. 1700-1899
10.1900-2099
11.Other (state)

6.Employment Status

1.Professional
2.Technical
3.Managerial
4.Clerical
5.Sales
6.Crafsman
7.Labourer
8.Retired/pensioner
9.Housewife
10.Unemployed
11.Selfemployed
12.Other (specify)

7. Highest Education

1.No formal education
2.Nursery
3.Pre-school
4.Primary
5.Secondary
6.Tertiary

8. Did the household receive grants/ remittances in the last 12 months?

Grants	
Remittances	

B. Dwelling

Type	**1.** Brick & tile	**2.**I/formal	**3.** Other (specify)	
Living Space	1 Room	2 Rooms	3 Rooms	4.Other
Housing Condition	**1.** Good	**2.** Satisfactory	**3.** Poor	
Housing Environment	**1.** Clean	**2.** Moderate	**3.** Dirty	
Is dwelling convenient for needs?	**1.** Yes	**2.** No		
If "no" what would you change if given the choice?	**Explain:**			
Is dwelling convenient for all weather?	**1.** Yes	**2.** No		
If " no" what problems do you experience?	Explain:			

C. Water and Sanitation

Source of Drinking Water	1. Tap (public/private)	2. Tank	3.River/stream	4. Other (specify)	
Water Storage	1. No Applicable	2. Tank	3. Other		
Distance to nearest W/source	1. Not Applicable	2. Metres/ kms			
Toilet Type	1. Flush	2. Septic Tank	3. Drainage	4. Manual Disposal	5. None (bush etc)
Availability of Public Toilet	1. Yes	2. No			
If "yes" above give distance p/toilet	metre/ kms				

D. General Knowledge of Industries close to the Community

1. How close in your opinion, are industries located to your resident/ home?

Distance	**CODE**
< 1 km	0
1 - 2 km	1
2 - 3 km	2
3 – 4 km	3
> 5 km (specify)	4

2. What problems would you identify as being associated with the industries in Richards Bay? (Multiple responses)

Problem	**CODE**
Water pollution	0
Air pollution	1
Soil pollution	2
Health impacts	3
Other (specify)	4

3. In your opinion, which is the most polluted area(s) in Richards Bay?

____

____

4. Which areas would you say is the least polluted?

____

____

5. Which industries, in your opinion are the main sources of air pollution in Richards Bay? Give a reason for your response.

____

____

____

____

____

6. What advantages would you say that the industries in Richards Bay have for the local communities and surrounding areas?

____

____

____

7. What in your opinion, are the disadvantages arising from industries located close to the local communities and surrounding areas?

____

____

____

8. Are you or any other member of your household currently employed at any of the industries in Richards Bay?

RESPONSE	**CODE**
Yes	1
No	2

8.1 If yes, what is the name of the industry? ______________________________

8.2 How long has he/ she been employed in the industry? ___________________

8.3 What is the nature of the employment? _______________________________

9. Are you aware of any governmental, civic/non-governmental organizations that are concerned about or involved in issues pertaining to industries impact on local communities and surrounding issues in Richards Bay?

RESPONSE	**CODE**
Yes	1
No	2

9.1 If yes, list the organization/s and the nature of involvement with local communities and surrounding areas:

NAME OF ORGANIZATION	**NATURE OF INVOLVEMENT**

E. Community Health Issues and Concerns

1. Do you or any of your household members have one or more of the following health conditions/ problems? (multiple responses)

CONDITION/ PROBLEM	CODE	Number of household members afflieted
Allergies	0	
Eczema	1	
Hay Fever	2	
Asthmatic bronchitis	3	
Reactive airway disease	4	
Chest illness	5	
Any other lung/ breathing condition (specify)	6	
Other illnesses (specify)		

2. Which of the following aspects do you think may be the cause of the present health condition/ problem (s) in the household? (Multiple responses)

CAUSE	CODES
Pets	0
Dust	1
Pollen, trees, fresh cut grass	2
Cigarette smoke	3
Industrial smoke	4
Being physically active	5
Colds or flu	6
Certain types of food	7
Chang of weather	8
Mold and mildew	9
Sprays of strong smells (perfumes, colognes, domestic cleaning agents	10
Any other cause (specify)	11

3. Who in the household is mostly affected with health conditions or problems?

Women	Men	Children	Elderly
1	2	3	4

4. Did the affected household member ever consult a doctor with regards to the health condition/ problem?

RESPONSE	CODE
Yes	1
No	2

PERSON	RESPONSE
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

5. If yes, where did the household member go to seek treatment for the condition/ problem?

PLACE	CODE
Private doctor	0
Local clinic	1
Private hospital	2
State hospital	3
Other (specify)	4

PERSON	RESPONSE
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

7. How frequently has the household member been going to the doctor/ hospital to seek treatment?

FREQUENCY	CODE
Weekly	0
Monthly	1
6 Monthly	2
Yearly	3
Other (specify)	4

PERSON	RESPONSE
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

F. Health Condition/ Problem of Affected Household Member

1. COUGH:

Does a household member usually cough?

