Incorporating Local Participation and GIS in Assessing Flood Vulnerability in Informal Settlements: Masiphumelele Case Study

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AUTHOR'S DECLARATION

"I know the meaning of plagiarism and declare that all the work in the document, save for that which is properly acknowledged, is my own".

Signed: …… Date: ……

Flooding in Masiphumelele, June 2010

"It has become appallingly obvious that our technology has exceeded our humanity.

~Albert Einstein~

ABSTRACT

The case study applies a GIS-based methodology to assess the vulnerability of Masiphumelele, to both wetland flooding and coastal storm surges. This informal settlement, south of Cape Town has rapidly expanded since its inception 20 years ago, and large numbers of economic migrants largely from the Eastern Cape have swelled the population and over-whelmed the local infrastructure. The settlement is now expanding northwards in a largely uncontrolled fashion into an ecologically important wetland.

The study involved a number of different approaches designed to assess the living conditions of the residents, their vulnerability to flooding in particular, and to gauge the community's ability to cope with disasters.

Shack counts undertaken on the most recent aerial photographic imagery allowed an estimation of the current population of the settlement to be made. It is now estimated to be more than 38 000 people, of whom over 5 000 live in the so-called Wetlands, an area highly susceptible to flooding. Numerous interviews were undertaken with various stakeholders, including local residents, NGOs and local government to gauge perceptions to the risks faced by the residents and the various mitigation methods.

Two questionnaire-based surveys were undertaken using local residents to determine demographic and socio-economic data in addition to information directly related to flooding. The spatial component of the data was incorporated into a GIS, where analyses were performed. The results confirmed that the population is a young one, largely involved in temporary service-based low-paid employment. The population distribution across the settlement shows no particular geographic bias. The section of the community most at risk and most vulnerable are the newest arrivals who are living on the northern edge of the settlement that has encroached into the wetlands.

The results of the case study suggest that decision-makers could reduce vulnerability in this community by making choices that steer development away from high risk flood areas. Considerable time and resources have already been expended by both local government and numerous NGOs to address various problems. In terms of addressing flooding risk, a more holistic approach is required, one in which the message of the real risks to flooding are more effectively communicated to the local community.

KEY WORDS: Vulnerability assessment · Informal Settlements · Flooding · Community Participation · Sea-level rise · Climate change impacts · GIS· Buffers ·Setback lines

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ACRONYMS

AIDS	Acquired Immune Deficiency Syndrome
ALIU	Anti-Land Invasion Unit
ANCYL	African National Congress Youth League
BBC	Bogardi, Birkmann and Cardona Conceptual Framework
BNG	Breaking New Grounds
CBO	Community Based Organisation
CORC	Community Organisation Research Centre
CPA	Cape Provincial Authority
CRA	Community Risk Assessment
CRED	Centre for Research on the Epidemiology of Disasters
CSIR	Council for Scientific and Industrial Research
DAG	Development Action Group
DBSA	Development Bank of South Africa
DEM	Digital Elevation Model
DFID	Department for International Development
DiMP	Disaster Mitigation for Sustainable Livelihoods Programme
DM	Disaster Management
DIMSA	Disaster Institute of Southern Africa
DMIS	Disaster Management Information System
DPLG	Department of Planning and Local Government (South Africa)
DPM	Natural Disaster Prevention and Mitigation Programme
DRM	Disaster Risk Management
DRR	Disaster Risk Reduction
DST	Department of Science and Technology
DTM	Digital Terrain Model
EIA	Environmental Impact Assessment
EM-DAT	International Disaster Database
ESIS	Emergency Sanitation Informal Settlements
EWS	Early Warning System
FFG	Flash Flood Guidance System
GDP	Gross Domestic Product
GIS	Geographic Information Systems
GIT	Geographic Information Technology
GPS	Global Positioning Systems
GRIP	Global Risk Identification Programme
HFA	Hyogo Framework of Action

HIV	Human Immunodeficiency Virus
ICMA	Integrated Coastal Management Act
ICSU	International Council for Research
IDNDR	International Decade for Natural Disaster Reduction
ILO	International Labour Organisation
ISDR	International Strategy for Disaster Reduction
IRMA	International Risk Management in Africa
ISDR	International Strategy for Disaster Reduction
KIP	Kampung Improvement Programmes
KPA	Key Performance Areas
MANDISA	Monitoring and Mapping of Disaster incidents in South Africa
MDG	Millennium Development Goals
MSG	Meteosat Second Generation
NASA	National Aeronautics and Space Administration
NDMC	South African National Disaster Management Centre
NDMF	South African National Disaster Management Framework
NEMA	National Environmental Management Act
NEPAD	New Partnership for Africa's Development
NGO	Non-Governmental Organization
NPO	Non-Profit Organization
NWA	National Water Act
O&M	Observations and Measurements
OGC	Open Geospatial Consortium
OSA	Open Service oriented Architecture
PAR	Pressure and Release Model
PDMC	Provincial Disaster Management Centre
PERIPERI	Partners Enhancing Resilience for People Exposed to Risks
PHP	People’s Housing Process
PGIS	Participatory Geographic Information Systems
PRA	Participatory Rural Appraisal
RADAR	Risk and Development Annual Review
RS	Remote Sensing
SAC	Satellite Application Centre
SAIEG	South African Institute of Engineering Geology
SARVA	South African Risk and Vulnerability Atlas
SAS	Sensor Alerting Service
SAWS	South African Weather Services
SDI	Spatial Data Infrastructures

SensorML	Sensor Modelling Language
SWE	Sensor Web Enablement
SOA	Service-Orientated Architecture
SOS	Sensor Observation Service
SPS	Sensor Planning Service
TB	Tuberculosis
TEAM	Training Educating Awareness Marketing Programme
TML	Transducer Markup Language
TRA	Temporary Relocation Area
UISP	Upgrading Informal Settlement Programme
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational Scientific and Cultural Organization
UNDP	United Nations Development Programme
VCA	Vulnerability and Capacity Analysis
WAMIS	Wide Area Satellite Monitoring Information System
WCRP	World Climate Research Programme
WRC	Water Research Commission
WMO	World Meteorological Organization

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CHAPTER 1

INTRODUCING THE RESEARCH PROBLEM

"He who sees the calamity of other people finds his own calamity light"

~ Arabian proverb ~

1.1 Background

Every day close to 200 000 people leave the world's rural regions and head for the cities, many of whom of necessity are forced to add to the statistics of residents of informal settlements (Neuwirth, 2004). The literature shows that there are at least one billion 'squatters' [squatters are the internationally accepted term for residents of informal communities] in the world today, representing almost one in six people on the planet (Neuwirth, 2004). It is also clear that those most physically vulnerable are also the most susceptible socio-economically and politically (UNISDR, 2009). If current trends continue, there will be no fewer than two billion (2×10^9) squatters by 2030 and an almost unbelievable three billion by 2050, which equates to one-third of the people on the globe (Neuwirth, 2004). Disasters resulting from natural hazards, such as flooding, severely affect millions of people every year. Communities most vulnerable to these disasters tend to be those from rapidly increasing high-density, low-income, often informal urban-settlements (Wisner *et al*, 2004). Settlements in coastal lowlands are particularly vulnerable to risks resulting from climate change (McGranahan et al, 2007). Vulnerability to flooding has been found to be exacerbated by inappropriate housing and inadequate infrastructure, often as a result of partial or no proper legal tenure (Thomalla *et* al, 2006).

Modern disaster management studies have shifted focus from the purely scientific study of hazards towards that of disaster risk and the investigation and understanding of the social vulnerabilities of communities (Bankoff *et al*, 2004). At the same time, there has been an increasing paradigm shift from a reactive response to disasters to a preventive approach (Bankoff *et al*, 2004). Such an approach is believed to assist sustainable development in that it probably saves lives and averts damage to property and infrastructure. During an emergency, access to the right data at the appropriate time, presented in a logical way is crucial if lives, property, and the environment are to be protected (Johnson, 2000). As example, one of the major problems experienced during the devastating hurricane Katrina disaster in the United States in 2005, was inconsistent, poorly integrated, and often inadequate information-flow to response agencies and field units. This led to the hampering of an effective response to the disaster (Asante *et al*, 2006). Poor data quality can therefore be life-threatening and could be the result of, amongst other things; invalid or non-current data, data with no or limited metadata, inconsistencies of scale, data that lacks standardisation, and data resulting from human errors, often due to a lack of training. The need for a systematic approach for the integration of geospatial technology to support disaster management is therefore also critical. In order for these approaches to be effective however, it becomes essential that local

communities are incorporated into the planning and implementation of disaster management (Pandey and Okazaki, 2004). This notion of community participation is becoming the norm internationally, though it is still in its infancy in South Africa. Community participation has been found to be an effective means of disaster risk management and has been implemented by a variety of organisations around the world.

Around 30% of people in the Cape Town area are living in inadequate housing, predominantly in informal settlements (Goldberg *et al*, 2009). Flood disasters have had devastating effects within these informal communities in the past. Many people have been displaced and livelihoods destroyed; millions of Rands have been expended as a result thereof. Flooding is considered a fundamental concern within the Cape Peninsula (Mukheibir & Ziervogel, 2006). Flooding in informal settlements occurs mainly, but not exclusively during the wetter winter months. Many informal settlements which are located on low-lying ground and/or encroaching onto wetlands, a prime example of this can be seen in Masiphumelele, the location chosen for this research.

The following published citations with their statistics, confirms the extent of the flooding problems:

As a result of heavy rains and flooding in Cape Town, the British Broadcasting Corporation (BBC) observed:

> August 2001: *"The South African Government has declared several areas of the flood-hit coastal city of Cape Town as disaster zones. About 13 000 families have been washed out of their shacks. Thousands of them have been moved by the South African army working with aid agencies to temporary shelter in churches and community halls. Conditions are truly miserable. Homes are surrounded by pools of water turned green by sewage"* (BBC, 2001).
>
> July 2007: Cape Town disaster-management spokesperson Johan Minnie said that unofficial reports indicated that more than 30 000 people living in about 8 000 shacks across the Cape Town metropolitan area may have been affected in different ways by flooding (Mailn and Guardian, 2007).
>
> 2008: In the Western Cape during the period 2003-2007, the cost of disasters has risen from R212 million in 2003 to R1.2 billion in 2007. Costs are expected to rise to R2.1 billion by 2011 (Holloway, 2008).
>
> July 2008: during one incident of flooding, the City of Cape Town said that 16 000 people and 3 500 structures were affected; with 3 000 people having to be housed in community halls (Mail and Guardian, 2008).
>
> 2008: Heavy rains in 2008 in the Western Cape caused widespread flooding of nearly 4 000 homes and damage to infrastructure with almost 30 000 people being affected.

> Because flooding is a major problem in the Western Cape, if it is not possible to re-locate the people affected, then it is necessary to make an attempt to improve drainage or raise the floor levels of their structures (Powell, 2008).
>
> May 2009: 29 informal settlements, 697 structures and 1 900 people were affected by a weekend of heavy rains (SABC, 2009).
>
> July 2009: Thousands of shack dwellers were left homeless on Monday morning after heavy rains caused flooding around Cape Town. About 9 000 people from 2 500 shacks were affected by the floods. Areas on the Cape Flats bore the brunt of the rainfall, particularly informal settlements in Khayelitsha, Masiphumelele, Sweet Home and Kosovo (news24, 2009).

In addition to flooding resulting from storms, is the very real threat of climate change, expected to exacerbate current conditions. Recent research indicates that regions most likely to be affected by climate change, particularly rising sea-levels, are located in the south-west corners of South America, Australia and Southern Africa (DPLG and DEAT, 2007). The Western Cape is likely to be particularly vulnerable to rising sea-levels associated with global warming in the next 20 – 35 years, meaning more erratic flash flooding, regardless of any efforts to reduce greenhouse gas emissions. People whose livelihoods are most vulnerable to sea-level rise are those living along the coast, and more especially those living in informal settlements, especially those located in low-lying areas (Drimie and van Zyl, 2005).

Although overall rainfall is expected to decrease, the severity of rainfall events is likely to increase (Wageningen and Du Plessis, 2007). An Integrated Coastal Zone Management (ICZM) framework of adaptation is considered to be an effective means of adapting to climate change (UNEP, 2010). The adoption of the concept of 'setback lines' creating buffer zones are an important component of the ICZM, and are of necessity becoming standard procedures as a means of alleviating the effects of climate change. Setback lines or buffer zones are delineated areas within a certain distance of a vulnerable system, such as a wetland or coastal protection zone where development is not allowed (Roets and Duffel-Canham, 2009). They are put in place not only to maintain a balance between environmental and human systems, but also to lessen the potential effects of climate change. Setback lines are particularly important as they provide a practical means of a systems' ability to protect human lives and their property. Wetlands and floodplains themselves are seen as important natural systems that already act as buffers and repositories for flood water originating due to storms or sea-level rises (Roets and Duffel-Canham, 2009). One small informal settlement, located on the fringes of a wetland system and within close proximity to the sea, and therefore to sea-level rise events, is Masiphumelele, the focus area for this study. Figure 1.1 shows the location of this settlement in relation to others in the Cape Town area.

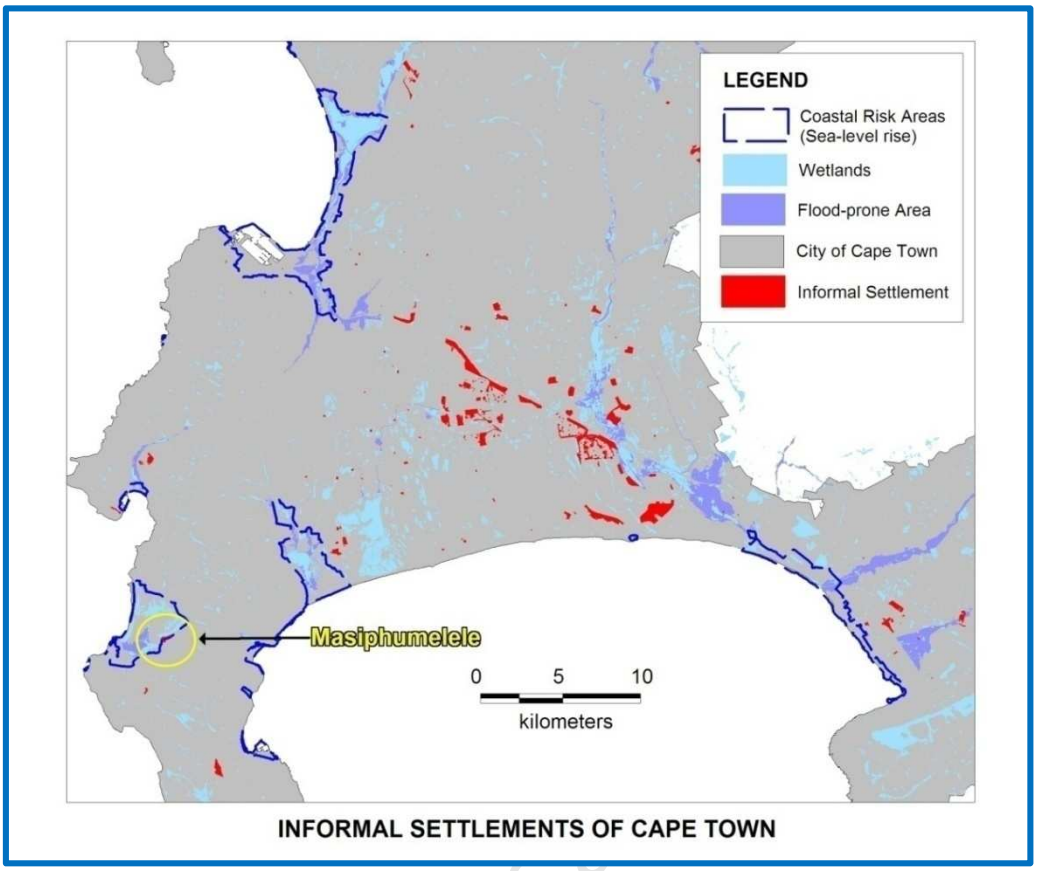

Figure 1.1 Informal Settlements of Cape Town (displayed in red)

Data, obtained from the City of Cape Town in 2009, indicates that there are 316 informal settlements within the boundaries of the city. The Location of Masiphumelele is circled in yellow. Flood-prone areas and water bodies are displayed in blue.

1.2 Aim and scope of the study

This study adopts the BBC conceptual model of vulnerability, based on Bogardi / Birkmann, 2004; Bogardi and Birkman, 2006 and Cardona 1999, taking into account the four thematic areas regarded as the causes of vulnerability (*i.e.* socio-political; economic and environmental spheres of reference) to examine potential exposure and coping mechanisms in Masiphumelele. It examined, first, the spatial distribution of present flood risk within the area, taking into consideration both inland estuarine flooding and coastal flooding as a result of storm surge, and, second, the physical distribution of three groups of communities within the flood-risk areas. It analyzed how the distribution of flood risk is also inherently linked and affected by socio-economic factors such as poverty and institutional policies. The study took physical exposure as an initial measure of vulnerability to show patterns of distribution. In order to obtain a more accurate understanding of the situation in Masiphumelele, however, the study also examined a number of indicators of social vulnerability, for instance poverty levels, age, education, tenure and perceptions of disaster risk management to determine the relationship between social and physical vulnerability aspects. The aim of this study was to answer the following questions in relation to Masiphumelele (refer to Fig 1.1 for location map).

a. How does the geographical distribution of physical vulnerability differ in the Masiphumelele settlement?

b. How does this geographical distribution of physical vulnerability correspond with other dimensions of vulnerability, particularly socio-economic and political vulnerability?

c. How can researchers engage with local participants in shared data acquisition that can be considered sufficiently reliable in a vulnerability analysis?

d. What are the strengths and weaknesses in engaging with local participants in the acquisition of such data?

These are the four specific research questions that this dissertation sought to answer. In the discussion section, a more comprehensive analysis of vulnerability of Masiphumelele is examined in order to determine the linkages of physical and social vulnerability. The central questions posed in this study are summarised in the following points:

1. Do the levels of vulnerability in Masiphumelele vary?
2. Does physical vulnerability significantly coincide with socio-economic and political vulnerability in Masiphumelele?
3. Is it possible to successfully utilize local participants in acquiring data? Would these local participants have a better understanding of their own circumstances and vulnerability than outsiders would have? Would the process of generating the best possible data allow both the researcher and participants to learn meaningfully through practical experience?

1.3 Outline of the dissertation

The analytical framework and theory is presented in chapter 2. This framework incorporates four elements of vulnerability, namely, physical, environmental, socio-economic and institutional, and these together with the concept of 'setback lines' form the key methodological concepts of the study. A brief background of the study area is discussed in chapter 3. Chapter 4 examines the methods and data manipulation procedures utilised during the study. Both the reliability and validity of the methods used are discussed. Results are presented in chapter 5 with a discussion thereof presented in chapter 6. Conclusions and recommendations are outlined in final chapter, with references and appendices following at the end of the dissertation.

CHAPTER 2
FRAMEWORK AND THEORY

"The difference between what we do and what we are capable of doing would suffice to solve most of the world's problems"

~Mahatma Gandhi ~

2.1 Establishing the Current 'State of the Art'

The theoretical framework for this research draws from literature on physical and social vulnerability and the correlation between the two. It explores the importance of techniques that assess this vulnerability, in the form of local community participation and GIS. Five significant terms are used in the literature to describe disastrous situations; hazard, disaster, risk, vulnerability and resilience. Researchers do not necessarily make distinctions between these four terms, since they perceive pre-existing conditions that result in poverty and suffering simply as disasters. In fact, disasters are commonly equated with the already existing socio-economic vulnerabilities occurring in communities. Disasters aggravate poverty and the economic predicament of people, particularly in lower income communities (de Dios, 2002). The five terms are defined below:

> "*A disaster is a situation or event which overwhelms local capacity, necessitating a request to a national or international level for external assistance"* (Centre for Research on the Epidemiology of Disaster *(CRED)* (CRED, 2009).
>
> "*A hazard is defined as a latent danger or external risk factor of a system or exposed subject. It is the probability of the occurrence of an event of certain intensity in a specific site and during a determined period of exposure*" (Cardona *et al*, 2003).
>
> "*Risk is the probability of a loss, and this depends on three elements: hazard, vulnerability, and exposure. If any of these three elements in risk increases or decreases, then the risk increases or decreases respectively*" (Crichton, 1999).
>
> Risk is conventionally expressed by the following widely accepted notation when applied to the research of natural disasters (WMO, 2008; Wisner, 2004; Cardona *et al*. 2003; Peduzzi *et* al, 2002; Granger, 2003). Exposure in this expression refers to people or assets being in physical contact with a particular hazard, such as flooding.
>
> Risk = function (Hazard x Exposure x Vulnerability)

2.2 Defining Vulnerability

The exact definition of vulnerability is still open to debate. A common description is the degree to which a person, system or unit is likely to experience harm due to exposure to perturbations or stresses (Kasperson *et al*, 2005) and can be considered among others things as the complex product of past institutional / political, economic and social processes (Kasperson *et al*, 2005). Another popular interpretation of vulnerability is that it is simply the antonym of resilience and refers to the ability of socio-ecological systems to cope with and adapt to change (Folke *et al*. 2002). In Turner *et al*. (2003), using the vulnerability analysis framework, resilience is not considered simply the opposite of vulnerability, but is one of three aspects of vulnerability, with the other two being exposure and sensitivity. Subsequently it is possible to have high resilience, but if exposure and sensitivity to risk are high, then a person or community can therefore still be considered vulnerable.

To complicate matters further not only is there a range of different frameworks that could be used in assessing this vulnerability, but there are also different scales of measurement, for instance International, National, Regional and Local (Sub-regional). The Pressure and Release Model (PAR) (Wisner *et al*. 2004: 51); (Cardona, 1999) and the Sustainability Systems Programme's vulnerability framework (Turner *et al*, 2003) and the BBC-conceptual framework are all examples of some of the different frameworks that have been developed in recent years. A brief introduction of each is summarised below.

2.2.1. The Pressure and Release Model (PAR)

The pressure and release model (PAR model) views disaster as the juncture of two major influences: the events leading to vulnerability, on the one side, and on the other, the natural hazard event. The PAR approach emphasises how disasters arise when natural hazards affect vulnerable people (Wisner *et al*., 2004). The conceptual framework stresses the reality that vulnerability and the development of a potential disaster can be seen as a process involving mounting pressure on the one side balanced by the potential to mitigate this pressure on the other. The PAR approach can effectively summarized by the commonly used equation:

Risk = Hazard *x* Vulnerability

2.2.2 Sustainability Vulnerability Framework

The framework developed by Turner *et al* in 2003 looks at the vulnerability of interlinked systems by describing exposure, sensitivity and resilience of vulnerability (Renaud and Jansky, 2008). The framework has the concepts of exposure, coping and impact response and adaptive measures as inherent facets of vulnerability. This framework in contrast to most

others emphasises the link between human and environmental systems with adaption considered a means of augmenting resilience (Bogardi and Birkmann, 2006).

2.2.3. BBC framework

The BBC-conceptual framework attempts to link and integrate the concept of sustainable development with the vulnerability framework (Renaud and Jansky, 2008). This framework emphasises that any assessment of vulnerability must include an appreciation of the levels of a communities' exposure and susceptibility and coping capacity (Bogardi and Birkmann, 2006). It highlights the need to be proactive and anticipate risk by taking appropriate measures to reduce vulnerability before it develops into a catastrophe. Politically it stresses the need for early warning systems to be 'part and parcel' of a government's routine operations.

These frameworks have all been incorporated into a number of different vulnerability case studies. For example, the PAR model was adopted during the study of the 2005 earthquake in Pakistan (Yasir, 2009). In using this model researchers were able to identify the vulnerable factors considered to be vitally important during earthquakes. A weakness experienced using this method however, was the unavailability of accurate and reliable disaster statistics, which limited the scope of the study.

The Turner *et al* vulnerability framework was implemented during two case studies in Mexico during 2003; one in southern Yucatan and the other in the Yaqui Valley (Turner II *et al*, 2003). A drawback of this framework was found to be that full vulnerability assessments following the framework will not be possible for most researchers, due to its complexities, particularly with regard to the amount of data required; although it does provide a meaningful starting point for examining vulnerability. The conclusion reached by the authors after implementing the framework was that it would be necessary to simplify it to suit the application being researched.

The BBC framework was incorporated into a study in 2007 of the tsunami in Sri Lanka, which took place in 2004. The framework was found to be practical in that it was able to define and prioritise areas that require indicators to measure vulnerability.

The majority of the literature is dedicated to measuring comparative vulnerability, primarily at international and national levels, but with an obvious gap apparent at sub-regional levels (Webber and Rossouw, 2009). A common trend apparent throughout all the frameworks though, is that vulnerability is portrayed in various thematic dimensions, these are physical, economic, social, environmental and institutional aspects (Bogardi and Birkmann (2006). Based on this information, it is clear that vulnerability is multi-dimensional in nature and subsequently complicated to measure.

The major findings also revealed that there has been an evolution of thinking in the field of vulnerability. Over the last decade, a global paradigm shift from relief and response to a focus on Disaster Risk Management was apparent. Traditional methods of disaster management (DM) have been replaced by disaster risk reduction (DRR) strategies (Yodmani, 2007). Such a paradigm shift represents current trends: more humane interests amongst a majority of people but more particularly of those underprivileged within the global community (Clifford, 2009). Not only has the relatively recent advent of relevant technological data-generation, analyses, and applications been possible, but the trend toward utilization for humane enhancement must be applauded.

2.3 Evolution of Disaster Theory

Until fairly recently, disasters were seen as isolated extreme events and were responded to as such, without any real consideration to the overall social and economic implications to communities. Over time, this notion started changing and more importance was placed on being prepared for the possibility of disasters. The response to this occurred with the accumulation of relief goods, the development of emergency plans, and by the increase of relief agencies, such as the Red Cross (Yodmani, 2007). This approach was however often inappropriate and ineffective in terms of the actual assistance received by communities in need due to problems with distribution.

Since 1960, there has been a notable increase in the number of recorded natural disasters as well as human and economic losses from these disastrous events. This increase in natural disasters could well be the result of improved reporting methods, knowledge of natural disasters and better modern record keeping. On the other hand, it is possible that certain disasters have actually increased as well, perhaps connected with climate change. In addition there are an increasing number of potentially vulnerable people living in informal communities. Over the last five decades, scientific knowledge about natural hazards and the technological means of confronting them has expanded greatly (James, 2007). Major progress has been made in the development of global meteorological models and their application to large-scale weather prediction. Yet despite the ample availability of knowledge and expertise, vulnerability is growing because of unsustainable development, climate change and extremes of weather which together increase the scope and cost of disasters (Yodmani, 2007).

The concept that people's vulnerability was a major influence on the impact of a disaster was first introduced in the 1980s and 1990s (Juneja, 2008). This resulted in a shift towards using vulnerability analysis as a tool in disaster management. It was during this period that the emergence of disaster mitigation as well as the linkage between disaster and development was established. Current trends, however, have moved away from disaster risk towards one of disaster risk management and education. This theory of disaster risk management takes the stance that disasters can be managed by identifying and managing specific risk factors (Arnold, 2006). With the increase in technological capability, together with scientific and social knowledge, much more

is known about the spatial and temporal distribution of natural hazards as well as the inevitable associated social aspects. Yet, despite new knowledge and methodologies, it would appear that loss of human life; damage to property and the environment have also sadly continued to increase.

There are two schools of thought when considering disasters; vulnerability theorists and resilience theorists (Miller *et al*, 2010). Essentially, both schools rely on many similar components, albeit generated using different terminologies and with perhaps inadequate or variable descriptions of concepts. The following discussion focuses on these schools of thought and the inter-relation between the two.

2.4 Social Vulnerability School of Thought

As seen above, there are varied definitions of social vulnerability; depending on the type of organisation involved. Hazards and vulnerabilities are mutually dependent and lead to risk (Cardona, 2004). Cardona believes that if there no hazard, an individual cannot logically be vulnerable. The postulation infers that if one component of risk is altered; *i.e.* hazard, vulnerability or exposure, then the risk will also change. Hazards, unless man-made, cannot be modified, so it stands to reason that only the components of vulnerability and exposure can be altered. Based on this conclusion, it would appear that in order to decrease the risk, it is a necessity that vulnerability and exposure be reduced. The non-linear relationship between the variables in the risk equation developed by Wisner *et al*, suggests that an increase in one variable leads to risks being increased exponentially, rather than proportionally (Wisner *et al*, 1994). Cannon lists five interacting components when describing the vulnerability of individuals and households to natural hazards, these are livelihood, baseline status, self-protection, social protection, and governance (Cannon, 2000). These five are interrelated, with the most important links being those that affect livelihoods and social protection. The main determinant in assessing peoples' vulnerability is how adequate their livelihood is, and how resistant it may be to hazards.

One component of vulnerability research is the frequent distinction of "top-down" and "bottom-up" approaches (Dessai and Hulme 2004). Top-down approaches originate from the focus on biophysical aspects of vulnerability, such as climate impact assessment. Bottom-up approaches originate from the fields of poverty reduction and disaster-risk reduction, development and food security. Bottom-up approaches often focus on social conditions and perceptions of vulnerability. Choosing between the two methodologies largely depend on the research questions and if stakeholders' perspectives are considered important or not.

How a country or province is governed determines largely how resources are distributed and the social protection afforded to the community. In some countries the ability of Non Governmental Organisations (NGOs) to fill in the gaps in self protection is greater than elsewhere but in others it

is even dangerous for NGOs to pressurise the government to provide even basic services to the people (Cannon, 2000).

Increasing vulnerability, particularly in developing countries like South Africa, results from *inter alia* rapid and uncontrollable urban growth and environmental deterioration (Cardona *et al*, 2003). This rapid growth is particularly noteworthy in the informal settlements. This implies that vulnerability and urban development are inherently linked. Vulnerability to flood risks in urban settlements, particularly in developing countries in informal developments can be attributed to the following factors (Cardona *et al* 2003; WMO, 2008):

- The physical exposure or fragility of the site with the most risk-prone areas being the only areas that the poor migrants are able to afford
- Socio-economic fragility – for example, infrastructure to reduce risk is not economically viable
- Lack of resilience (due to lack of information and available funds to alleviate the situation, weak social structures, *etc.*) - Failure to perceive flood risks due to lack of knowledge till a flood strikes
- Flooding (particularly local flooding) occurs so regularly that residents become accustomed to living with risks.
- The ability to obtain adequate self-protection from a hazard depends on a community's capability and willingness to build a home that is structurally sound and is situated out of harm's way (for example, away from a flood plain).

2.5 Social Resilience School of Thought

Resilience theorists attempt to study the relationship between ecological and biophysical changes, whether longer term with slow onset, like climate change, or through short-term, rapid onset scenarios, in the form of flooding (Miller *et al*, 2010). This relationship is often neglected in vulnerability studies. Resilience theorists' main aim is to secure future sustainability.

Social resilience is associated with practical and ongoing support systems or redundancy; this occurs traditionally in the form of family or extended family, churches, neighbours, work colleagues, charities and Non-Government Organisations (NGOs) to name a few, but also from National or Local government (Folke, 2006). The more support or backup systems available, especially in the event of a natural disaster such as flooding, the more resilient a community is likely to be.

2.6 The Relationship between Social Vulnerability and Social Resilience

Social vulnerability and resilience are not directly correlated because they are calculated using different units; however, they are effectively two sides of the same coin (Vulnerability Index,

2009). The greater the vulnerability, the less the capacity to cope, and the tendency to adopt coping mechanisms is of necessity increased (Saperstein, 2006). The unit of measurement for calculating social vulnerability is human or economic cost, particularly statistics such as, how many lives have been impacted or lost and at what cost (Bankoff *et al*, 2004). Social resilience on the other hand is calculated by units of time; such as the length of time it takes for communities to get themselves back on their feet and return back to a state of normalcy after a crisis or disaster. The longer it takes to return to normal, the more chance there is that a community will fragment.

The vulnerability and resilience schools of thought although inherently linked, are commonly studied separately, mainly due to conceptual constructs, scientific traditions and lack of interaction in academia (Miller *et al*, 2010). The vulnerability school of thought originated through the theories of hazards which are based on physical, human and political sciences (Eakin and Luers 2006, McLaughlin and Dietz 2007). The resilience school of thought on the other hand came from the ecological and natural sciences (Folke 2006, Gallopín 2006). Investigation of the relationship and connectivity of resilience and vulnerability theories are still in their infancy. Confusion and ambiguity in terminology and theory inhibits closer effective collaboration between the two schools (Miller *et al*, 2010). Therefore, it would seem to imply that more integration is necessary; this must include qualitative and quantitative research methods as well as local community involvement through action research methods.

2.7 Community Participatory and Bottom-up Approaches

During the 1990s, vulnerability assessment tools such as 'Vulnerability and Capacity Assessments' (VCAs), hazard mapping and community profiling were developed. By the late 1990s, the increase in successful application and use of these assessment tools transformed the theory of vulnerability reduction to a measurable parameter (Frerks and Bender 2004). The ineffectiveness of the top-down management approach has to many researchers, become apparent in its inability to reduce vulnerability due to its failure to address the needs of vulnerable communities. Due to the fact that there has been an exponential increase in small and medium scale disasters in recent years, the need to introduce a new strategy that would include vulnerable communities in the disaster management process became evident. There is now an increasing trend towards a bottom-up approach (Yodmani, 2007). A major advantage of a bottom-up approach is that communities are able to assess and determine their own ways of alleviating vulnerability and can therefore decide for themselves which risks are acceptable and which are not. According to the International Strategy for Disaster Reduction (ISDR) and ProVention Consortium, however, most analysis and mapping of vulnerability and risk in Africa is done on a top-down level only. Although community participation tends to be very limited, there is some progress towards integration (UNISDR, 2009 and/ ProVention Consortium, 2005).

There are many theories and opinions as to what are the most suitable methods for minimising vulnerabilities, the most common and agreed upon theme to be found in the literature is the incorporation and importance of local participation, empowerment and capacity (Davis, 2004).. There is strong emphasis that improving Vulnerability and Capacity Analysis (VCA) tactics together with the implementation of community-based projects should facilitate the reduction of vulnerability. Although VCAs are becoming more common in disaster risk management, there are still no formally agreed upon methodologies for assessment, perhaps because of the lack of information available related to the various assessment approaches (Davis, 2004). It is believed that there is a need to explore the links between social vulnerability and capacity assessment data, the most urgent need being to incorporate both into an integrated Disaster Management Information System (DMIS). Social vulnerability data is generally collated prior to a disaster, whereas capacity data is usually collected afterwards (Davis, 2004). Another common theme within the literature is the need to implement a multidisciplinary and interdisciplinary approach to vulnerability and capacity assessment, and by so doing be able to combine social, technical, economic and environmental data. Also of concern is the accuracy and consistency of data collected as well and the need to incorporate it into affordable GIS systems, particularly in developing countries (Davis, 2004).

2.8 Participation and GIS

The concept of Participatory Mapping and Participatory Geographic Information Systems (PGIS) originated in methods utilised in Participatory Rural Appraisal (PRA); a technique developed during the late 1980s (Rambaldi *et al*, 2005). PGIS improves upon the PRA method by combining geo-information technologies (GIT), such as Geographic Information Systems (GIS), Global Positioning Systems (GPS) and remote sensing image processing software, into its rationale (Rambaldi *et* al, 2005 as cited by Christiansen, 2007). This was made possible when computer prices became more affordable as well as the development of more user-friendly software platforms during the 1990s. The development of the internet also played an important role in information exchange. PRA and GIS methods encourage local communities to examine their environment as well as enhancing their self-confidence once they realise that their local knowledge is worthy of protection.

PGIS is an excellently suited method of incorporating local knowledge. In the search for relevant case studies assessing the vulnerability of communities to natural hazards applied through PGIS techniques; it was noticeable how few examples were available. In urban areas of developing countries, PGIS methods have not been used frequently. Existing examples are limited regarding issues such as the management of informal settlements (Sliuzas, 2004, Koti and Weiner, 2006) or slum upgrading initiatives (Kuffer *et* al, 2006 and Christiansen, 2007).

However, one particularly relevant case study is that of Búzi, a small town in Mozambique, which commenced in 2000. This project collected primary data through participatory approaches using semi-structured interviews, transect walks and community mapping. Participatory methods and especially PGIS methods were found to be well suited in the implementation of vulnerability assessments and were crucial for their success (Kienberger and Steinbruch 2005). The following conclusions were drawn from the study: that in order for these methods to be successful, the following prerequisites were found to be essential if PGIS methods are to be effective:

- Policies or social environments permitting participation must be in place
- An information flow must be maintained
- Strengthening of local GIS focal points for data processing
- Active involvement of local people

Another successful example of the successful incorporation of PGIS methods was highlighted in a project conducted in Sofala Province, Mozambique. PGIS methods were used in assessing flood vulnerability; Community mapping and community integrated GIS. (Kienberger & Steinbruch 2005; Kienberger and Steinbruch 2005 and Kienberger, 2007). Although the participatory approach adopted in this study was mainly one-directional, it was deemed appropriate for the collection of spatial information and to capture the perception of people regarding disasters the participatory approaches. The potential of the participatory maps for planning of evacuations in the case of floods was discovered after the project had been completed and was adopted by individuals as well as the local Disaster Risk Committees. Maps were also used in community meetings to discuss spatial-relevant issues. In one community, maps are used for teaching pupils about their community environment.

In Thulamela Municipality in the Limpopo Province of South Africa - PGIS and political ecology were used to study flood vulnerability coping strategies by incorporating, mental maps and PRA. The study concluded that household flood vulnerability is socially constructed and is determined by political, socio-economic and environmental factors (Nethengwe 2007). PGIS was found to be useful for studying the political ecology of flood hazards as it facilitated the understanding and visualization of the politics of power relationships that led to local vulnerability. It proved to be an effective technology and methodology for assessing the social and spatial vulnerability of flood-prone communities.

2.9 Conceptual Framework of the Study

The need for a holistic approach is apparent from the literature review. An approach that comprises not only of geological and structural aspects, but also features economic, social, political and cultural disciplines is essential. The application of PGIS methodology in this dissertation was a research attempt to understand, locate and map social and physical vulnerability in the study area. It was based on a conceptual framework of social and physical realms of vulnerability, but also incorporates aspects of political and environmental issues.

The research was also based on the BBC Conceptual Framework, which differs from the other frameworks in that it acknowledges that the environment itself can be vulnerable to natural hazards (environmental dimension of vulnerability). The framework is a holistic approach to vulnerability assessment since it integrates natural (including engineering) and social (including economics) sciences. The framework is illustrated in Figure 2.1

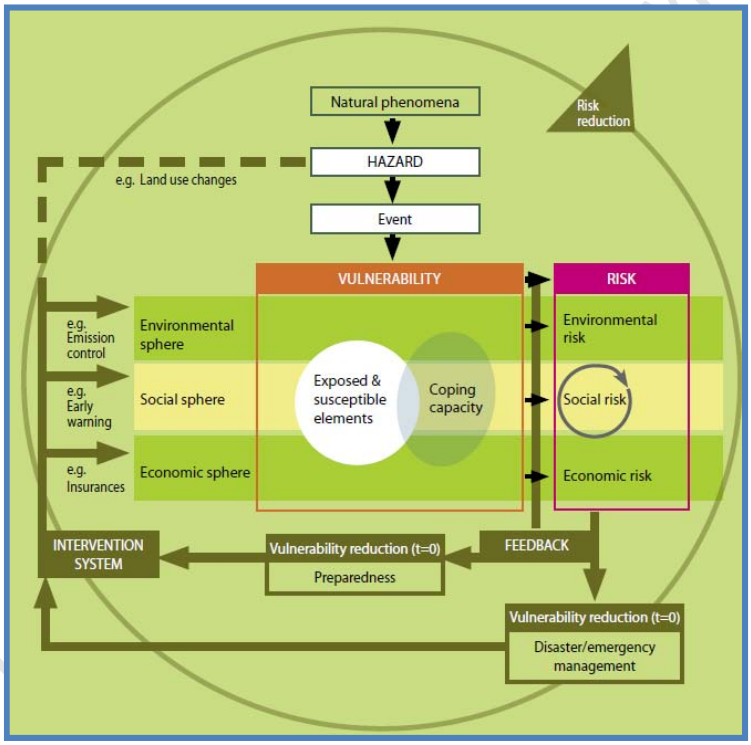

Figure 2.1: BBC conceptual Framework - Source: Birkmann (2006).

It maintains that disaster management capacities are required to limit the impact of catastrophes and manage the crisis; but it also demonstrates the importance of anticipating risk and taking action before a possible event (See Figure 2.1) (Bogardi and Birkmann, 2006). The BBC framework views vulnerability within a dynamic process, focusing on vulnerability, coping- capacity and intervention tools to reduce vulnerability: In particular, social, economic and environmental aspects (see Table2.2).The framework therefore links itself to the notion of sustainable development.

Based on the above theory, the key elements of human vulnerability can therefore be outlined in four distinct categories; environmental, physical, socio-economic and institutional. These elements are summarized in Table 2.1.

Environmental	Physical	Socio-economic	Institutional
Terrain Low elevation and proximity to water can increase flood potential. **Ground water levels** The higher the water table, the more prone to flood risk **Soil bearing capacity** Permeable soils (e.g. sand) will retain water in pores. **Sea-level rise** Areas located near the coast are more at risk to sea-level rise. **Proximity to waterbody** Settlements located near waterbodies are subject to increased flood risk.	**Building materials** Sub-standard or inappropriate materials cause leaks and seepage into dwellings. **Quality of construction** Poor construction may increase the risk of flooding. **Density** Shacks built too close together hamper emergency relief during a flood event. **Structure / condition of roads** Badly designed roads will lead to ponding water and flooding. **Infrastructure quality and or quantity** Poorly constructed and insufficient infrastructure (e.g. toilets, taps or drains) leads to unhygienic conditions. **Proximity to social and economic services** The greater the distance, the higher the vulnerability.	**Land and housing tenure** Lack of tenure results in low respect for surroundings and could lead to vandalism. **Community organisations** More community organisations lead to stronger community spirit and increased ability to cope with disasters. **Demographic** Woman, children and the elderly more vulnerable. **Ethnicity** Ethnic differences could lead to increased social tensions with a commensurate capacity to cope with disasters **Economic** Inadequate family income results in poor living conditions and reduces family ability to cope.	**Central and Local Government Policy** Anti-eviction of squatters Act of 1998. **Move from top-down to bottom-up** New initiatives in this century to more community-driven operation. **Changing control of City** ANC to DA since 2008. **Attitudes of local residents to private investment** Residents often expect government to pay for upgrading rather than private investors.

Table 2.1 Four Components of Social Vulnerability

The four components of Social Vulnerability include a combination of multidisciplinary socio-economic, institutional, physical and environmental aspects. Adapted from a number of sources principally, (Kasperson *et al*, 2005; Rogers, 2007)

This study focuses primarily on the social sphere of the conceptual framework, encompassing both social risk and coping capacity. In addition to the adoption of a conceptual framework of vulnerability is the need to incorporate the principles of sustainable development in relation to informal settlements. The physical vulnerability of communities often increases due to the physical location of the area in question. The following discussion therefore incorporates some important principles related to physical development of settlements within close proximity to water bodies, such as wetlands as well as closeness to the sea.

2.10 Principles of Sustainable Development

Sustainable Development is defined as "*the protection of the life opportunities of future generations and the natural systems on which all life depends*" (UNDP, 1996).