RESPONSE	CODE
Yes	1
No	2
Sometimes	3

PERSON	RESPONSE
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

1.2 How long has he/ she been experiencing this cough

PERSON	NUMBER OF YEARS
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

1.3 Does he/ she cough on most days of the week for as much as three months of the year?

RESPONSE	CODE
Yes	1
No	2

PERSON	RESPONSE
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

2. Wheezing

Have you or any member of your household had an attack of wheezing that has caused you or him/ her to be short of breath?

RESPONSE	CODE
Yes	1
No	2

PERSON	RESPONSE
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

How often does he/ she have such episodes?

FREQUENCY	CODE
Once a day	0
Several times a month	1
During season change	2
After sport	3
Other (specify)	4

PERSON	FREQUENCY
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

2.3 Has he/ she ever required medicine or treatment for any of the episodes? If Yes, how old was he/ she when he/ she had the first attack?

RESPONSE	CODE
Yes	1
No	2

PERSON	RESPONSE	AGE
Person1		
Person 2		
Person 3		
Person 4		
Person 5		
Person 6		

3. Chest pain

3.1 During the past few years have you or any member of your household experienced any chest pain that has prevented you / him / her from usual activities for as much as 3 days or more?

RESPONSE	CODE
Yes	1
No	2

PERSON	FREQUENCY
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

3.2 Has he/ her ever been hospitalized for any chest illness? If Yes, how old was he/ she when he/ she had his/ her first chest pain?

RESPONSE	CODE
Yes	1
No	2

PERSON	RESPONSE	AGE
Person1		
Person 2		
Person 3		
Person 4		
Person 5		
Person 6		

4. Asthma

4.1 Has a doctor ever told you or any other member of your family that you/ he/ she had asthma?

RESPONSE	CODE
Yes	1
No	2

PERSON	RESPONSE
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

4.2 At what age did the asthma begin?

PERSON	AGE
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

4.3 Does he/ she still have asthma?

RESPONSE	CODE
Yes	1
No	2

PERSON	RESPONSE
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

4.4 Does he/ she currently take medication or treatment for asthma?

RESPONSE	CODE
Yes	1
No	2

PERSON	FREQUENCY
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

4.4.1 If NO, at what age did the asthma stop?

PERSON	**AGE**
Person1	
Person 2	
Person 3	
Person 4	
Person 5	
Person 6	

G. General information regarding household and household health

1. What would you say is your general health status?

Good	Excellent	Satisfactory	Poor
1	2	3	4

2. What would you say is the general health status of your household member's?

Good	Excellent	Satisfactory	Poor
1	2	3	4

3. Does any member of the household smoke cigarettes, cigars, or pipes in the home? Yes/ No

3.1 If yes, how many people smoke? Yes/ No

3.2 How many cigarettes would you say that they smoke each day? ___________________

4. What is the main source of fuel used in the household for cooking, heating or lighting? What other sources of fuel are used (multiple responses)? Please indicate where the source is stored/ located and used.

COOKING

Fuel type	**Main source**	**Others sources**	**Stored**	**Where used**
Fuelwood				
Utility gas/ fuel oil/ kerosene				
Tank or LP gas				
Electricity				
Candles				
Other (specify)				

Fuel type codes

Stored	Where used
1. In the yard 2. In the home (kitchen) 3. In the home (other than kitchen) 4. Outside the homestead or yard 5. Not applicable 6. Other (specify)	1. Outside the kitchen 2. In the kitchen 3. Throughout the home 4. Other (specify)

5. Do you have any household pets living in the home? Yes/ No

6. Have you done any of the following things in the house to control the health condition or problem?

Control Measure	CODE
Removed visible mold growth	0
Removed pets from the home	1
Changed cigarette smoking rules in the home	2
Attempted to control or remove insects or cockroaches	3
Other (specify)	4

6.1 If any control measures were taken in the home, did it alleviate the health condition or problem?

RESPONSE	CODE
Yes	1
No	2

7. Have you ever considered moving out of the area?

RESPONSE	CODE
Yes	1
No	2

7.1 If yes, what is your reason for considering moving out of the area?

Reason	CODE
Health impacts from industrial chemicals	0
Environmental impacts	1
Work related	2
Personal reasons	3
Other (specify)	4

8. What are some of the challenges facing your household?

____

____

9. In your opinion, what are some of the challenges affecting the local community?

____

____

10. Is there anything else regarding your and your household members' health that you think is important for us to know?

____

____

THANK YOU FOR COMPLETING THE QUESTIONNAIRE!