The physical vulnerability of urban populations, particularly in informal settlements, increases in direct proportion to the dense concentration of potentially dangerous infrastructure and substances. Perhaps the most significant are, collapsed drainage reticulation, unsafe bridges, poorly built shacks, inadequate bridges, ineffective disposal of solid and liquid waste, leaching of chemicals,

poorly screened electric facilities *etc*. The presence of health-threatening infrastructure such as sewage treatment plants), waste dumps or dangerous industries increase the risk of secondary hazards, such as waterborne epidemics (WMO, 2008).

Three systems are identified as basic to sustainable development: the economic social and biophysical. They are both interconnected as well as mutually dependent (sustainable settlements, 2009). In order to realize a well balanced relationship between these three systems, certain development principles are therefore necessary. One particularly relevant principle is that of set-back lines creating buffer zones.

Coastal erosion, wind generated storms and flooding of riverside properties is an increasing problem, costing local government and the private sector millions of Rands every year. Coastal and riverine erosion, increased intensity and frequency of flooding, and wind generated storm surges that damage coastal areas must be planned for as a matter of urgency. The only practical solution appears to be the proactive delineation and enforcement of realistic setback lines for all developments. Sensible setback lines if enforced have the ability to maintain both the economic and ecological functioning of coastal and riverine systems and to counteract the potential impacts of climate change (Roets-Wietche and Duffel-Canham, 2009).

2.11 'Setback Line' / Buffer Zone Methodology

The term buffer zone gained international recognition largely through UNESCO's Man and Biosphere Programme in 1979. The objectives of the buffer zone approach have subsequently evolved from a solely geographically delineated area to the protection of larger conservation areas, often peripheral to it (Ebregt and Greve 2000). Buffer zones are determined by setback lines.

'Setback Line' methodology, a relatively recent concept, aims to provide protection not only to coastal resources, but also to public and private property (CSIR, 2000). The 'Setback Line' theory provides a number of principles to enhance effective environmental sustainability and urban development.

The 1 in 100-year flood line as referred to in the National Water Act (NWA) (Act No 36 of 1998) and Provincial Spatial Development Framework (PSDF) must be implemented as a minimum measure, without any compromise. Irrespective of the 1 in 100-year flood line, there must be a buffer area of at least 40 meters in width before developments (including intensively farmed areas) should be allowed (South Africa, 2009b). This can be expected to ensure protection of the important flood plain processes and ensure maintenance of the process and pattern requirements of the ecological corridor functions associated with aquatic ecosystems (*i.e*. all drainage lines, rivers, streams and associated wetlands ecosystems).

According to these principles, and notwithstanding the 40m wide buffer area adjacent to the 100-year floodline, a 32-metre minimum wide buffer zone between the 1:50-year flood line and the developed area is also required (Roets-Wietche and Duffel-Canham, 2009). The 32m buffer could however range up to as much as 75m around a wetland, depending on the sensitivity of the area. Development is not to occur within the 1:100-year flood line or the 5metre amsl (*i.e.* the 5metre contour line) at all, according to Roets-Wietche and Duffel-Canham (2009); They believe that raising the floor level of structures, such as shacks, above 5metres above sea-level is not an adequate enough flood alleviation method.

The following key points relevant to flooding within informal settlements, illustrated in Table 2.2, have been extracted from the South African Institution of Engineering Geology (SAIEG).

Constraint	Most Favourable	Intermediate	Least Favourable
Seepage	Permanent or perched water table more than 1.5m below surface.	Permanent or perched water table less than 1.5m below surface.	Swamps and marshes.
Areas subject to flooding	Not applicable	Areas adjacent to known drainage channel of floodplain, or in areas of less than 1% slope.	Areas within a known drainage channel of floodplain.

Table 2.2 Geotechnical Classification for Urban Development
Relevant portions extracted from SAIEG guidelines.
Source: South African Institution of Engineering Geology (CSIR, 2000)

The two constraints with respect to difficulties for urban development are important points to consider when assessing flood risks. Building near a swamp will obviously result in seepage, but so will building in areas where the water table lies within 1.5m of the surface (CSIR, 2000).

Wetlands and aquifers are classified as recharge zones and development is therefore not desirable in these areas; recharge zones are areas where water can penetrate easily (www.ecologydictionary.org). If there are no other alternatives for development within close proximity to areas such as these, the following principles should be adhered to according to a report conveying specific guidelines for human settlements and planning (CSIR, 2000).

- Appropriate development at lower densities is advisable to allow for the penetration of water. Urban storm water runoff may infiltrate the water table and contaminate the ground water.
- No development should occur within the 1:50-year flood line area; although this restriction should be regarded as a minimum safety requirement only.
- A buffer zone of at least 32m width must be established between the 1:50-year flood line and the developed area (or area to be developed); this requirement is to prevent any building occurring that would impact on the natural flow in and around the wetland. The National

Environmental Act (NEMA) EIA regulation however, requires the minimum buffer of at least 32m, but can range up to 75m around a wetland (South Africa, 2009a).

- Storm water management should be the standard routine practice (pro-active) rather than only reactive measures.
- Backfilling should be discouraged within the 1:50-year flood line because it will lead to further destruction of natural habitats and interference with the flow of water.

2.12 Summary

The evolution of disaster risk management has progressed from reaction-based responses to a more proactive stance. This paradigm shift has resulted in a focus on the systematic management of disaster risk rather than the management of the symptoms of disasters (Cardona, 2004).

Two schools of thought within the realms of disaster management were evident, namely social resilience versus social vulnerability. Although inherently linked, the two schools are commonly studied separately, mainly due to conceptual constructs, scientific traditions and lack of interaction within academia. Within the school of social vulnerability are two approaches of gathering data, top-down versus bottom-up approaches. The new challenge in disaster risk reduction, suggested by various authors, like Cardona (2004) and Davis (2004) is to adopt a more holistic approach. Various, relatively new methodologies to implement a holistic approach have been developed. These include, participatory or community-based vulnerability assessments, bottom-up approaches *etc*. There are an increasing numbers of success stories to be found in the literature from around the world that demonstrates the effectiveness of such approaches.

Participatory mapping and PGIS were widely cited as an excellent method of incorporating local knowledge, however, in the search for relevant case studies, it was noticeable how few examples were available, and this was particularly evident in developing countries.

When considering physical vulnerability, the important concepts of buffer zones and setback lines emerged. Sensible setback lines have the ability to maintain both the economic and ecological functioning of coastal and riverine systems and to counteract the impacts of climate change.
Despite technological advancements and improved forecasting models and the shift towards proactive disaster management in South Africa, there are still major gaps in the methodology to be found, especially with developments at a local level and particularly within informal settlements.

Some of the recent developments and advancements within South Africa and worldwide are summarised in Appendix I.

CHAPTER 3
CASE STUDY MASIPHUMELELE
BACKGROUND AND DESCRIPTION

Nobody made a greater mistake than he who did nothing because he could do only a little.

~ Edmund Burke ~

3.1 Background and Description of the Study Area

Masiphumelele, the location chosen for the study, is a small (0.45 km²), largely informal community, situated between Noordhoek and Fish Hoek in the Cape Peninsula. The settlement is located within the Noordhoek catchment basin, one of a number of major catchments within the Cape Metropolitan area.[1] Masiphumelele is made up of three different housing areas of which, the 'Formal' area makes up the largest portion (approximately 0.37 km²); the Formal housing area also includes a large group of 'Backyard' residents. The informal 'Wetlands' area in the north and the 'Temporary Relocation Area' (TRA) on the western boundary, make up the rest of the settlement. Masiphumelele is a small settlement but with a number of problems, including high levels of poverty and severe overcrowding. The informal settlement has also extended beyond the urban boundary into the wetland reed beds (known as the 'Pick and Pay Reed Beds') immediately to the north (See Figure 3.1).

Masiphumelele is effectively hemmed in on three sides; with the Sunnyvale residential area to the east, the Kommetjie industrial area to the west and the main Fish Hoek – Kommetjie road to the south. The only significant 'open' area lies to the north across the main wetland. Further growth into this wetland could ultimately end in its destruction and cause severe environmental degradation of the adjacent wetlands, particularly Wildevoelvlei to the west and 'The Lakes' (Lake Michelle) to the north-east.

In addition to their obvious aesthetic appeal, wetlands have a crucial environmental role to play. Firstly they serve as large shallow collecting areas which slow the flow of floodwater and effectively act as a sponge for this water. Vegetation in a wetland helps to control large inflows of water originating from storm water systems as well as in the case of coastal wetlands, of the sea, thereby acting as natural filters. They also improve water quality by trapping nutrients such as nitrogen and phosphorus and disease-causing bacteria and pollutants such as heavy metals. This in turn encourages the growth of bulrushes, grasses, reeds, water lilies, *etc*. This forms an optimum habitat for large numbers of insects, fish, birds and other animals (UWC, 2009).

[1] Other catchment basins include: Zeekoe, Silvermine, Hout Bay, Salt River, Muizenburg and City, amongst others.

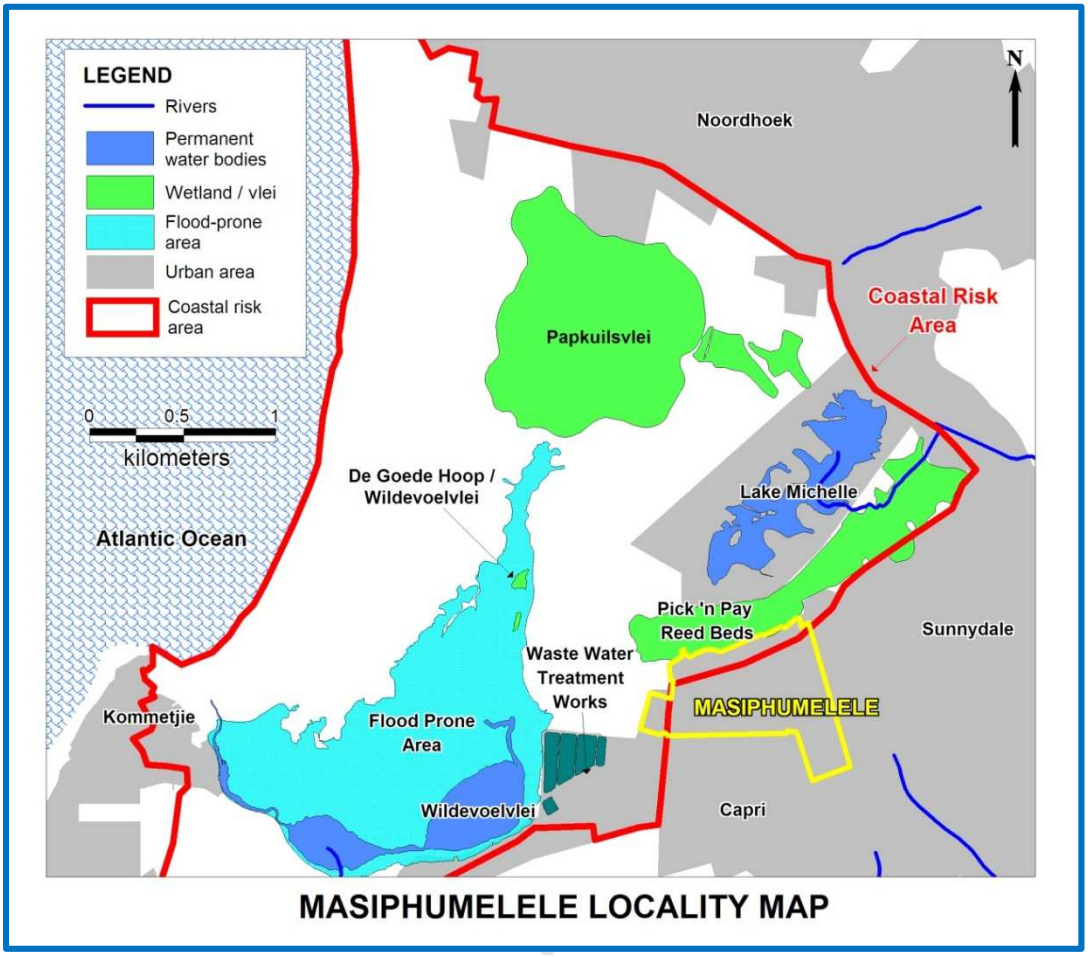

Figure 3.1 Masiphumelele Locality Map

The coastal risk area is outlined in red. This area is prone to sea-level rise events. Masiphumelele falls on the fringes of this risk area (The Wetlands and TRA areas fall within the coastal risk area).

3.2 The Noordhoek Basin Ecosystem

The Noordhoek Basin consists of a series of inter-connected seasonal wetlands, artificial pans and permanent marshlands, notably, Papkuilsvlei, Wildervoelvlei and the 'Pick and Pay' reed beds. There are also a number of aquifers within the basin which contribute to a high water table, caused by an impermeable layer of granite which lies beneath a sandy surface layer (Van Wieringen, 1999). The basin became deeply eroded during the time when the sea level was lower (*i.e.* before the last Ice-Age). After the sea attained its current level, the deep, fairly steep-sided valley as we know it today remained. This valley subsequently filled with layers of unconsolidated sand, silt, clays and organic material, which facilitates the development of swampy ground, particularly in the winter months. There are also a series of small dunes which lie approximately 500 metres from the present coastline; although in the past they extended much further inland, which gives an indication of the dynamics of this system (Van Wieringen, 1999).

One characteristic of the Noordhoek Basin is the nonexistence of any natural watercourses. This makes the basin extremely absorptive with the result that water tends to flow sideways within the

basin. Due to ongoing urban expansion within this area there are higher levels of storm water runoff, all of which ends up in the wetlands through pipes, channels and paved areas. Most of the run-off seeps into the basin floor and is absorbed by the sand (Van Wieringen, 1999). These factors, together with the high rainfall, low elevation and aforementioned geological conditions mean that marshy conditions are common. In fact, there has been an expansion of the reed beds and permanent saturation of many areas, both to the detriment of the seasonal wetlands (Van Wieringen, 1999).

The wetlands have undergone considerable transformation recently mainly through changes to the natural surface-water and groundwater conditions. Other changes to this area can be attributed to increased pollution, land infilling, excavation, silt deposits and alien plant invasion (Van Wieringen, 1999). Wildevoelvlei, to the west of the settlement is a permanent wetland which is considered to be hyper-eutrophic, which means that it contains high nutrient levels and subsequently the water is often clouded with blue-green algae. The predominance of this type of algae is a symptom of a drastic reduction in bio-diversity, often associated with extreme eutrophication. These algal blooms can often produce toxins which can be detrimental to human health (Grange, 1999).

3.3 Flood Risk

As well as its close proximity to various wetlands, Masiphumelele is located on the fringes of a large coastal protection flood risk zone which are 'highly vulnerable' to sea-level rise events. In this context, the two key criteria defining a 'Coastal Protection Zone' in section 16 of the Integrated Coastal Management Act (ICMA) are any land a) that would be inundated by a 1:50 year flood or storm event and b) that is situated wholly or partially within 100 metres of the high-water mark (South Africa , 2008). Recent research prepared for the City of Cape Town on sea-level rise, predicts that there is an 85% chance of a 4.5 metre storm surge sea-level rise in the next twenty five years (Cartwright, 2009). In addition to this, a minimum development buffer of at least 32 metres (but ranging up to 75 metres) is required around wetlands, according to National Environmental Management Act (South Africa, 2009a) Environmental Impact Analysis (EIA) regulations (see Figure 3.2).

This settlement is also adjacent to the 'Pick 'n Pay Reed Beds' wetland area. The water levels within these reed beds are at around 4.3 amsl (above mean sea-level), which is the same level that the water from the reed beds flows into Lake Michelle. Flood run-off enters the reed beds from the south (next to Masiphumelele) and the east, thereafter draining into Lake Michelle. The 50– and 100-year flood levels fluctuate between 4.8 and 4.9m respectively over this area in comparison to 3.0 amsl next to Wildevoelvlei to the west (Wilkinson, 1999). The 32 and 75m buffer zones are delineated from the edge of the wetland boundary (Pick 'n Pay Reed Beds) (see Chapter 5 for more

details). The 5m contour line has been extracted from the City of Cape Town digital elevation model for 2009.

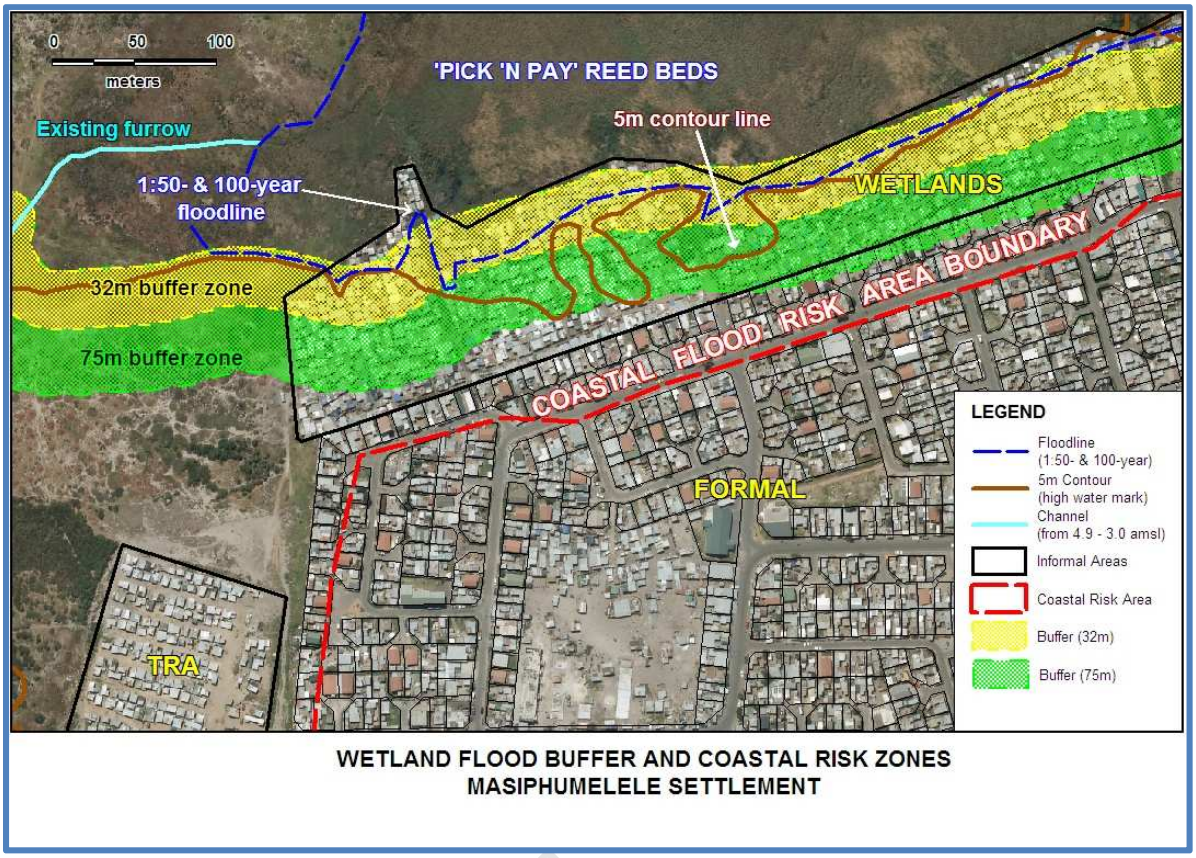

Figure 3.2 Flood Buffers and Coastal Risk Zone

1:50- and 1:100 year flood lines are just below the 5m contour line and are essentially at the same level (4.8 and 4.9m amsl. The coastal risk area extends just below the informal 'Wetlands' settlement area. Clearly the settlement has encroached upon the boundaries set by environmentally sustainable urban development zones.

The rapid influx of mainly illegal settlers, over the last decade, into the informal areas of this settlement, has led to further encroachment into this important wetland area. It would appear that current flood lines only include areas lying on or below the 5-metre topographic contour line. Clearly this is not an entirely accurate representation of what is happening in reality. Research by the author suggests that more than 80% of those households interviewed, who are residing in informal areas, are experiencing seasonal flooding during the rainy seasons (Refer to Chapter 5). Many of the settlers are residing at elevations as low as 4 metres above sea-level – as determined from the digital elevation model (DEM) obtained from the City of Cape Town.

Homes in many parts of these wetland areas are also damp during the summer months (as noted by the author on summer field visit to the area). Although these people may be living in these areas illegally, the reality is they are unlikely to be moving out in the near future; in fact numbers are still increasing here (Confirmed by the authors observation of recent aerial imagery and numerous field trips to the area). The same could possibly also be said of similar settlements countrywide and

worldwide. Government policy in South Africa maintains that forced removal of these people is undesirable and against accepted social norms and only necessary if no other option exists (Western Cape Government, 2003).

Immediately to the west of Masiphumelele is Erf 4198, an area proposed, by the City of Cape Town, for the Phase IV development of Masiphumelele (see Appendix IV). Environmental policy states that within areas such as the Noordhoek wetland, building will only be permitted above the 1:50 year flood line; which has been positioned at the 5m contour (CSIR, 2000). Potential Phase IV development, together with wetland areas have however already encroached upon this 5m contour; this has consequently resulted in an increased risk of flooding to people living here. It is therefore self-evident that the geographic setting of Masiphumelele is far from ideal for the residents of the Wetlands (and possibly also those in the TRA to the west). The numbers of people who have been allowed to reside here have clearly led to the development of an environmentally unsustainable situation. In the next section, the sequence of events which have led to the seemingly haphazard expansion of Masiphumelele is considered.

3.4 History and Development of Masiphumelele

The following history of Masiphumelele was obtained from a variety of sources, but most notably, a paper given at the Black Sash National Conference in the Western Cape during 1989 (‘*Squatting in the Peri-Urban Areas of Metropolitan Cape Town*, by Tolly, 1989). Masiphumelele developed during the 1980s when around 500 people set up shacks into what was then called “Site 5”. It was later renamed Masiphumelele, which means ‘we will succeed’ in Xhosa. Originally, two small groups of illegal settlers had occupied land in the Noordhoek area, one area known as ‘The Tip’ and the other a portion of Dassenberg farm. Some of these people had been in this area for over 40 years. In December 1987, during ‘Operation Dassenberg’, 200 police arrived at the site with trucks and bulldozers. 700 people were then removed from Noordhoek, to a piece of barren land in Khayelitsha, where a make-shift temporary camp had been prepared for them. This consisted of 120 green tents, 20 tin toilets and 2 taps. Considerable suffering resulted as many lost their local jobs as domestic workers and gardeners (Tolly, 1989).

The squatters made repeated attempts to return to Noordhoek, but they were continually forced back to Khayelitsha. In April 1988, the squatters however won a court case, after which the Cape Administrator ordered them to move back to Noordhoek. By May 1988, most people had returned, this time on land across the road from Dassenberg; today the site of the Sun Valley shopping centre, though conditions were still very poor. Following an appeal to the Cape Administration, the squatters were informed that no land was available for blacks in the South Peninsula; subsequently however, nine areas were investigated for the suitability of housing. One of these, site 5 was allocated in December 1990. It took another two years however, before the squatters were able to move onto this land.

In December 1992, Phase 1 development of 235 sites was completed. Phase II involved 51 more houses as a result of the People's Housing Project. With the ending of the *Apartheid* era, more people started moving into Masiphumelele, mostly from the Eastern Cape and by 1995, a school and a health clinic had been built. By 2001, the population census reported over 8000 residents living in Masiphumelele. There is relatively little information on the settlement during the period 1992 to 2001 (City of Cape Town, 2001).

By 2006 a Community Risk Assessment (CRA) workshop was held in Masiphumelele assessing risks such as flooding, fires and health (City of Cape Town, 2008a). This workshop was a co-operative between research institutions, an NGO and government. Despite this workshop, in this same year a devastating fire occurred which destroyed 400 shacks and 1 200 people were left homeless. In response to this, a local community organization called Amakhaya Ngoku (meaning "homes now") was formed in 2006. Subsequently in the last few years, this organisation has been able to build blocks of flats in the 'School Site' after having received private overseas funding. Some residents have already relocated into these newly build flats, the rest of the residents are waiting for development to continue and are currently being housed in the TRA.

Due to outdated statistics it is not officially known how many people are now living in Masiphumelele, but it is speculated that there are more than 25 000 (Masicorp, 2010). New figures however, calculated during the Phase 1 survey of this study, together with the use of shack count information, indicate that the number is probably closer to around 38 000 people (Refer to Chapter 5).

Flooding has not only caused the displacement of many individuals but has also caused health-related problems, damage to property and livelihoods and general misery. The influx of people into the area seems unabated and there are already calls to allow the settlement to expand outside its current designated boundary. This has led to high numbers of low income residents, who are also desperate for houses as well as employment.

The lack of available land and proper tenure has often resulted in widespread violence within the community, particularly in the last few months. Other problems within the settlement include xenophobic attacks on foreign African Nationals and general lawlessness (IOL, 2009; Cape Argus, 2009 and Pretoria News, 2006).

Tables 3.2 provide a review of the significant developments in Masiphumelele, from 1986 – 1992, and from 2001 – 2010, respectively. Information for 1993 – 2000 is not readily available.

Development of Masiphumelele (1986 – 1992)

Date	Description
1986	By the end of the year there were two pockets of illegal squatters, some had been there for 40 years. One on the rubbish dump and the other on the Dassenberg farm.
January 1987	Divisional Council of the Cape threatened landowners in Noordhoek area with prosecution under the Illegal Squatting Act for allowing squatters to reside on their land. .
21 April 1987	Dassenberg farm residents were forcibly removed to Khayelitsha
1988	Case for the Noordhoek residents to return to the land they once lived on argued in Supreme Court.
November 1989	Cape Provincial Authority (CPA) promised to allocate land for informal settlements thereby becoming the city's first recognised "black spot" in a white Group Area.
December 1990	Land now known as Site 5 allocated for residential township.
March 1991	93 squatter households removed from the Pick 'n Pay Reed Beds onto Site 5. 40 illegal sites were already established at the site.
December 1992	Site 5 erected and the phase I development became known as Masiphumelele; now the permanent home for Fish Hoek (20 sites) and Noordhoek (215) informal communities. The 51 outstanding properties were to be allocated during the erection of phase 2 development. Many people who occupied the sites arrived from Old Cross Roads or from the former Ciskei and Transkei homelands.
2001	Population Census of 2001 puts population at 8 242.
January 2006	Community Risk Assessment (CRA) workshop was held in Masiphumelele assessing risks such as flooding, fires, health amongst others. The workshop was hosted by Disaster Mitigation for Sustainable Livelihoods Programme (DiMP), University of Cape Town (UCT), in collaboration with the Development Action Group (DAG) and Disaster Management City of Cape Town.
2006	Amakhaya Ngoku (meaning "homes now") was formed in 2006 by local residents after a fire destroyed about 400 shacks, leaving more than 1,000 people homeless. 352 sectional title flats will offer rent-to-buy scheme that enables them to rent their homes for four years at R400 a month, after which they can buy and own them.
2007	Lord Irvine Laidlaw approached to fund the Amakhaya Ngoku housing project. He has subsequently donated R9 million.
2008	It took Amakhaya Ngoku two years to receive permission to build flats, which eventually happened in 2008.
April – May 2008	Temporary relocation area prepared for the 1 200 families from School site.
August 2009	33 families move into the first Amakhaya flats.

Table 3.1 Development of Masiphumelele (1986 – 2010)

Sources: City of Cape Town Census 2001; Tolly, 1989; Van Dijk, 2010

3.5 Summary

The early history of the Masiphumelele settlers is an unfortunate one, with the first settlers having been forcibly removed to Khayelitsha 30km to the north-east under the existing *Apartheid* legislation of the time. Some restitution occurred in the early 1990s when the settlers were allowed to return to the South Peninsula when land was eventually allocated to them. This land originally called Site 5 became the first phase of Masiphumelele development. The initial development of Phase 1 and Phase 2 appears in retrospect to have been reasonably well planned. In the early part of this century, the settlement appeared to have expanded rapidly and planning problems seemed to have been exacerbated by political interference. Subsequently an apparent uncontrolled influx into the settlement occurred; this was allowed to continue into the Wetlands.

The inescapable fact is that Masiphumelele is a very small (0.45 km²) and low-lying area (5 – 15 metres above sea-level), whose northern and western areas are very prone to flooding. Despite some initiatives from some of the stakeholders, notably the Amakhaya Ngoku housing scheme and the Community Risk Assessment workshop, the situation remains far from ideal (refer to Appendix II for more details on the Amakhaya Ngoku housing scheme). Subsequently, the vulnerability of the people living here appears to remain high. Based on this, it became apparent that the extent of the effect of this vulnerability to flooding needed to be assessed. In order to investigate this, the perceptions of residents from areas thought to be the most vulnerable were required. Consequently a socio-economic survey questionnaire and a mapping exercise were conducted in order to obtain more current and relevant information.

In chapter 4, data sources together with research methodology, reliability and validity of data are considered.

CHAPTER 4

DATA SOURCES AND RESEARCH METHODOLOGY

"Experience is the teacher of all things."

~ Julius Caesar

This research integrates participatory techniques of generating data using GIS, based on the BBC conceptual model of vulnerability in studying the social and spatial delineation of flood vulnerability in Masiphumelele. In accordance with this framework, the following factors were incorporated:

- The research focus was limited to the prevention, mitigation and preparedness sectors of the disaster management cycle (*i.e.* the pre-disaster phase) and therefore does not include response and recovery aspects (*i.e.* the post-disaster phase). The framework emphasizes preparedness rather than response.
- The framework emphasizes that the location of a human settlement and its infrastructure play a crucial role in determining susceptibility of a community, so priority is given to physical location and infrastructure. The fact that the settlement is located within close proximity to the sea, and therefore at risk to climate change means that storm surges will affect anyone in their path, although the extent of the susceptibility however is more pronounced for poorer people.
- Because vulnerability is a dynamic process, the study focused on aspects of coping capacity and potential intervention tools, therefore information relating to flood mitigation needed to be collected and captured.
- Sustainable development principles were also taken into account, and therefore linked to the social, environmental and economic spheres of the framework. In this regard, therefore, it was necessary to gather information from all three spheres.
- Flood-related deficiencies such as the lack of mitigation measures and the poor state of infrastructure; together with corresponding socio-economic information such as poverty (lack of jobs) and social grants.
- To increase the validity of the research, participatory methods of data acquisition were used (PGIS).

Three areas of study were defined, a) 'Wetlands', an area immediately adjacent to the actual water-body, b) Temporary Relocation Area (TRA), a newly developed area for residents awaiting housing currently being built in the previously informal area of Masiphumelele known as 'School Site' and 3)'Formal' area, an area of formal housing comprising the largest

surface area of Masiphumelele and located immediately to the south of the Wetlands (Refer to Figure 4.1 for a map showing the survey areas).

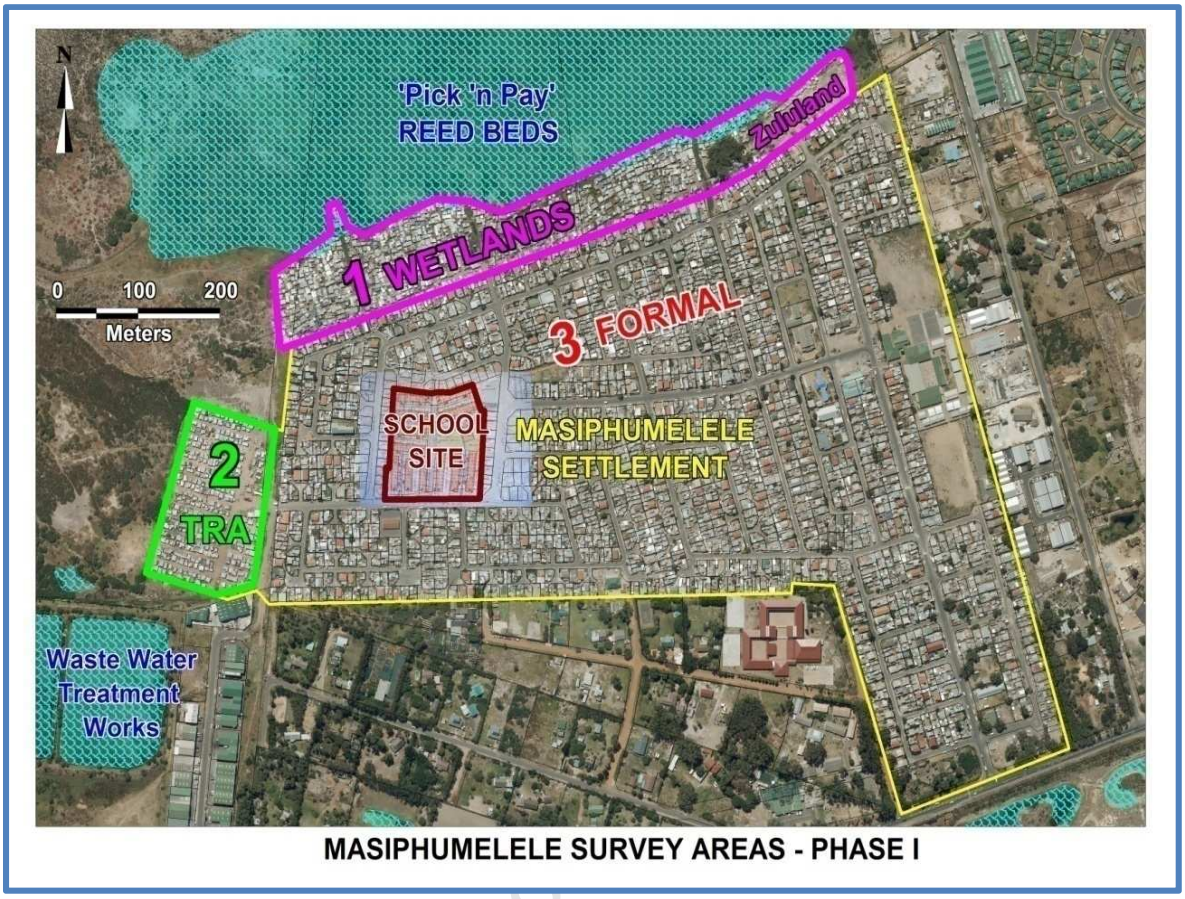

Figure 4.1 Masiphumelele Survey Areas: September / October 2009

Three areas were surveyed: 1) Wetlands (including 'Zululand'); 2) Temporary Relocation Area (TRA)

The decision to use three sites within Masiphumelele was also a way of comparing the Wetlands with the other areas of the community. Although the Wetlands constitute by far the highest number of informal residents within the settlement, other areas of Masiphumelele also house informal residents, the so-called 'Backyarders'[Backyarders are those people who live informally in the backyard of formal housing] in the more formalised area as well as the 'temporarily re-located' residents within the TRA.

In terms of the four primary research questions posed in chapter 1, data requirements were diverse and included topographic and drainage data, digital elevation models (DEM), aerial photographs as well as socio-economic data. Table 4.1 summarizes the four core research questions, specific aims and the methodology for data collection.

Research Question	Research Aims	Data Collection Methods
How does the geographical distribution of physical vulnerability vary across the Masiphumelele settlement?	• Collection of spatial data • Delineation of setback lines and buffer zones based on Digital Elevation model (DEM) • Delineation of 5m contour line based on DEM • Identification of Flood-prone areas • Mapping of physical components of flood vulnerability – topography, aerial imagery, drainage, elevation • Examine and analyse physical components of flood vulnerability.	• Topographic data • Drainage data – flood-prone areas, wetlands, rivers • Digital elevation model (DEM) • Sea-level rise prediction model • Aerial photographs • Digitizing of non-spatial information • GIS buffering • Shack count data • GIS map compilation
How does this geographical distribution of physical vulnerability correspond with other dimensions of vulnerability, particularly socio-economic and political vulnerability?	• Interview cross section of Informal settlement dwellers. • Interview various stakeholders, NGOs, politicians. • Calculate current population	• Detailed socio-economic & demographic survey questionnaire. • Shack count data • Face to face informal meetings & focus group; Transect walks • Database compilation and analysis
How can researchers engage with local participants in shared data acquisition that can be considered sufficiently reliable in a vulnerability analysis?	• Use teams of locals to undertake interviews in settlement. • Geographic component for mapping dwellings • Compile and analyse data • Present results in map format – superimpose on physical vulnerability data • Present results of study to team members for comment & input.	• Teams accompanied, and advised by experienced field worker. • GPS training and utilization • Basic socio-economic & demographic survey questionnaire • Face to face informal meetings & focus group; Transect walks • Database compilation and analysis • Map compilation using GIS
What are the strengths and weaknesses in engaging with local participants in the acquisition of such data?	• Is the apparent advantage of using people with local knowledge outweighed by possible bias of interviewers? • Do the results of the surveys correspond to the mapped physical vulnerability?	• Validation of socio-economic data with physical data using GIS • Comparison with other recent surveys

Table 4.1 Research Questions, Aims and Data Collection Methodology

4.1 Research Methods, Ethical Considerations and Author Involvement

In order to answer the research questions identified above and achieve the aims of the project in relation to the BBC methodology, combinations of methods were utilized in order to gather primary data. Amongst these were survey questionnaires, community transect walk and mapping exercises, focus groups, face to face interviews as well as various correspondence with stakeholders. In addition to these, a variety of secondary data was also collected.

A two-phased approach in the gathering of socio-economic data was designed. In the first phase, a detailed survey questionnaire was designed to gather the necessary information. The rationale behind this survey was to obtain important background information about the settlement. Phase 2 consisted of a participatory mapping exercise and also included a survey questionnaire.

Prior to undertaking the various surveys, important ethical considerations were necessary as the research involved the use of human subjects as sources of data. Authorization was therefore obtained from the Faculty of Engineering and the Built Environment at the University of Cape Town. The research in no way discriminates on the grounds of gender, race or ethnic group, age range, religion, income, handicap, illness or any similar classification. Although it involves the participation of minors in Phase2 (*i.e.* grade 12 high school scholars), prior consent was obtained from the principle of the Masiphumelele high school. Some confidential information was collected (including name, surname and in some cases telephone numbers); this information will however not be disclosed and are not incorporated into the research in any way.

The author's involvement in the action research was passive in the case of Phase 1 and active in Phase 2. During Phase 1, the author's role was to give guidance and training to the supervisor in charge of the field-work teams. In Phase 2, however, the author was actively involved in the collection of data; the role being one of technical training (GPS and Coordinates), supervision and guidance. During the Phase 2 interviews however, the author's role was as observer.

4.2 Phase 1 Survey Design and Questionnaire Rationale

After preliminary research, a questionnaire was developed. The questionnaire included a wide range of both statistical and subjective issues. It also incorporated some questions similar to those posed in a 2009 survey undertaken by CORC (Community Organisation Research Centre) in Philippi, an informal settlement in the east of Cape Town (CORC, 2009). The questionnaire consisted of four major categories, each posing a number of relevant questions. These categories were: household information; housing; water sanitation and health; and disaster risk management. The questionnaire was extensive in the hope that the information obtained would be of practical use for future research within this settlement as well as for other similar informal settlements within the City of Cape Town and elsewhere. Table 4.2 shows details of these categories and the questions associated with each. (See Appendix I for the layout and design of the questionnaire).

The following discussion gives the rationale behind the specific questions posed within each category of the survey.

The household information category included questions such as the details of the head of household including: given name, surname, gender, age and home language. The purpose of this was to determine the population demographics of residents in the area. The origins of the residents was deemed important as ethnic differences have led to increased social tensions, as witnessed in 2008 by the outbreak of xenophobic violence (News24, 2008). Such incidents have been shown to lead to a commensurate decreased capacity to cope with disasters (Polzer, 2010).

The information on gender and age gives an indication of the economic potential of the inhabitants and the number of dependants; that might be expected; both the elderly and more commonly those who are below the age of 18 years of age. It has been shown that women and children and the, elderly are consistently more vulnerable to hazards than men (Patel, 2009).

The question on education levels and number of children at school as well as the location of the children's school provided information related to literacy levels and dependency. Employment information was obtained by questions related to the number of people in the household who were employed, the frequency and type of employment as well as their monthly income, together with the distance and cost of getting to the place of employment. The information gave an indication of the financial capacity of a community; inadequate family income results in poor living conditions and reduces a family's ability to cope. The question about expenses per month by category gave an indication of how a community spends its earnings and to what degree families live beyond their means. An important question of social grants was also asked; social grants are another indication of as the ability to cope, particularly for those who are unemployed.

The housing category questions included the length of time those interviewed had been living in the settlement and their perception of happiness and any problems associated with it. This information gives an indication of perceived quality of life, ability to cope and the reasons for moving to Masiphumelele. The construction materials of the homes were determined as were the residents' perceptions to the suitability of their homes in providing safety against natural hazards. Unsuitable building materials and poorly constructed homes are more susceptible to natural hazards and therefore make a community more vulnerable to flood risks.

Household Information	Housing	Water, Sanitation And Health	Disaster Risk Management
• Name, Surname, Gender, Age, Home language (Head of Household) • Number of people living in the house • Details (age group and gender) of people in the house • Education level • Number & school location of children attending school • Number of people employed • Type of employment • Proximity of job to house • Monthly income • Main monthly expenses • Transport method to work • Grants received • Which grants	• Length of time lived in community • Place of residence before coming here • Reason for moving to this community • Conditions since move here • Happy here or not • Problems in this community • Condition of house • Construction material of house • Suitability of house for all weather conditions • If unsuitable, list the problems	• Type of toilet • Number of people using the toilet • Where water obtained from • Refuse collection time period • Is the refuse collected often enough • Illnesses while living here • Health facilities accessible to you • Are these facilities adequate • If inadequate, give reasons	• Aware of flood risk before building here? Why still build here? • Fires and floods, how many times, when was the last time • Are you at risk to flooding? What type? • Flood mitigation methods (current or proposed) • Flood warning received • If able to move, would you? Where to? • What can government do to reduce risk of flooding

Table 4.2 Phase 1 Socio-Economic Survey Questionnaire

A summary of all questions and the questionnaire is presented as Appendix II

The water, sanitation and health category posed questions that showed the amount and quality of the infrastructure made available to the community by local government. Poorly constructed and insufficient infrastructure (such as toilets, standpipes and storm-water drainage) can lead to unhygienic conditions and an increase in vulnerability. The individuals' perception of the services available to a community and the reasons for any inadequacies in these services gives an idea of the level of government intervention and / or commitment. Although not a major focus of this study, health concerns being a fundamental indicator of vulnerability were incorporated and are a sector where further research could be beneficial.

The disaster risk management section of the questionnaire hoped to expose the frequency, causes and perception of risk associated with flooding. The residents' perceptions towards government intervention to the problem of flooding in this community were assessed by the question regarding what government could do to reduce the residents' risk. The willingness of the community to relocate to a more suitable location other than the Wetlands was also assessed. The rationale behind this was essentially to determine the number of residents prepared to move away from the Wetlands. Questions related to the frequency of wild-fires were also posed in the questionnaire,

though not a focus of this project. The relationship of fires and flooding was deemed to be worthy of investigation, and the results obtained, as with the health information was considered useful data for further research in the area of disaster risk management.

4.3 Sample Size Methodology

One major aim of the survey was to identify specific areas prone to flooding. The Wetlands, due to its proximity to the area known as the 'Pick 'n Pay Reed Beds', is thought to be the most flood-prone area, and therefore needed a higher proportion of the total survey sample size. A sample size of 10% of the total population was thought to provide an accurate representation of the overall population situation. The population for Masiphumelele has been previously estimated as ranging somewhere between 20 000 and 30 000 people (although some consider it higher). An average of 25 000 people was therefore used as a yard-stick for the basis of calculations during the Phase 1.

A sample size of 650 households was originally intended for the survey; however, due to a number of inadequately completed questionnaires, the results of only 632 questionnaires were incorporated into the final sample population. An average of 4 people per household was used to determine the number of households to be included in the survey. This average was the result of a 50 household census that was undertaken in September 2008 by SevaUnite, a prominent NGO operating within Masiphumelele (SevaUnite, 2008).