APPENDIX TWO
FOCUS GROUP INTERVIEW SCHEDULE
AIR POLLUTION AND HEALTH IMPACT STUDY

A: Background Information

1.1 Name of Community:

1.2 Date of interview:

1.3 Interviewer:

1.4 Note taker:

1.5 Interview start time:

1.6 Interview end time

B: Knowledge about residential communities in Richards Bay (mapping exercise to guide discussion)

1. Where are residential areas in Richards Bay located?

2. What are the demographic profiles of these communities?

3. What are the dwelling conditions in these areas (including water and sanitation as well as energy)? Why do communities use the resources they do?

4. What are the types of indoor pollution in the communities?

C. Knowledge of industries close to the communities

1. How close in your opinion, are industries located to residents in Richards Bay?

2. What problems would you identify as being associated with the industries in Richards Bay?

3. What are the main advantages and disadvantages of having industries in Richards Bay?

4. Which are the most and least polluted areas in Richards Bay? (identify areas on a map and indicate why)

5. Which industries are the main sources of air pollution in Richards Bay and why? (mapping exercise)

6. What advantages and disadvantages do the industries in Richards Bay have for the local communities and surrounding areas?

D: Air pollution and health issues

1. What are the main air pollution health related ailments that in the communities?

2. What are the main causes of these ailments? (ranking exercise)

3. Who in these communities suffer the most and why?

4. What impacts do indoor and outdoor air pollution ailments have on the communities?

E: Coping strategies

1. What coping strategies are used to deal with air pollution and illnesses in the community?

2. What are the challenges faced in adopting these strategies?

3. How can strategies be improved?

F: Knowledge of organizations

1. Which governmental, civic/ non-governmental organizations are you aware of that are concerned about or involved in issues pertaining to air pollution and health issues in Richards Bay?

2. Please list these organizations and indicate the roles that they play?

3. Are they effective? What would you change?

4. Are communities provided with information about air pollution and health impacts? Who informs the communities? Are the approaches used to communicate with the communities effective?

G: Challenges facing the community

1. What are some of the challenges affecting the local community? (rank challenges)

2. Is there anything else regarding air pollution and residents' health that you think is important for us to know?

THANK YOU FOR YOUR FULL COOPERATION AND ASSISTANCE!

APPENDIX THREE
KEY INFORMANT INTERVIEW SCHEDULE
AIR POLLUTION AND HEALTH IMPACT STUDY

A. Background Information

1.6 Name of Organisation:

1.7 Website:

1.8 Survey Completed by:

1.9 Position at Organisation:

1.10 Email:

B. General Knowledge of Industries close to the Community

1. How close in your opinion, are industries located to residents in Richards Bay? (Answer in kilometres)

2. What problems would you identify as being associated with the industries in Richards Bay?

6. In your opinion, which is the most polluted area(s) in Richards Bay?

7.Which areas would you say is the least polluted?

5. Which industries, in your opinion are the main sources of air pollution in Richards Bay? Give a reason for your response.

6. What advantages would you say that the industries in Richards Bay have for the local communities and surrounding areas?

7. What in your opinion, are the disadvantages arising from industries located close to the local communities and surrounding areas?

8. Besides the organisation that you represent are you aware of any other civic/ non – governmental organisations that are concerned about or involved in issues pertaining to industries impact on local communities and surrounding issues in Richards Bay?

9.1 If yes, list the civic/ non – governmental organisation/ s and the nature of involvement with local communities and surrounding areas:

NAME OF ORGANIZATION	NATURE OF INVOLVEMENT

9. In your opinion, what are some of the challenges affecting the local community?

10. Is there anything else regarding air pollution and residents' health that you think is important for us to know?

C. SERVICES PROVIDED BY YOUR ORGANISATION

Now I would like to ask you a few questions about the organisation that you work at.

1. What does your organisation do in Richards Bay?

2. What are some of the services your organisation offers to the community?

3. Are the impacts of air pollution on communities in Richards Bay monitored by the organisation regularly?
    i. How is this done?
    ii. What are some of the outcomes?

4. Does other organisations, institutions, researchers, scholars etc have access to information that your organisation collects? Y/N – Please provide a reason for your reason.

5. Would you be able to allow the PhD researcher access to information on air pollution levels and trends, communities impacted upon, and other health related information? Y/N – Please provide a reason for your reason. If yes, how does the researcher gain access to such information?

THANK YOU FOR YOUR FULL COOPERATION AND ASSISTANCE!