Table 4.4 illustrates the data obtained in the SevaUnite census. Based on these estimates, approximately 10% of the estimated average population of 25 000 people were reached during the survey. A proportionately higher sample of households was required in the Wetlands in comparison with both the TRA and the Formal Area. The Wetlands survey therefore included over 60% of the total survey sample size. The sample size information is summarised in Table 4.4.

The rationale behind sampling the Temporary Relocation Area was because it is the site of the planned 'Phase IV' development of Masiphumelele. All residents of the TRA have been re-located temporarily from what was known as the 'School Site'; this area is currently being developed by Amakhaya Ngoku, a community-based initiative. Most of the residents questioned in the Formal area surveyed are 'Backyarders', though a small percentage of those surveyed own the tenure rights.

In order to establish the suitability of the questionnaire to its audience, a pilot survey of twenty households was undertaken. This was done by a single fieldworker (a grade 12 scholar from Masiphumelele High School) in the north-eastern portion of Masiphumelele adjacent to the so-called 'Zululand' area. The rationale behind this was to test the willingness of residents to answer questions, their ability to understand them correctly and identify any gaps within the questions. The results were analysed and some questions were amended accordingly. The most notable change to

the questionnaire was the inclusion of 'prompting'; this was achieved with the utilisation of 'tick box' style questions.

Phase 1 Masiphumelele – Sample Size

Survey Area	Sample Size (households)	% of Total Sample	No. Surveyed (people) *	% of Estimated Population **
Wetlands	384	61%	1 536	6%
Temporary Relocation	101	16%	404	2%
Formal	147	23%	588	2%
Total	**632**	**100%**	**2 528**	**10%**

* Based on 3.6 (4) per house (SevaUnite 50 household survey – (SevaUnite, 2008)

** Based on estimated population of 25 000 (Masicorp, 2009) approximately 10% of the population was sampled.

Table 4.3 Sample Size Phase 1 Survey

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SevaUnite Census: September 2008

Category	Female	Male	Total
Adults	53	50	103
Children:			
0 – 3 yrs old	7	7	14
3 – 6 yrs old	7	7	14
6 -10 yrs old	9	8	17
10 – 14 yrs old	6	3	9
14 – 17 yrs old	13	4	17
Unknown			4
		Total children	75
		Total persons surveyed	178
		Average persons per household:	3.56 (4)

Table 4.4 SevaUnite Census September 2008

A total of 50 households were surveyed, this revealed an average of approximately 4 persons per household.

The pilot survey revealed a poor response to certain questions dealing with perceived 'problems' within the settlement and flood mitigation methods. This poor response during the pilot study resulted in questions being unanswered (*i.e.* the questions were left blank). It was decided that the inclusion of 'tick boxes' with likely suggestions (promptings) would indeed improve the response rate.

Subsequently, a slightly amended questionnaire was designed for the Formal Area. Slight changes included adding a question relating to tenure, what the person interviewed thought could be done to reduce the risks of both fires and floods; this question did not appear on the original survey forms for both TRA and Wetland areas. This question was included in 'tick-box' style format. Another alteration to the original questionnaire was that the question relating to the type of flooding was omitted for households in the formal area. Copies of these survey forms are reproduced in Appendix II.

4.4 Phase 1 Data Collection Methodology and Reliability

The Phase 1 survey took place during September and October 2009; the rationale for the timing of the survey was essentially to determine the effects of flooding that had taken place during the rainy season. The data collection methodology for the Phase 1 survey was to employ local literate residents from the community of Masiphumelele in the data collection process. This was achieved by contacting *Men-on-the-Side-of-the-Road*, an NGO that brings together unemployed people with potential employers. The main aim of this organisation is to enhance unemployed people's capacity to earn a sustainable income.

Suitable field-workers were sourced and supervised by Mr. Siya Cwayi, a representative from the *Men on the Side of the Road* Organisation, and also a resident of Masiphumelele (Employmen, 2009). Five fieldworkers from the settlement were selected and employed to carry out the survey in the 'Wetlands' and 'TRA' areas; while another four were employed to survey the Formal area. Each field worker was remunerated; a deposit was given in advance as an incentive to the field workers, and once the completed questionnaires were checked by the supervisor, the balance was paid. Each field worker spent approximately 4 days in the settlement conducting the interviews. Fieldworkers were instructed to interview the head of the household. In some cases, because the head of the household was at work, it meant that an interview had to be conducted during the evening. All field workers were given the necessary stationary as well as a locality map indicating the area to be surveyed. All questionnaires were checked by the local supervisor before being handed back to the author for data capture and validation.

4.5 Phase 2 Data Collection Methodology and Reliability

The Phase 2 participatory mapping exercise was conducted on the 11 May 2010. The rationale behind the exercise during the wetter winter months was to see first-hand, the effects of flooding on the community. The study was also undertaken in order to obtain specific positional information of surveyed households in order to map the extent of the flooding with the settlement in a GIS. This was achieved with the aid of four handheld GPS (Global Positioning System) units. Effectively, this exercise was a continuation of the Phase 1 informal settlement-wide socio-economic survey, which took place in October 2009. A key aim of the mapping exercise was to involve local high school students in mapping flood-prone areas of their community.

From a data perspective, additional flood-related information was collected in order to represent it spatially within a GIS. The data collected was very similar to that of the Phase 1 data, although differences included:

- The use of a shorter, more concise questionnaire
- The inclusion of positional information (*i.e.* eastings and northings)
- The inclusion of a question relating to the emergency contact number in the event of a flood.

Figures 4.2 and 4.3 show students receiving practical tuition on some aspects of mapping and the operation of GPS units.

Figure 4.2 Students plotting coordinates onto a map in the classroom.

All students expressed eagerness to learn the new techniques of mapping.

Figure 4.3 GPS demonstration in the school car park.

This was the first time any of the students had used a GPS.

The exercise comprised of using hand-held Garmin GPS units and the plotting of metric coordinates onto laminated maps. The co-ordinate system utilised was Gauss-Kruger Lo19, WGS84; the standard co-ordinate system for the City of Cape Town. Students were also tasked with interviewing residents and recording answers onto a questionnaire (a copy of this

questionnaire can be found in Appendix II). Questions included were mostly extracted from the original socio-economic survey. Four categories of data were collected, namely a) household information; b) housing; c) water, sanitation and health and d) disaster risk management.

The methodology for this exercise was to incorporate the local community into the survey. In order to achieve this, contact was made with the Masiphumelele High School. Twelve grade 12 students were selected by senior teaching staff to participate in the survey. Four teams of three students each were formed. One adult accompanied and assisted each team and one student from each team was appointed as team leader. The teams (A – D) were each assigned to a different portion of the Wetlands; a small portion of the TRA was also included in the survey. Each group of students was given a Garmin 60 GPS, three laminated A3 maps of the different areas and a plastic folder containing questionnaires, and basic stationery. Before going into the field, an introduction in the use of the GPS was given to all participating students. In addition, the purpose of the mapping exercise and the specific points of the questionnaire were explained.

The *modus–operandi* was to traverse by foot through the informal parts of the settlement, and complete the questionnaire with a random sampling of shack dwellers. *En-route,* the teams recorded the positions of pertinent data, such as areas of standing water and infrastructural information; for instance toilets and taps.

Figure 4.4 Student conducting an interview.

A typical scene showing the close proximity of shacks to one another; certainly less than the 5 metre spacing recommended by Disaster Risk Management.

Figure 4.5 Student plotting GPS coordinates onto the map

Aerial photographs used in the hardcopy maps were obtained from the City of Cape Town.

In each team, one of the students conducted the interview, another filled in the questionnaire form, while the third took the GPS reading and plotted the positions on the map. All forms and GPS positioning were recorded by the students themselves, though an adult was present to assist. Few problems were encountered and the students were polite and eager to learn. Access to some parts of these areas proved to be quite difficult, due to the close proximity of shacks to each other and numerous areas of standing water.

Figure 4.6 Students from Team D Conducting an Interview.

This shack dweller (in common with most people interviewed) was friendly and co-operative.

Figure 4.7 Area Adjacent to the Wetland.

Even students were surprised by the attempts by some residents to build in the wetland.

The information from the questionnaires was recorded into a relational Access database; thereafter basic statistical analyses were performed in Excel. Some limitations included the fact that the accuracy between actual ground co-ordinates and GPS co-ordinates varied depending on the number of satellites tracked by the GPS unit. More modern GPS units have higher accuracy levels; for which more satellites, up to ten in some cases, increase accuracy. Generally, the accuracy in the area surveyed was within approximately 5 metres. Although this meant that there would be slight shifts of recorded positions when plotted onto the aerial imagery, the accuracy was considered adequate enough to determine where the worst areas of flooding were taking place.

Positions recorded during the survey have been adjusted accordingly (shifted) based on the high resolution aerial imagery, where displacement was obvious. Infrastructure, like toilet blocks and standpipes (taps) which are clearly visible on the aerial photographs, were subsequently used to determine the amount of shifting required. The readings were noticeably less accurate (approximately 7 – 8 metres) in areas where shacks were closer together because the line of site to the satellites was masked.

Figure 4.8 Student Completing a Questionnaire.

Students conducted themselves well and no hostility was encountered.

Figure 4.9 Students Capturing Infrastructure Information.

It was very evident that water and sanitation infrastructure was totally inadequate in the informal areas.

4.6 New Population Estimates

Statistics currently available for the settlement of Masiphumelele are outdated. New socio-economic information was therefore collected for the settlement. The most recent census figures quoted on the City of Cape Town's website for example, date back to 2001 (City of Cape Town, 2001) The website records the population for Masiphumelele as just over 8 000. Estimates from local residents and staff members of NGOs working in Masiphumelele, however, believe this number to be now more than 25 000 (Masicorp, 2009). In order to formulate a suitable analysis of this population, more up-to-date information was required. A new population estimate based on weighted average number of persons per household was obtained from each of the three survey areas of Phase 1 and the Wetlands in Phase 2. Weighting was calculated by the sample size in each area (The average person per household from an additional survey undertaken during 2008 was also incorporated into the calculation) (SevaUnite, 2008). The methodology for estimating the current population of Masiphumelele is as follows:

The average number of inhabitants per shack in Wetland areas of Masiphumelele is calculated as approximately 3.56 from a SevaUnite Census of 50 households during 2008. New estimates from the Phase I Socio-Economic Survey of 2009 puts the average persons per shack at 3.5 in the Wetlands, 3.2 in the Temporary Relocation area (TRA) and 3.0 in the Formal area. Results of Phase 2 questionnaires estimate the Wetlands as having an average of 3.5 persons per shack. The weighted average of five sample areas (three from Phase 1; one from Phase 2 and another from the SevaUnite Census) has therefore been calculated as 3.4 inhabitants per shack. The weighted average is calculated by taking the average and multiplying it by a weight based on the relative importance of the area. The result is then summed and the total divided by the sum of the weights. The importance of the weighting is related to the sample size; with the Phase 1 Wetlands having the highest weighting (of 384 samples), followed by the Formal area (of 147 samples) then the TRA (101 samples), the Phase 2 Wetlands (with 64 samples) and lastly, the SevaUnite Census (with only 50 samples); therefore, the higher the number of samples, the higher the weighting. New population estimates are based on this figure (Table 4.5 gives a summary of these figures).

4.7 Shack Counts

Shack count data have been calculated for all informal settlements within the City of Cape Town. (Data obtained from the Geomatics section of the Corporate GIS branch, within the Information and Knowledge Department, City of Cape Town) These calculations were made for the years 2002 to 2008 (Refer to Table 4.6 and Figure 4.10). Ortho-rectified aerial photography was used as a base for the shack counts. This was achieved by capturing a point for every shack identified from the imagery (Rodriques *et al,* 2006). According to these calculations, there has been an almost three-fold increase in the population within the Wetlands between 2002 and 2008. As mentioned

previously, shack counts are undertaken manually and are liable to subjective observation. Dwellings hidden beneath trees are an example of where errors can occur during a count, especially if there is no follow-up ground-truthing. Ground-truthing in this case would be a way of confirming that the information inferred from aerial imagery is in fact true by field trips to the site in question. Since the 2009 shack counts were unavailable at the time of writing this report, the author conducted a shack count from the aerial imagery (imagery dated March 2009). This count was undertaken primarily to estimate the density of the population per hectare of the three survey areas.

Population : Weighted Average

Survey Area	Data Source	Sample Size (No. of Households)	Average Pax per Shack
Wetland	SevaUnite Census 2008	50	3.7
Wetland	Phase I Socio-Economic Survey 2009 (R Tyler)	384	3.5
Wetland	Phase 2 Socio-Economic Survey 2010 (R Tyler)	64	3.5
Temporary Relocation Area	Phase I Socio-Economic Survey 2009 (R Tyler)	101	3.2
*'Formal'	Phase I Socio-Economic Survey 2009 (R Tyler)	147	3.0
****Weighted Average:**			**3.4**

Table 4.5 Masiphumelele Population Statistics

Sample size from various surveys and calculated population density.
*Formal area includes 105 'Backyarders', 37 owned properties and 5 unknown.
**Averages weighted by number of households per survey area.

Shack Counts: Masiphumelele Wetlands

Date	Shack Count	Increase (Number)	Increase (%)
2002	289	Unknown	Unknown
2003	387	98	34%
2004	523	136	35%
June 2006	752	229	44%
September 2007	815	63	8%
June 2008	1083	268	33%

Table 4.6 Shack Count Data – Masiphumelele Wetlands

There has been a steady increase in shacks in this area during 2002 and 2008, with a slightly reduced rate of during 2007.
Source: City of Cape Town, Geomatics Section, 2009

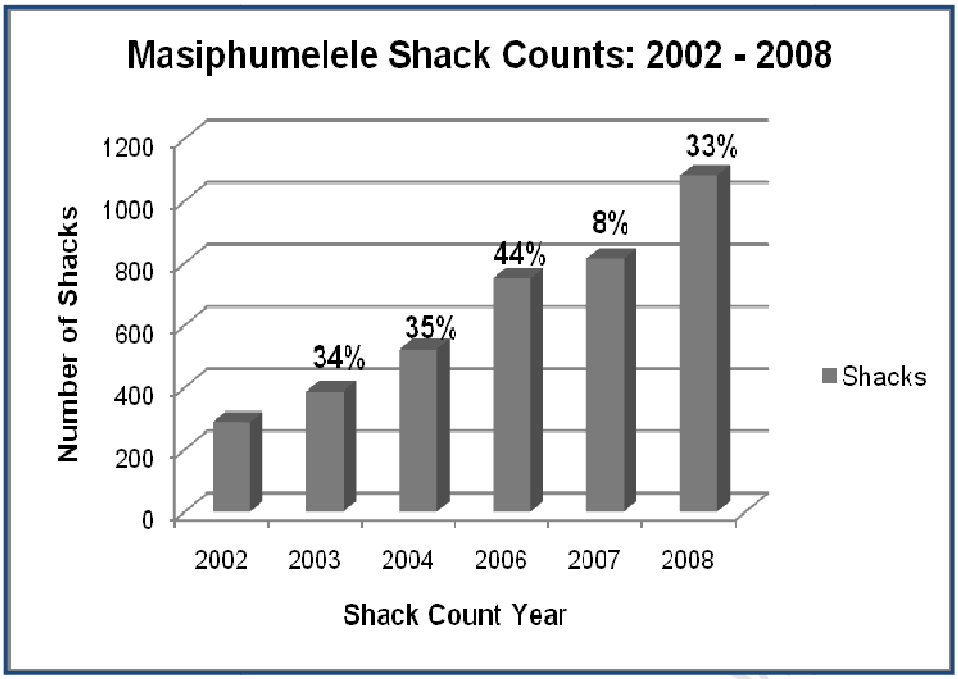


Figure 4.10 Shack Count Data – Masiphumelele Wetlands

There has been a steady increase in shacks since 2002 in the Masiphumelele Wetlands. Percentages show increase over previous year. Source: City of Cape Town, 2009

4.8 Merits of the Questionnaire Method

A random sampling method was used during both Phase 1 and 2 data collection. Each fieldworker was allocated a specific area of the settlement, but the actual sampling was random. The advantage of using random sampling is that each person interviewed within the population had an equal chance of being selected. A possible disadvantage might have been that a field worker, being also resident in the population, could have had a bias to certain people, possibly based on language group or simply that he or she knew the person interviewed. Masiphumelele has had incidents of xenophobia in the past, which could have also played a role in the selection process.

Some questionnaires had to be rejected as information documented therein was either obviously falsified or incomplete; misrepresented information would not necessarily have been detected had a local supervisor not been appointed.

A disadvantage of using the paper questionnaire format is the fact that its compilation is time-consuming. Data entry and validation requires a certain amount of skill and because it is also manual, is also time-consuming. Another method that could have been adopted is the use of palm-top computers. This method would reduce the data entry time substantially, although its accuracy would however depend on the ability of local field workers to use the technology; it would also require some basic computer training.

4.9 Data Collection, Capture and Validation

Primary data from household questionnaires, collected during both Phase 1 and Phase 2, was validated and entered manually into two relational Access databases.

The benefits of using relational databases are numerous; some are listed below:

- Data collected is kept together in one place.
- Different information categories are easily incorporated into an Access database with the use of primary keys. This was achieved by allocating a unique household identification number for each completed questionnaire, both in Phase 1 and Phase 2 of the project.
- Duplication of data is avoided.
- Data validation occurs during the entry process and cross-checking of data is straightforward.
- Numbers and text remain separate if this is initially setup before the data entry process begins.
- Manipulating data is quick and reliable; this is achieved through using queries.
- Data from the relational database can easily be linked to the GIS or spreadsheet software.

Basic uni-variate Statistics were calculated using both Access and Excel, and data with a spatial component was incorporated into GIS software programmes. During this study, a multitude of informative maps were produced, as they are often a more effective means of explaining data, especially to residents of informal settlements where some are illiterate. Hardcopy maps were created and utilized during the Phase 2 participatory exercise; many residents were eager to view their homes on the aerial imagery. Maps are useful in that data can be visualised more effectively, particularly if people are illiterate. Using maps to inform residents of potential flooding problems could therefore also be an effective means of informing the residents.

The major source of secondary data was acquired from the City of Cape Town's Spatial Data Sourcing Unit (Corporate GIS). Base data in the form of aerial photography was obtained for the years 2002 – 2009. This imagery made it possible for temporal analysis to be undertaken, in particular the growth of Masiphumelele. Shack count data was available for the years 2002 - 2008. The City of Cape Town shack count data for the year 2009 was unavailable at the time of analysis; subsequently, the author undertook a shack count using the 2009 aerial imagery. Shacks were manually counted from the imagery in three 1-hectare blocks in each of the three survey areas. The shack count method is partly subjective; it is not always possible to distinguish where one shack ends and another begins due to high densities. The validity of shack count data was determined by ground-truthing; therefore a number of visits were made by the author to the area.

4.10 Secondary Data

Other data obtained from the City of Cape Town included; ecological buffer zones, water bodies, flood-prone areas, infrastructure (overhead electricity reticulation, underground electricity, sewer networks, inspection chambers), and contour data. The projection system of the spatial data obtained from the City of Cape Town is Transverse Mercator, Lo19 based on WGS84. All additional data obtained were therefore re-projected into this format.

Other geo-spatial information such as biological, environmental and geological data was also collected from a number of sources. A full list is presented in Table 4.5. Noteworthy was the assistance given by Geordie Ractliffe of the Freshwater Consulting Group who gave various reports on the wetland and Mark Pluke from Disaster Risk Management who supplied numerous contacts and information. Table 4.6 summarises the major categories of data collected during this study.

4.11 Data Processing and Incorporation into GIS

Bringing together all the information collected during the course of this study was made possible through the use of GIS software. GIS software utilised during this study included: ArcGIS, Arcview and MapInfo / Discover. The City of Cape Town and the University of Cape Town both use ArcGIS software, therefore the collation of the spatial data was not problematic. The Masiphumelele High School currently makes use of Arcview software in their computer laboratory; and it was therefore necessary to incorporate the data given to the school into an Arcview format. Arcview and ArcGIS are easily compatible, with Arcview being essentially an older version of the same software. The MapInfo / Discover software combination was also used during the course of this study; the motive for this was purely author preference. Both ArcGIS and the MapInfo / Discover software programmes are easily inter-changeable, although each uses slightly different terminology and file-naming conventions; in essence they produce similar outputs.

The advantages of using GIS in a study such as this are numerous; one advantage being the ability to merge and interpret various data sets, another is the ease of which it is possible to update files when new information is acquired; exporting it to other commonly used formats, for example, Excel spreadsheets and JPEG images, are also possible. GIS also provides the ability to see the spatial distribution of responses and allows for spatial analysis. Another advantage of GIS is that spatial patterns and trends, that are not always evident in a database, can be visualised easily.

Not all information acquired was in digital format, and therefore some documents required scanning, geo-referencing and digitising. An example of this is the information from the proposed Phase IV housing development produced by Chand Environmental Consultants and obtained from Bernie Wentzel of the New Housing Directorate, City of Cape Town. Details on this are presented as Appendix IV (CHAND, 2006).

4.12 Gathering Qualitative Information

A number of stakeholders were interviewed either in person, telephonically or by email correspondence. Some of the most significant interviews were with the Disaster Risk Management and members of the New Housing Directorate staff from the City of Cape Town plus the local ward councillor. This provided important insights for the study; political as well as operational. All stakeholders consulted were willing to exchange information freely; not only spatial, but also anecdotal and a number of reports were supplied.

There are a number of non-governmental organisations (NGOs), notably, Masiphumelele Corporation and Trust, SevaUnite, Hokisa and Intern Africa operating within the boundaries of Masiphumelele; these organisations are often of the few forms of assistance available for destitute residents. It was also important to gauge their opinions of the project area.

4.13 Benefits of the Transect Walk Method

During the summer months, a transect walk was carried out with a staff member from the Disaster Risk Management team. A transect walk is an effective, inexpensive method of gathering valuable insights into a community; it is a way of collecting both quantitative and qualitative information.

The purpose of this walk was to observe conditions on the site during the dry months; enabling comparisons to be made of the same area during wetter months. A community leader organised a guide to accompany the author around the Wetlands. During the course of this transect walk, a number of residents were interviewed informally; providing interesting insight into their living conditions and attitudes towards government. The exact direction and course of the walk would take was not planned in advance; many paths being subject to frequent change due to the dynamic nature of building that occurs there.

4.14 Validity of the Study

The measurement of the vulnerability of families in Masiphumelele was explored through the following elements:

- Exposure: proximity of dwellings to high-risk areas as determined by wetland buffer zones, the 5m contour line and the coastal risk area.
- Susceptibility: quality of housing material, gender, age, landownership
- Coping capacities: social networks, income, flood mitigation strategies
- Intervention tools: knowledge of hazard, warnings, 32 - 75m buffer zone around wetlands, willingness of residents' to relocate.

In order to increase the validity of this research, a combination of methods and data sources were incorporated; Table 4.7 gives an indication on the sources of primary and secondary data.

Sector	Organisation	Contact	Information Obtained
Local Government	City of Cape Town - Spatial Data Sourcing Unit, Corporate GIS	Jeffrey J. Williams	Aerial imagery: (2002 – 2009); shack counts: (2002 – 2007); informal areas: (2002 – 2007; topographic and drainage data
	Disaster Risk Management (DRM) – Cape Town	Mark Pluke	Interview Transect walk through Wetlands with DRM representative
	New Housing Directorate	Bernie Wentzel	Interview Copy of Appendices Final Scoping Report Masiphumelele Phase IV
	Ward Councillor	Alderman Nicki Holderness	Interview
Non-Government Organisation (NGO)	SevaUnite	Mark Frankel	50 Household Census - Wetlands
	InternAfrica	André du Plessis	10 year history on fires and flooding in the informal settlements
	MasiCorp	Andrew Smith	Contacts for High School and Website Information
	Men-on-the-side-of-the-road	Siya Cwayi	Socio-Economic Survey Questionnaires (Phase 1) - Wetlands - TRA - Formal / Backyarders
School	Masiphumelele High School	Patrick Barnes	Participatory GPS Mapping Exercise – GPS Positioning and Questionnaires; Focus group - Wetlands and TRA
Research Institutions - Environmental	Chand Environmental Consultants	Melanie van Breda	- Environmental Impact Assessment Report - Phase IV Masiphumelele
	The Freshwater Consulting Group	Geordie Ractliffe	- Wetland information - Proposal for Extension of Houmoed Road

Table 4.7 Primary and Secondary Data Sources

Data collected during this project was gathered from a variety of different sources.

4.15 Summary

This research integrated participatory techniques of generating data using GIS, based on the BBC conceptual model of vulnerability in studying the social and spatial delineation of flood vulnerability in Masiphumelele. The methodology for the research included survey questionnaires; transect walks, a community mapping exercise, focus groups and interviews with stakeholders. Technologies such as the GPS and GIS software were also incorporated. A wide variety of primary and secondary data such as aerial photography, topographic and drainage data were required as well as socio-economic data. Data processing techniques such as the creation of relational databases, digitizing, geo-referencing, buffering, layering and map production (to mention a few) were also incorporated.

In Chapter 5, the results of the various analyses are discussed.

Figure 4.11 View over the wetlands

North-west corner in the Wetlands Survey area

CHAPTER 5

RESULTS OF ANALYSES

"After all is said and done, more is said than done."

~ Anonymous ~

In this chapter, a new estimate of the current population in Masiphumelele is documented. The results of the mapping of spatial data together with the application of setback lines using GIS are overviewed and regions of vulnerability to flooding are delineated. Non-spatial survey data acquired during Phase 1 is thereafter compared with this vulnerability mapping.

5.1 Estimation of Current Population

Three areas, of 1ha each (100 metre by 100 metre) were selected for the current population counts; a) Wetlands, b) Formal and c) TRA. (Figures 5.1 and 5.2 show the Wetland and Formal area counts) Results of this count reveal that very high population density is prominent within all three areas of the Settlement, although the TRA has substantially less people when compared with both the Wetlands and the Formal areas. A number of field visits were made to the area in order to determine the accuracy of the shack count. Some limitations occurred due to outdated imagery (dated March 2009), most notably, the additional shacks that had been erected in the Wetlands after the imagery date (as observed during various field visits to the area). These additional shacks were therefore not included in the shack count. Based on this limitation, the new population calculation is therefore probably an underestimate; accuracy can only be established up until March 2009 (Refer to Table 5.1).

Figure 5.1 Shack Count in Wetland area (March 2009 – undertaken by the author)

Recent field visits during 2010 revealed a number of new shacks in the north.

Figure 5.2 Shack Count in Formal area (March 2009 – undertaken by the author)

One hectare (ha) of land is outlined in yellow.

New Population Estimates: Masiphumelele

Survey Area	Dwellings per ha*	People per Dwelling**	Total Ha	% of Total ha	People per ha	Estimated People in Area
Wetlands	289	3.5	6.0	12	983	5 896
TRA	160	3.2	2.4	5	544	1 306
Formal	252	3.0	41.6	83	756	31 450
		3.4	**50.0**	**100**		**38 651**
		Weighted Average				**Estimated Population**

Table 5.1 Estimated Populations

***** Dwellings per ha calculated by shack count method
** People per dwelling calculated by average of person per dwelling divided by number of dwellings (collected during phase 1 and 2 surveys).

All dwellings per hectare counted from aerial photography (dated March 2009).

Masiphumelele is clearly well in excess of any apparent 'ideal' per hectare population density figure. The estimated population was calculated from the shack count information (estimated for March 2009) and the weighted average people per household (estimated at 3.4 per household – refer to Chapter 4 for more details), and is based on the total area (hectares) of each survey area. If these estimates are indeed accurate, population in this settlement has increased from 8 242 in 2001 (City of Cape Town, 2001 Census) to approximately 38 651 in 2009, a substantial growth of 369%. The following series of maps (Figures 5.3 – 5.8) illustrate the growth within one area of the Wetlands (1 ha, the north-west corner); the maps also incorporate the City of Cape Town shack count data, for the period 2002 – 2008.

Figure 5.3 Shack Count Wetlands (2002, CoCT)

During 2002, 56 shacks per ha were counted by the City of Cape Town.

Figure 5.4 Shack Counts Wetlands (CoCT, 2003)

Considerable growth occurred between 2002 and 2003. (76 shacks per ha)

Figure 5.5 Shack Counts Wetlands (CoCT, 2004)

Shacks increased from 76 to 121 per ha during this period.

Figure 5.6 Shack Counts Wetlands (CoCT, 2006)

Significant densification occurred during 2006. (147 shacks per ha)

Figure 5.7 Shack Counts Wetlands (CoCT, 2007)

There was an overall increase in households, though some reduction is notable in the north-west corner when compared with 2006 imagery.

Figure 5.8 Shack Counts Wetlands (CoCT, 2008)

Approximately 239 shacks per Ha were counted in 2008.

5.2 Geographic Distribution of Physical Vulnerability

The geographic distribution of physical vulnerability varies across the Masiphumelele settlement. The extent of this physical vulnerability becomes evident when considering the following four factors:

a) Application of setback line methodology in terms of buffer zones around a wetland
b) Location of the 1:50 and 1:100-metre flood lines
c) Location of the 5m contour line in relation to the flood lines (delineated from DEM – see Figure 5.10)
d) Possibility of sea-level rise associated with climate change

'Setback Line' methodology aims to provide protection not only to coastal resources, but also to public and private property. The 'Setback Line' theory provides a number of principles to enhance effective environmental sustainability and urban development (CSIR, 2000). According to these principles, a 32m minimum wide buffer zone between a wetland boundary and a developed area is required. The 32m buffer could however range up to 75m around a wetland, depending on the sensitivity of the area. Development is not to occur within the 1:100 year flood line or the 5m amsl (*i.e.* the 5m contour line) at all. In Masiphumelele the 5m contour line falls largely above the 1:50 and 1:100-year flood line, in fact the 5m contour line extends up to the edge of the 75m buffer zone in the north-west of the Wetlands settlement. Figure 5.9gives an illustration of this phenomenon.

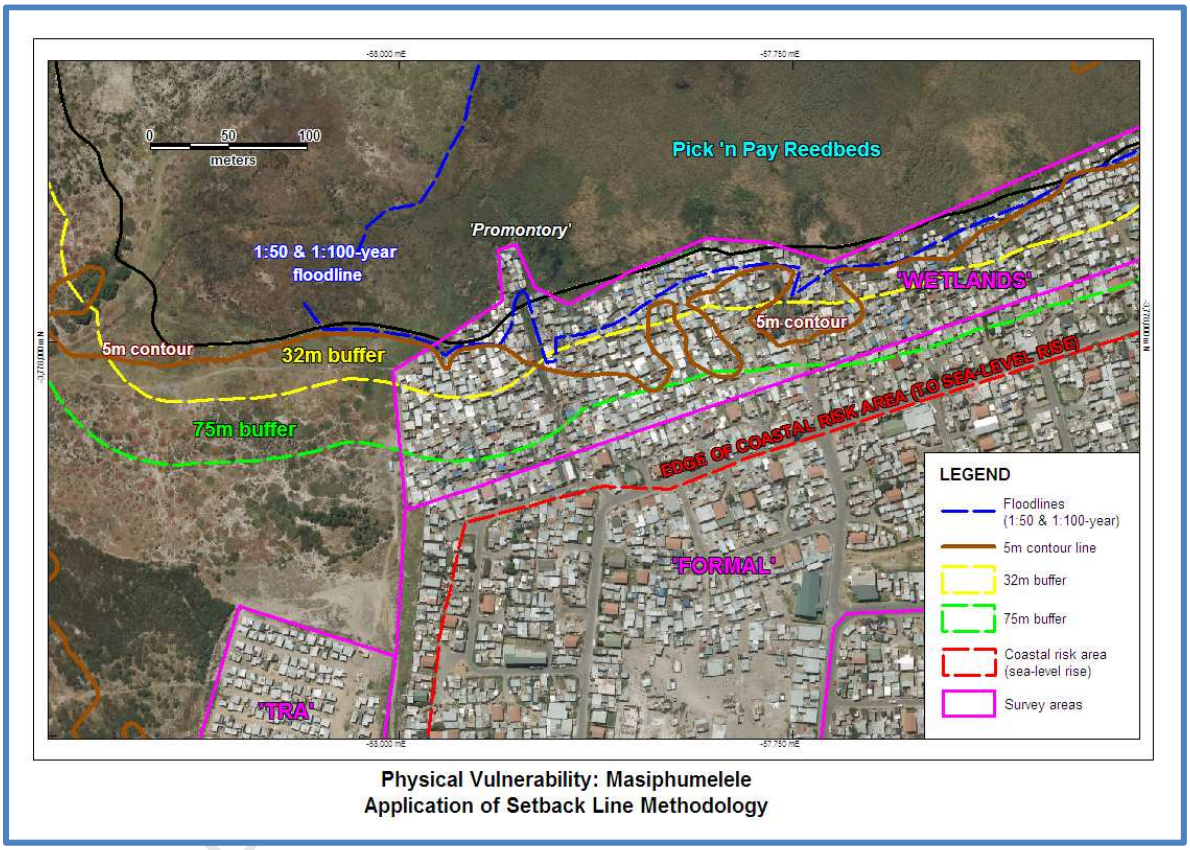


Figure 5.9 Physical Vulnerability of Masiphumelele: Application of Setback Line Methodology

The Wetlands area is particularly vulnerable in terms of its location to the 1:50 and 1:100-year flood lines, proximity to a wetland, within the 32 and 75meter buffer zone, and near the 5m contour line, notwithstanding the fact that it also lies within the coastal risk area (an area vulnerable to sea-level rise events). The wetland boundary is shown as a black line.

Based on this evidence, it is apparent that development in this area is unsuitable and residents located here are highly vulnerable to the risk of flooding. The theoretical buffer zone of 32m in width around the reed bed water feature to the north of Masiphumelele is displayed as a yellow dotted line on the map. This spatial data was obtained from the City of Cape Town, whilst the 50- and 100-year flood line data (shown as dashed dark blue lines on the map) were obtained from the Chand Final Scoping Report of 2006. These flood levels were estimated at 4.8 metres amsl (above mean sea-level) and 4.9amsl metres respectively (these flood lines were originally delineated by Wilkinson Consulting Engineers in 2002). Since there is subsequently no substantive difference

between these two levels, the 50- and 100-year flood lines are displayed at the same location (see below).

Within the north-western corner of the Wetlands a noticeable topographic-high or 'promontory' is seen, on which building of shacks has occurred. There appears to be an associated channel immediately south-southeast of this feature which magnifies the effect of flooding in the Wetlands. Indeed, in this area, the 5m contour line has a noticeable flexure. This effect has been displayed in Figure 5.9. Due to this, it is apparent that the areas at risk to estuarine flooding within Masiphumelele extend further to the south. If the setback methodology were to be rigorously applied in Masiphumelele, the surface area suitable for human habitation would be considerably reduced. The extent of the unsuitability of inhabited areas with regard to these buffer zones in the Wetlands is shown in Figure 5.10 and the effects thereof have been summarized in Table 5.2.

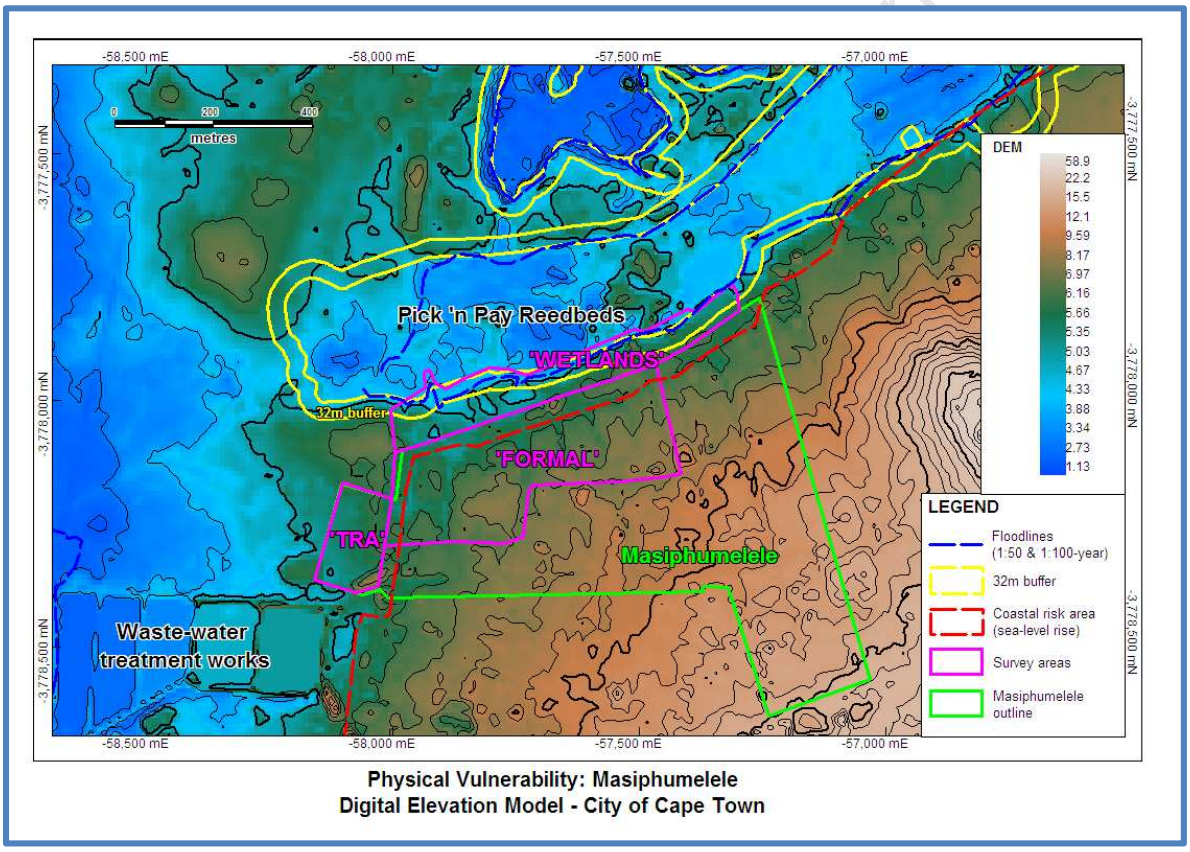


Figure 5.10 Physical Vulnerability of Masiphumelele: Digital Elevation Model

The DEM shows clearly that the area adjacent to the Wetlands has a low elevation. It is evident that small pockets of land with lower elevations extend into the TRA and Formal area, which could account for flooding occurring here.

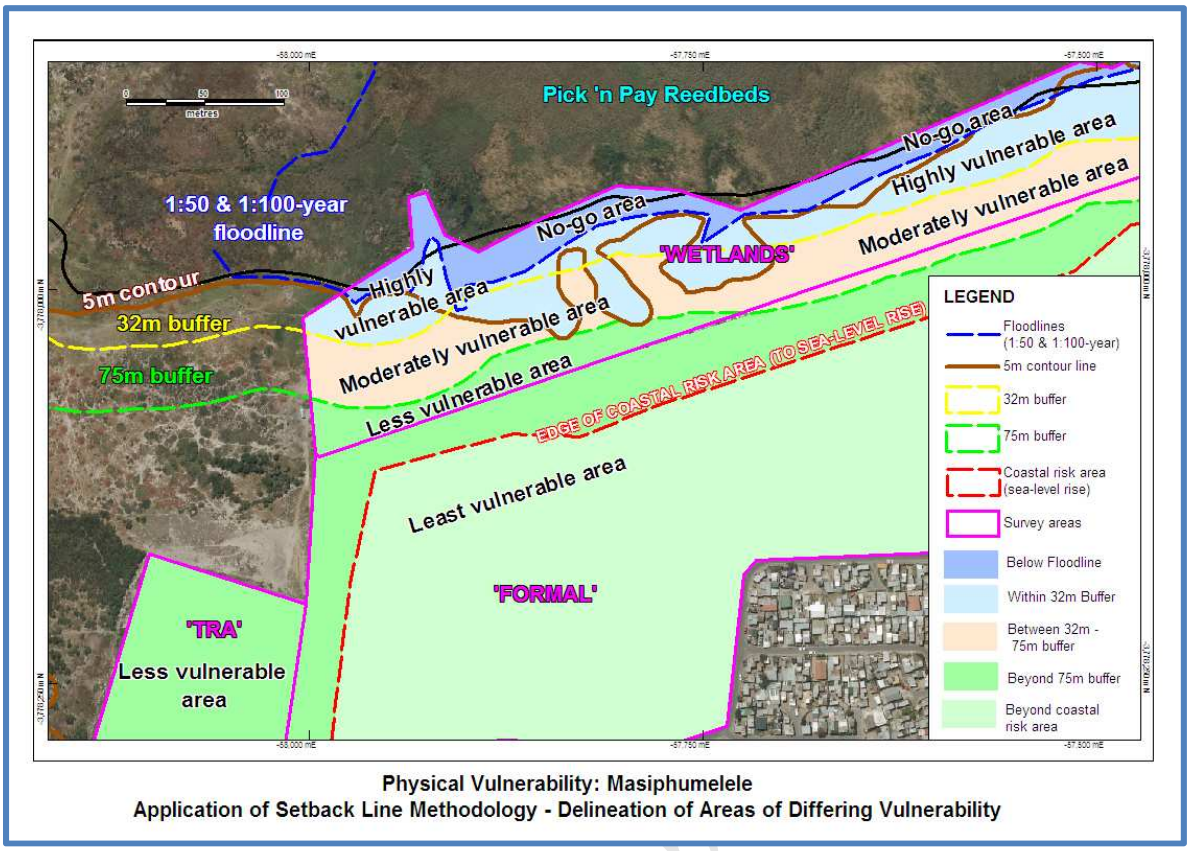


Figure 5.11: Delineation of Areas of Vulnerability

Three areas of physical vulnerability have been delineated based on the superimposition of setback lines. The most vulnerable area is immediately to the south of the Pick 'n Pay Reed Beds. This area lies below the flood lines, and in many areas the 5m contour line and within the 32m buffer zone.

Setback Line Methodology vs Number of Affected Residents of Wetlands

Setback ('buffer') Area	Physical Vulnerability	Surface Area (km^2)	Surface Area (ha)	Approximate Number of People affected*
Below 4.8m AMSL (50-year) and 4.9m AMSL flood line (100-year)	NO GO Area – most vulnerable	0.01048	1.09	**1 071**
Within 32m 'buffer' zone and below 5m contour line	Highly Vulnerable	0.025	2.5	**2 458**
Within 75m 'buffer' zone	Moderately Vulnerable	0.019	1.9	**1 868**
Beyond 75m 'buffer' zone and within coastal risk zone	Less Vulnerable	0.005	0.50	**492**
		0.059	**6.0**	**5 889**

Table 5.2 Setback-line Methodology Implication for the Wetlands

Considerable numbers of residents are living in areas considered to be risky housing development areas with regard to estuarine and coastal flooding.
* Based on number of people per hectare as calculated in chapter 4.

The area below the flood line (shaded in light blue on Figure 5.10) is considered to be a 'no go' development zone according to the environmental literature. The area below the 5m contour line, which represents the closest practical contour line to the 50- and 100-year flood line (outlined in brown), is considered risky as it is the level at which the seasonal wetland is supported (Roets and Duffell-Canham 2009**)** Building developments are restricted to above the 1:50-year flood line in the Noordhoek wetland area (which includes the 'Pick 'n Pay Reed Beds' and Wildevoelvlei), and is demarcated at the 5m contour line (Jackelman, 2004). For all practical purposes, this means that the 5m contour line represents the 50-year flood line.

The least vulnerable area in terms of setback line methodology and as illustrated on Figure 5.11 is the area beyond the 75m buffer zone. This relatively small area (0.5ha) is home to approximately 492 people, only 8% of the total Wetland population. The most vulnerable areas are those below the flood line; below the 32m buffer zones and 5m contour line affects approximately 3 529 people, almost 60% of the inhabitants of the Wetland area. Around 32% of the inhabitants of the Wetlands are living in moderately vulnerable areas.

This methodology is also applied to both the TRA and Formal areas and is summarised in Table 5.3.

Setback Line Methodology vs Number of Affected Residents of TRA and Formal Areas

Setback ('buffer') Area	Physical Vulnerability	Surface Area (km^2)	Surface Area (ha)	Approximate Number of People affected*
Beyond 5m contour but within coastal risk zone (TRA)	Less Vulnerable	0.0259	2.6	**1 414**
Beyond 75m buffer but within coastal risk zone (Formal)	Less Vulnerable	0.02219	2.2	**1 663**
Beyond 75m buffer and outside coastal risk zone (Formal)	Least Vulnerable	0.09448	9.4	**7 106**
		0.142	**14.2**	**10 184**

Table 5.3 Setback-Line Methodology Implication for the TRA and Formal areas.

Although the residents in both the TRA and Formal areas can be considered less vulnerable than those who reside in the Wetlands, they are nevertheless still vulnerable.

Vulnerability in the TRA and Formal areas is much less severe than in the Wetlands. This is illustrated in Figure 5.11. The TRA area lies away from both the water body (Pick 'n Pay Reed Beds) and the 5m contour line so vulnerability to estuarine flooding here can be considered to be

relatively low. The TRA however, does fall within the coastal risk area as does a small portion of the Formal area. Based on this evidence, physical vulnerability still exists. Most of the Formal area is located outside the coastal risk area, so physical vulnerability here is the lowest.

In addition to the potential risk of estuarine flooding, residents of the Wetlands and TRA and smaller portions of the Formal area are at risk to sea-level rise events. Although not a focus of this project, the scenarios presented are relevant to the Masiphumelele settlement. Table 5.4 summarises the potential impact to the Western Cape Coastal zone in the event of sea-level rises.

Three scenarios are displayed in a GIS inundation model, obtained from the City of Cape Town, namely a) 2,5-metre (displayed in blue) b) 4,5-metre and (displayed in red) c) 6.5-metre (displayed in orange) sea-level rise events. The probability of these scenarios occurring in the next 25 years is 95%, 85% and 20% respectively (Cartwright, 2009). Figure 5.12 illustrates two of the three sea-level rise scenarios in relation to the settlement of Masiphumelele. In the event of a mean sea-level rise of between 4.5 and 6m resulting from climate change, complete inundation of the Wetlands as well as substantive parts of the northern boundary of the Formal area are likely. This implies that the entire Wetlands, TRA and a significant portion of the Formal area are physically highly vulnerable to potential coastal flooding.

Impact of Sea-Level Rise – Western Cape			
Coastal zone	**Defining features**	**Drivers of sea-level rise impacts**	**Defining sea-level rise impacts**
Western Cape Coast: Melkbos to Cape Hangklip	High density and high value commercial, industrial and residential. Low and high gradient coastline, vulnerable "pocket beaches".	Higher eustatic sea-levels levels. Coastal low pressure systems, south west winds, imprudent coastal development.	Damage to transport, electricity and water infrastructure and residential coastal property. Increasing frequency and intensity of damage to the sea-wall buffers to reclaimed land in Cape Town.

Table 5.4 Western Cape Coast Impact of sea-level rise

Causes and vulnerabilities to sea-level rise are summarised. Extracted from a report by Cartwright, entitled: '*Coastal vulnerability in the context of climate change: a South African perspective'* (Cartwright, 2009)

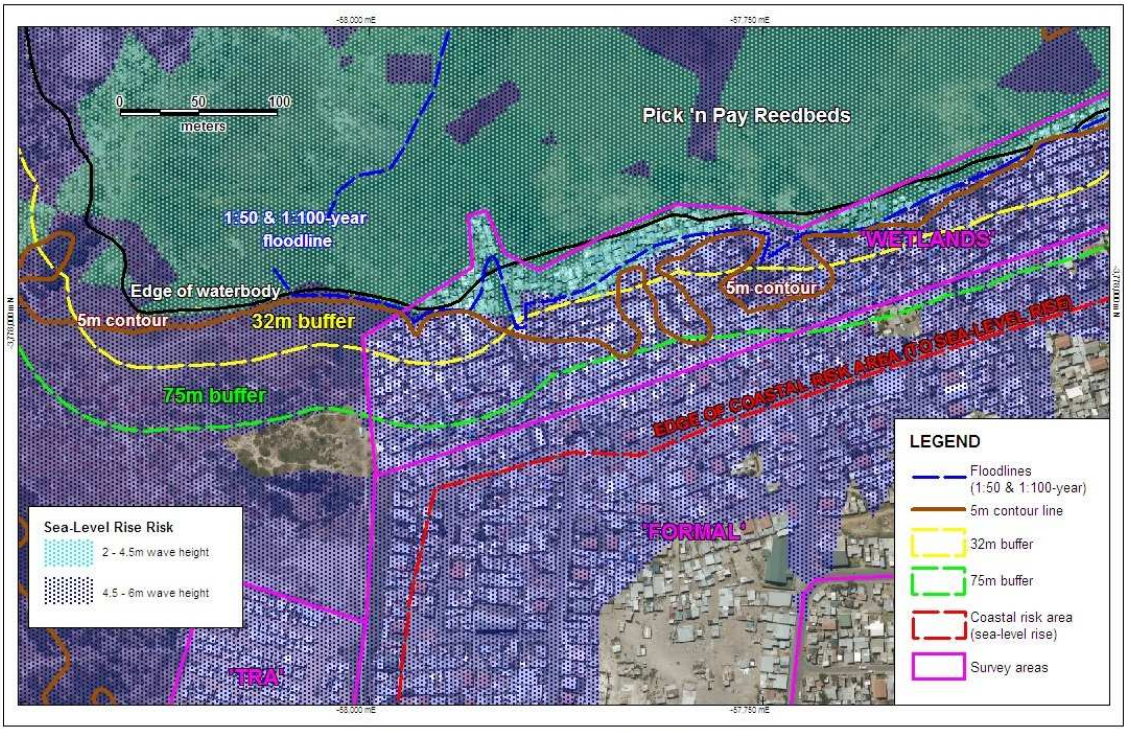


Figure 5.12 the Impact of Sea-Level Rise Events on Masiphumelele

Two scenarios of potential sea-level rise are illustrated, firstly a wave height of between 2 and 4.5m (illustrated in light blue) and secondly a wave height of between 4.5m and 6m (illustrated in dark blue).

5.3 Geographic Distribution of Physical Vulnerability in relation to Socio-Economic Vulnerability

The two-phased socio-economic surveys undertaken in Masiphumelele reached 702 households, an estimated total of 2 387 people. Of the data gathered during the surveys, most was collected during Phase 1 (90%) while a further 10% was collected during Phase 2. The Wetlands area was the primary focus of the surveys, with 64% of the data originating from there; the Formal area made up 21% and the TRA 15%. 'Backyarders' made up approximately 70% of those surveyed in the Formal survey area. This information is summarised in Table 5.5.

When comparing the physical data (*i.e.* physical vulnerability mapping data incorporating setback line methodology) with the socio-economic data (collected during the two surveys), a number of relationships became apparent, most notable were:

HOUSEHOLD INFORMATION				
Phase	**Area**	**Households**	**Total population sampled***	**% of total sample**
I	**Wetlands**	384	1 306	55%
I	**TRA**	101	343	14%
I	**Formal**	147	500	21%
	a. Backyard	105		
	b. Owned	37		
	c. Unspecified	5		
II	**Wetlands**	64	126	9%
II	**TRA**	6	20	1%
TOTAL		**702**	**2 387**	**100%**

Table 5.5 Household Information of Areas Surveyed

A total of 702 households were included in the two-phased survey
* based on weighted average of persons per shack (see table 5.1)

- Relationship between the physical location of households and the incidences of flooding in the Wetlands.
- Relationship between the perceived suitability of a dwelling and the number of flood related incidents was also apparent.
- Relationship between the number of mitigation measures in place and the number of flood related incidents.

Inconsistencies of data were also apparent when comparing the following:

- Perceived flood risks to actual flood risks

Table 5.6 represents a summary of the most important questions with regard to the social vulnerability to flooding.

Summary of Statistics: Phase 1 (October 2009) and Phase 2 (May 2010)

Phase:	PHASE 1			PHASE 2		
Survey Area within Masiphumelele:	**Wetlands**	**TRA**	**Formal**	**Wetlands**	**TRA**	**Formal**
Sample size (of 632 households) % of Total Households	**61%**	**16%**	**23%**	**91%**	**9%**	**0%**
Households surveyed (Percentages expressed per survey area)	384	101	147	64	6	0
Average number people per household	3.5	3.2	3	3.5	3.5	n/a
Males	53%	49%	49%	n/a	n/a	n/a
Females	47%	51%	51%	n/a	n/a	n/a
Households with children (under 18)	70%	74%	57%	n/a	n/a	n/a
At least 1 member of household employed	83%	78%	95%	n/a	n/a	n/a
Full-time employment	33%	38%	51%	n/a	n/a	n/a
Part-time employment	33%	37%	30%	n/a	n/a	n/a
Self-employed	3%	4%	4%	n/a	n/a	n/a
Average household income	1 187	1 243	1 182	n/a	n/a	n/a
Receive welfare grants	22%	30%	24%	n/a	n/a	n/a
Housing (Percentages expressed per survey area)						
Happy in Masiphumelele	41%	54%	80%	n/a	n/a	n/a
Adequacy of home (adequate or good)	12%	22%	20%	17%	15%	n/a
Adequacy of living conditions (adequate or good)	12%	26%	31%	n/a	n/a	n/a
Improvement of living conditions since moving to settlement	15%	17%	1%	n/a	n/a	n/a
Home suitability to all weather conditions	10%	9%	62%	n/a	n/a	n/a
Water, Sanitation and Health(Percentages expressed per survey area)						
Communal toilet	83%	88%	3%	84%	100%	n/a
Average number of toilets per person	100+	14	n/a	Many	Many	n/a
Satisfaction level of sanitation	8%	14%	11%	0%	0%	n/a
Access to potable water (communal)	96%	100%	100%	81%	100%	n/a
Satisfaction level of refuse collection	26%	13%	76%	n/a	n/a	n/a
Waterborne illnesses	24%	30%	25%	n/a	n/a	n/a
Access to hospital	37%	24%	27%	n/a	n/a	n/a
Access to clinic	77%	75%	88%	n/a	n/a	n/a
Adequacy of health facilities	28%	46%	82%	n/a	n/a	n/a
Disaster Risk Management (Percentages expressed per survey area)						
Awareness of risk to flooding	28%	15%	n/a	n/a	n/a	n/a
At risk to flooding	66%	55%	29%	91%	50%	n/a
Experienced flooding	93%	89%	33%	94%	100%	n/a
Experienced fires	60%	44%	10%	63%	0%	n/a
Flood type = Seepage from underground	31%	54%	n/a	25%	50%	n/a
Flood type = Leaking from roofs or walls	10%	8%	n/a	14%	25%	n/a
Flood type = Compete inundation	47%	21%	n/a	55%	25%	n/a
Attempting flooding mitigation measures	71%	75%	29%	77%	50%	n/a
Warnings received before storms / flood risks	14%	9%	2%	9%	17%	n/a
Willingness to relocate elsewhere	62%	56%	29%	n/a	n/a	n/a
Department to Contact during Flood Event	n/a	n/a	n/a	42%	0%	n/a
Knew Number to Contact Department	n/a	n/a	n/a	0%	0%	n/a

Table 5.6 Summary of Phase 1 and Phase 2 Survey Data

A total of 632 households were included in the Phase 1 and 2 survey

5.3.1 Relationship between Physical Location and Flood Occurrences

Figure 5.13 illustrates the correlation between the frequency of flooding and the location within the Wetlands.

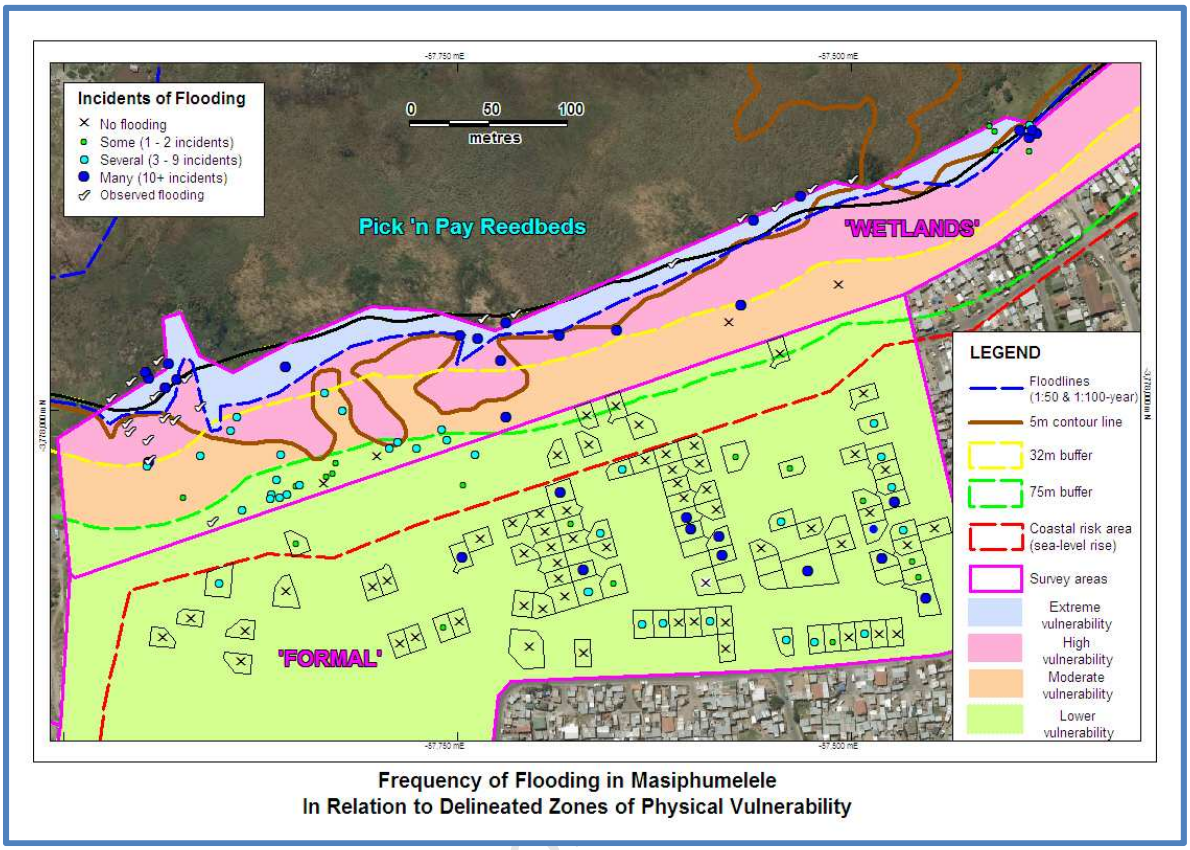


Figure 5.13 Frequency of Flooding *vs.* Delineated Zones of Physical Vulnerability

The settlement experiences a high number of flood incidents, particularly the area within close proximity to the Pick 'n Pay Reedbeds.

Data from the Phase 2 participatory mapping exercise indicated that wide-spread flooding is common in the Wetlands (94% of those interviewed reported that they had suffered the effects of flooding). Flooding is a factor of both the location of a house as well as the quality of its construction, with the most frequent flooding (10 or more floods) experienced predominantly near or below the 5m contour line (31% of households interviewed). The majority of households surveyed in Phase 2 (83%) considered their homes to be of a poor quality. Despite 13% of those who perceived their homes to be of an adequate quality, they have all experienced some incidents of flooding. Several incidents of flooding were also reported to have occurred in the area that is considered the least vulnerable in the Wetlands; one-fifth of households in this area reported to have been flooded up to 9 times. The highest percentage of households who experienced no flooding at all was found to be in the least vulnerable area; although this represents only 5% of all households surveyed. Table 5.7 summarises the frequency of flooding within each demarcated area within the Wetlands, together with the perceived quality of the dwelling.

Frequency	Location	Perceived House quality	Households (Total: 64)	% of Total Households Surveyed
Frequent incidents (10+)	Below or near 5m Contour	Poor	20	31%
	Between 32 - 75m buffer zone	Poor	2	3%
	Beyond 75m buffer	n/a	0	0%
Several Incidents (3 – 9)	Below or near 5m Contour	Poor	6	9%
	Between 32 - 75m buffer zone	Poor	4	6%
	Beyond 75m buffer	Poor	12	19%
Some Incidents (1 – 2)	Below or near 5m Contour	Adequate	8	13%
	Between 32 - 75m buffer zone	Poor	3	5%
	Beyond 75m buffer	Adequate	5	8%
No Flooding	Between 32 - 75m buffer zone	Poor	1	2%
	Beyond 75m buffer	Adequate	3	5%

Table 5.7 Frequency of Flooding vs Location

The data collected during the Phase 2 indicates that the highest frequency of flooding can be found below or near the 5m contour line.

The spatial data from Phase 1 also shows that even portions of the Formal areas have experienced flooding. Formal area data was collected during phase 1; the data shows that of those who have had incidents of flooding (33%), 81% percent perceive their homes to be of inferior quality, of which a large proportion are 'backyarders' (41%). Similarly in the TRA, almost 90% of residents have experienced flooding at some point, with over two-thirds of these residents considering their homes to be of inferior quality. It is not clear whether residents of the TRA were reporting incidents of flooding in the TRA or the old 'School Site' from where they were recently relocated.

5.3.2 Relationship between Quality of Homes and Physical Location

Figure 5.14 illustrates the influence poor-quality housing has with respect to the location and frequency of flooding. Unsurprisingly, the frequency of flooding tends to increase the closer the home is to the wetland. Perceived poor-quality homes are located in the most vulnerable areas. Despite living in the least vulnerable areas, several floods occurred.

The correlation between incidents of flooding and the perceived condition of housing is evident from the data obtained during the Phase 1 survey; this is outlined in Table 5.8. Although the data from the TRA and Wetland areas in Phase 1 cannot be mapped spatially, the results present the overall trends.

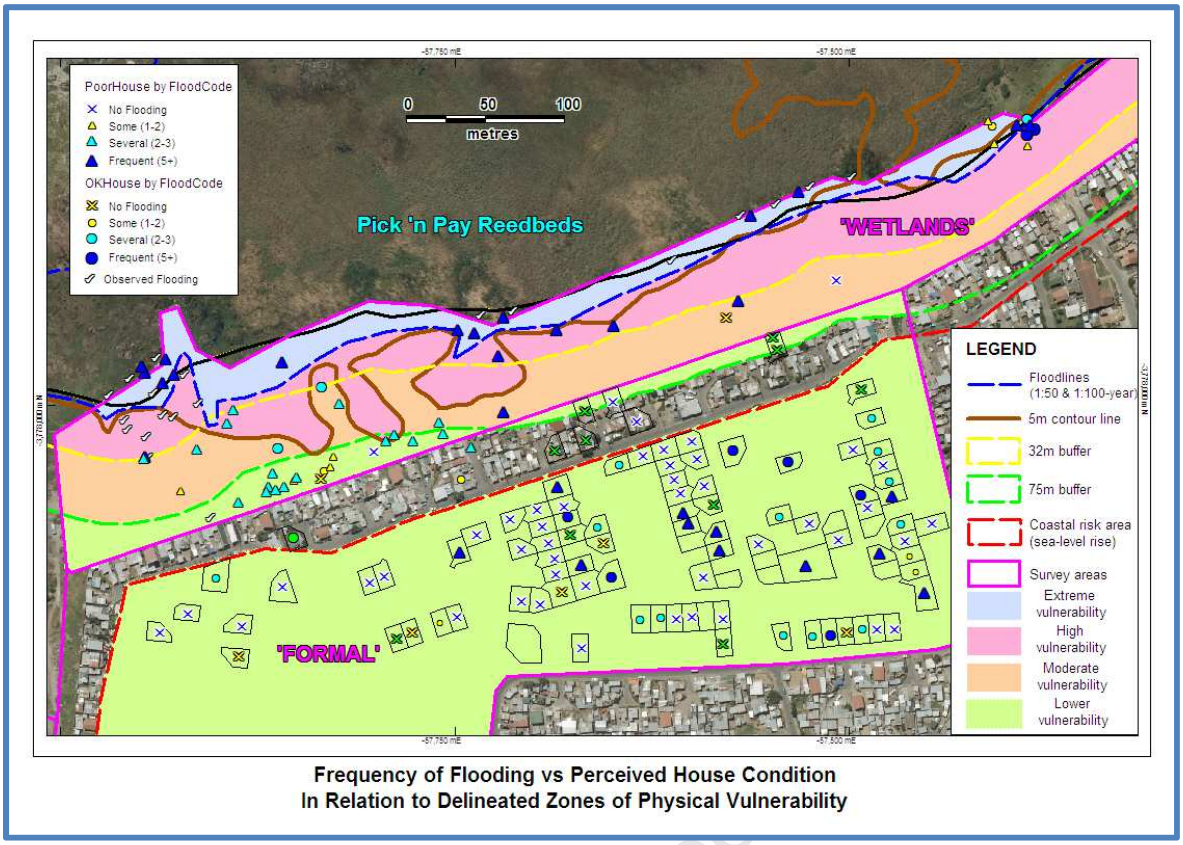


Figure 5.14 Frequency of Flooding *vs.* Perceived House Condition

Poor housing (and physical location) is cited as the main cause of flooding within the Wetlands community of Masiphumelele.

Results from the Phase 1 survey revealed that the most common complaint was inferior housing (64%), followed closely by fires and floods (55%), with slightly less mentioning unemployment (51%). Less problematic areas of concern were drugs, and lack of services. Of those interviewed, at least 80% of the households who experienced flooding also indicated that they believed their homes to be of an inferior quality.

Survey area	Flooding	No flooding
Formal	10%	67%
TRA	18%	11%
Wetlands	72%	7%
% Total of Households Surveyed	**78%**	**22%**

Table 5.8 Flooding vs No Flooding by Survey Area

78% of all those surveyed have experienced flood related incidents.

An alternative question related to the suitability of homes to severe weather conditions was also posed in the questionnaire; findings revealed that households who experienced flooding also perceived their homes to be unsuitable to severe weather conditions. These results therefore support the correlation between flooding and the quality of home. Table 5.9 corroborates the theory that

flooding results mainly because homes are of a poor or substandard quality. The data reveals that 86% of flooding in the Wetlands is a result of substandard housing. Very few homes were considered to be of a good quality (only 3% in total) and despite this claim of the others being of good quality, flooding still occurs in all three survey areas, although to a much smaller extent (2% of the households). The correlation between perceived home suitability and the occurrence of flooding is summarized in Table 5.9.

Perceived home suitability / Occurrence of flooding	Unsuitable	Suitable	% Total by Survey Area
Formal	**38%**	**62%**	**100%**
No flooding	43%	82%	**67%**
Flooding	57%	18%	**33%**
TRA	**91%**	**9%**	**100%**
No flooding	8%	44%	**11%**
Flooding	92%	56%	**89%**
Wetland	**90%**	**10%**	**100%**
No flooding	6%	18%	**7%**
Flooding	94%	82%	**93%**
% Total of All Households Surveyed	**78%**	**22%**	**100%**

Table 5.9 Perception of Home Suitability vs Occurrence of Flooding

This indicates that most homes in both the TRA and Wetlands are unsuitable, whereas in the Formal area, two-thirds of households believe their homes to be suitable. In fact 83% of all housing in the survey areas was perceived as being of a 'poor' quality. This perception is substantially higher in the Wetlands (88%), than the Formal (78%) and TRA areas (69%). 14% of those surveyed in all areas believed their homes to be of an 'adequate' quality and as stated above a mere 3% considered homes to be of 'good' quality. Almost 99% of dwellings that formed part of the survey are constructed out of a combination of wood and corrugated sheeting. Very small percentages (only 1%) are constructed from brick. Only 12% of residents in these areas consider that their living conditions have improved since moving there. Most people however, believe their living conditions have remained the same. A large number of residents (78%) consider their homes to be unsuitable for all weather conditions; problems experienced are predominantly connected with roof leakages and water seepage from underground.

Table 5.10 illustrates the fact that poor housing is one of the major causes of flood-related incidents. Figure 5.15 shows the number of flood related incidents that occur due to poor quality housing.

Flood Frequency / Perceived Home Quality by Survey Area	Some	Several	Frequent	Unknown	% Total by Survey Area
Formal	**33%**	**31%**	**31%**	**4%**	**100%**
Good	19%			50%	**8%**
Adequate	6%	7%	7%		**6%**
Poor	75%	87%	87%	50%	**81%**
Unspecified		7%	7%		**4%**
TRA	**48%**	**13%**	**19%**	**20%**	**100%**
Good	9%		6%		**6%**
Adequate	23%	17%	6%	17%	**18%**
Poor	65%	83%	82%	83%	**74%**
Unspecified	2%		6%		**2%**
Wetland	**30%**	**13%**	**27%**	**31%**	**100%**
Good		2%		5%	**2%**
Adequate	8%	4%	7%	17%	**10%**
Poor	92%	93%	88%	76%	**86%**
Unspecified			5%	2%	**2%**
% Total by Households Surveyed	**33%**	**15%**	**26%**	**26%**	**100%**

Table 5.10 Frequency of Flooding vs Perceived Condition of Home

5.3.3 Number of Flood Mitigation Methods vs Actual Flood Incidents

The data generated indicates that the number of flood occurrences correlate to the number of mitigation methods in place. A third of all households that experienced flooding had no mitigation measures in place. Over half of all households with one mitigation method (of which the most common is the diversion of water), experienced at least one occurrence of flooding. The households with two or more methods of flood alleviation (13%) experienced significantly lower flood-related incidents. Flood mitigation measures are being attempted by many residents from both the Wetlands (73%) and TRA areas (79%); a small portion of those living in the Formal areas also have some form of flood alleviation methods in place (21%). Survey data revealed that in spite of residents implementing at least one flood mitigation method, at least two-thirds of the respondents from both the TRA and the Wetlands still experienced flooding.

It must also be considered that residents of the TRA have recently been relocated from other areas of Masiphumelele (predominantly from the 'School Site' area). These households might actually be reporting incidences of flooding within this site prior to being relocated to the TRA, though this is not known for certain. Figure 5.16 illustrates that large numbers of households do in fact attempt at least one mitigation method.

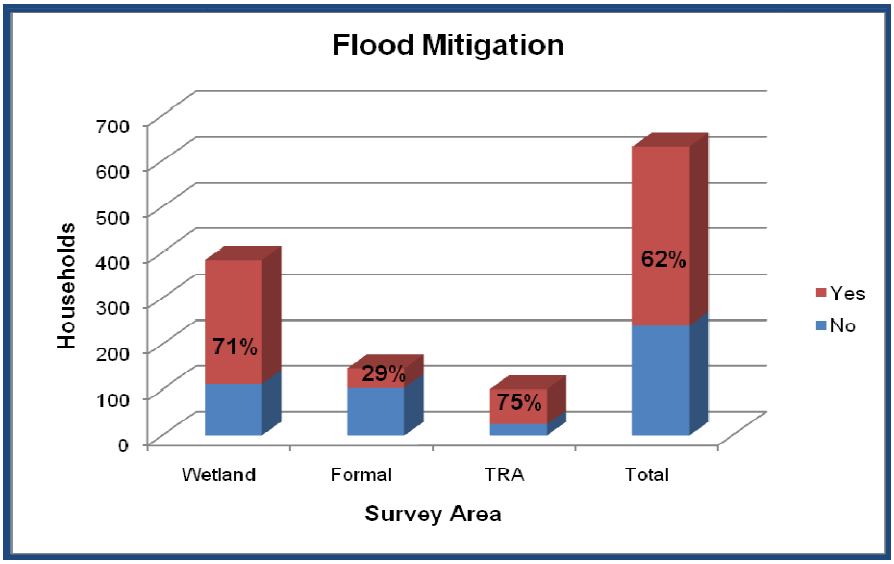


Figure 5.15 Number of Households who attempt Flood Mitigation

Almost two-thirds of residents have at least one method of flood alleviation in place.

The most common methods of alleviating flooding as cited by residents in the questionnaires were, in order of prevalence, the following:

a) Diversion of water by digging channels (47%)

b) Improvement of homes (39%)

d) Laying concrete onto floors (8%)

e) Raise homes using stilts (4%)

A number of 'temporary' measures during times of flooding were also utilised in the community, the most notable being, staying with family, friends or in community centres (12%). These methods were not classified as a mitigation method *per se*, but rather an interim relief measure.

Figures 5.16 and 5.17 show two mitigation methods utilised by this community.

Figure 5.16 Example of Mitigation Methods

Diverting water by digging channels.

5.17 Examples of Mitigation Method

Raising home by using stilts.

5.3.4 Perceived Flood Risk vs Actual Flood Incidents

Table 5.11 summarizes the perceived risk of flooding versus the actual occurrences of flooding. The perception of risk to flooding appears to be generally higher in the Wetlands area compared to both TRA and Formal areas. Almost two-thirds of households within the Wetlands believe they are at risk to flooding, compared with just over half of those in the Formal and TRA areas. The data indicates that the majority of the households questioned are aware of the dangers of flooding. There are however, some interesting inconsistencies; of those who feel they are at risk to flooding in the Wetlands (66%), almost all of them had experienced flooding at some point (93%).

Perceived risk / Actual occurrence	Formal	TRA	Wetlands	% of Total Households
No flooding	**67%**	**11%**	**7%**	**22%**
Not at risk	98%	100%	92%	**21%**
At risk	2%		8%	**1%**
Flooding	**33%**	**89%**	**93%**	**78%**
Not at risk	17%	38%	27%	**23%**
At risk	83%	62%	66%	**55%**
Total & of Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.11 Perception of Flood Risk to Actual Flood Occurrences

More than half of all households surveyed within the TRA regard themselves to be at risk to flooding, yet almost 90% reported incidences of flooding. These inconsistencies, in the Wetlands and TRA point to the fact that either residents may not understand the concept of risk or that they may not have the knowledge to the fact that they may be vulnerable to flooding. In the Formal area

by contrast, over 80% of those surveyed feel they are at risk, yet only 33% of them had experienced flooding.

5.4 Other Socio-Economic Indicators of Flood Vulnerability

A number of other indicators were important determinants of vulnerability to flooding, these included the population structure (number of children and the elderly in particular) and gender distribution (number of males *vs* females); employment and monthly income (including social grants) and access to basic services (such as potable water, sanitation facilities and health facilities).

5.4.1 Population Structure

The population surveyed was fairly evenly distributed by gender throughout the three areas. Males comprise slightly higher proportions in the Wetlands (53%) compared with females (47%), whereas females have slightly higher proportions in the Formal (51%) and TRA (51%) areas. 66% are adults (18 to 64 year age category), and 30% are children (of which 18% are younger than 13 years of age and 12% are between 12 and 17 years of age), while those aged 65+ years constituted a mere 4% of the population. Table 5.12 shows the percentages of males and females and 5.13 shows the population distribution by survey area.

Gender	Wetlands	Formal	TRA	% Total by Gender
Male	53%	49%	49%	**51%**
Female	47%	51%	51%	**49%**
% Total by Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.12 Gender Distribution by Area

Males slightly outnumber females in the Wetlands

Age Category	Formal	Wetland	TRA	% Total by Households Surveyed
0-12	8%	23%	11%	**18%**
13-17	14%	11%	15%	**12%**
18 - 64	74%	62%	72%	**66%**
65+	4%	4%	2%	**4%**
% Total by Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.13 Population Distribution by Area

30% of the estimated population are children (<18 years)

The data shows that there are a high percentage of households with at least one child (67%). The highest percentage of households with children was found in the TRA (74%), followed by the

Wetlands (70%). The Formal area indicated a relatively low percentage of households with children compared with the other two areas (57%). (Refer to Table 5.14)

Percentage of Children per Area				
Children in Households	**Wetlands**	**TRA**	**Formal**	**Total % of Households**
Children	70%	74%	57%	67%
No Children	30%	26%	43%	33%
Total % of Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.14 Percentage of Children per Area

Higher percentages of children are resident in the TRA and Wetlands compared with the Formal area.

5.4.2 Employment and Living Expenses

The overwhelming majority of households earn less than R1 500 per month (79% of all areas combined); with Wetlands comprising 44%, Formal 21% and TRA 14%. Only 3% of households earn more than R3 000 per month. A higher proportion of residents from the Wetlands earn less than R500 per month (20%) compared with both the Formal (7%) and TRA areas (18%). Figure 5.15 gives the monthly income breakdown per income category and survey area.

Monthly Income (% by Survey Area)				
Income Level	**Wetlands**	**TRA**	**Formal**	**% Total of Households Surveyed**
0-499	20%	18%	7%	**16%**
500-999	24%	19%	34%	**26%**
1000-1499	34%	39%	41%	**37%**
1500-2999	19%	22%	16%	**19%**
3000	4%	3%	1%	**3%**
% Total by Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.15 Monthly Income per Area

The majority of residents earn between R 500 and R1 500 per month

Of those who were surveyed, 24% of households received some type of social grant. The child support grant was the most common (17%), followed by pension (3%) and disability (2%). 14% of households who receive grants are in the income category R 0 – R 499. 34% receiving grants did not specify which income category they belonged to, and of those, 29% said they were not

working, meaning that social grants are their only source of income. The percentages of grants received and the types of grants are tabulated below in Tables 5.16 and 5.17.

Social Grant	Wetlands	TRA	Formal	% Total of Households Surveyed
No	78%	70%	76%	76%
Yes	22%	30%	24%	24%
% Total by Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.16 Social Grants Received

Approximately ¼ of those surveyed receive social

Type of Grant	Wetlands	TRA	Formal	% Total of Households Surveyed
Child Support	81%	73%	49%	**72%**
Disability	4%	10%	9%	**6%**
Pension	9%	7%	20%	**11%**
Refugee	1%	3%	9%	**3%**
Unspecified	5%	7%	14%	**7%**
% Total by Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.17 Type of Social Grants Received

Child Support is the most common grant received by residents.

Although not all households specified directly as to how many people were employed within the household, other questions inferred that at least one member of the household have some form of employment. The following questions, '*Is the job full-time; part-time or are you self-employed'?; 'Is the job close to Masiphumelele?'; 'What type of transport do you use when going to work and how much does it cost you to travel to work per day?'*, all have a reference to employment and if any of these were answered affirmatively, employment of some form was presumed. Based on this assumption, 94% of those households surveyed, indicated that they had some form of employment. Of the households surveyed, there was a tendency for only 1 person to be working (76%). 20% of households reported 2 people working and only 4% of households indicated that 3 or more people were employed. Of those who were employed, 64% indicated that their work-place was far from their home, spending on average R44 per day for taxi and train costs.

Of all those interviewed during Phase 1, 37% claimed to be fully employed; 33% worked part-time while only 4% were self-employed. A third of those interviewed were employed as domestic servants doing housework and babysitting (33%) and gardening (11%). Others were employed in construction (18%), retail (16%) and security (9%). It is notable however, that a very small percentage of those who were employed fell into the category of civil servants (1%) or tourism.

Similarly very few fell into the category of 'white collar' or professional workers. Figure 5.18 displays the distribution of employment type.

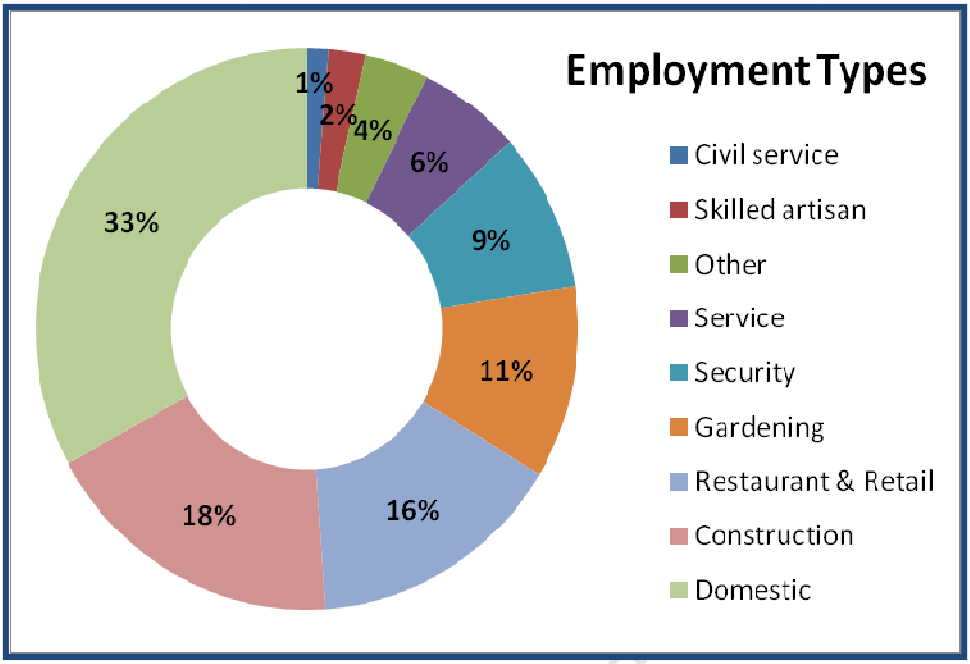


Figure 5.18 Employment Types

Most people are employed in the domestic, construction and retail

The total monthly income without grants was calculated by taking the median of each income bracket (for example, for the income bracket of R0 – R 499 per month, a figure of R 250 was used). If the type of grant was known, these amounts were summed together with the total monthly income, to obtain the total monthly income with grants. These figures were then averaged across the surveyed population to obtain the average monthly income without grants and the average monthly income with grants. Table 5.18 shows the calculated weighted average monthly income against the weighted average monthly expenditure.

Weighted Average Monthly Income vs Weighted Average Monthly Costs		
Average Income without grants	**Average Income with grants**	**Average cost per month**
1 194	1 259	1 893

Table 5.18 Weighted Average Monthly Income *vs* Weighted Average Monthly Costs

Average income without grants is slightly less than income grants. Average costs are slightly higher than income.

5.4.3 Water, Sanitation and Health

The data shows that sanitation facilities in this community are considered poor by the majority of residents. Interestingly, although almost all of those canvassed in the Formal areas claim to have access to a house toilet (97%); almost 90% consider them to be inadequate, despite the fact that there are less than 10 people per toilet. In comparison, most residents from the Wetlands have only access to communal toilets (83%), and over two-thirds of those questioned, share these facilities with at least 10 others, and in many cases many more (some respondents stated that they shared the facilities with upwards of 50 or more). The communal toilets facilities are considered inadequate by 77% of Wetland residents. Although 88% of TRA residents use communal toilets, almost half consider them adequate. The levels of satisfaction in the TRA are considerably higher than elsewhere, presumably a function of the fact that this area was adequately planned in advance. An example of communal toilet facilities (in the Wetlands) can be found in Figure 5.19; while Figure 5.20 illustrates the number of toilets per person.

Figure 5.19 Toilet Facilities in Wetlands area

Most residents are dissatisfied with the toilet facilities

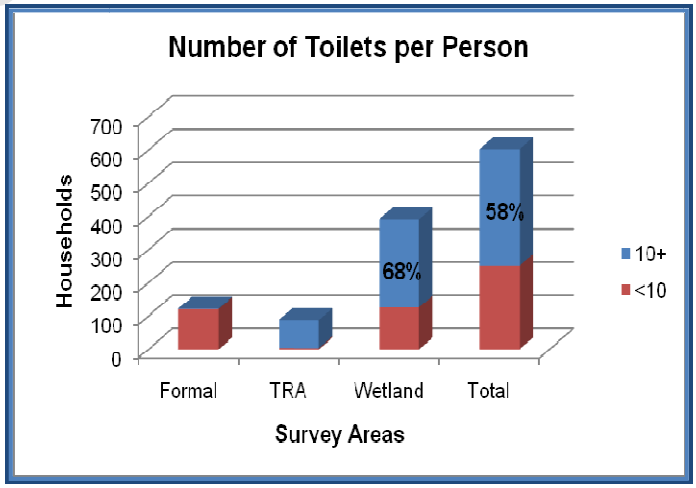


Figure 5.20 Numbers of Toilets per Person

68% of Wetland residents share toilets with 10 or more people.

Potable water for almost all of the residents of the TRA and Wetlands comes in the form of communal standpipes, 100% and 96% respectively. In contrast, the Formal area has little need for standpipes being serviced predominantly by house taps. Table 5.19 summarises the responses by area, to the question related to access to potable water. An example of a communal standpipe can be found in Figure 5.21.

Potable Water

Water Source	Wetland	TRA	Formal	% Total of Household Surveyed
Communal Standpipe	92%	100%	18%	**76%**
House Tap	4%		74%	**19%**
Unspecified	4%		8%	**5%**
% Total % by Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.19 Potable Water Sources

Almost all the residents of TRA and Wetlands rely on communal standpipes, as shown in Figure 5.21.

In the Wetlands, approximately 5 stand-pipes at 150m apart were counted using the aerial imagery (which calculates to over 1 000 people per stand-pipe).

Figure 5.21 Communal Standpipe

A typical standpipe in the Wetlands, This standpipe is adjacent to a rubbish-clogged drainage channel.

Rubbish is collected at least once a week, according to just over three-quarters of Wetland residents and the majority of residents from both the Formal and TRA areas. The level of satisfaction on the regularity of rubbish collection is much higher in the Formal area than elsewhere, the majority of residents in the Wetlands and TRA being dissatisfied with the current level of service (refer to Table 5.20) Only one communal refuse 'skip' was found in the Wetlands (see photograph in Figure 5.22).

Level of Satisfaction with Rubbish collection	Wetlands	Formal	TRA	% Total of Households Surveyed
Satisfied	26%	76%	13%	**36%**
Dissatisfied	74%	24%	87%	**64%**
% Total % by Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.20 Frequency of Refuse Collection

68% of Wetland residents share toilets with 10 or more people.

From the data collected, it is evident that the community as a whole is prone to diseases. Approximately a quarter of the residents of all survey areas have at some time contracted a water-borne illness. Tuberculosis (TB) and associated illnesses are particularly significant in the Formal area, with 62% having contracted them. The percentages for TB in both the Wetlands and TRA are relatively high, (49% and 34% respectively). Also notably in the Formal and TRA areas is the high occurrence of 'other' illness; these include *inter alia* influenza, diabetes, diarrhoea and rashes. The following tables (Table 5.21 and 5.22) give summarize the health status of this community.

Figure 5.22 Rubbish Collection Point in Masiphumelele

One rubbish collection point services the whole Wetland area.

Illness	Wetlands	TRA	Formal	% Total of Households Surveyed
Illness	70%	92%	93%	**79%**
No Illness	30%	8%	7%	**21%**
% Total by Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.21 Community Health Status

The statistics reveal a high percentage of illnesses in this community.

Illness	Wetlands	TRA	Formal	% Total of Households Surveyed
Waterborne (Cholera / Typhoid)	35%	32%	27%	**32%**
TB	53%	26%	50%	**47%**
Hepatitis	1%	2%	2%	**1%**
Other	11%	40%	20%	**19%**
% Total by Survey Area	**100%**	**100%**	**100%**	**100%**

Table 5.22 Community Health Status

The statistics reveal a high percentage of illnesses in this community.

Figure 5.23 Homes in Masiphumelele built close to drainage channel

The ill health of the community is reflected in the statistics; many complain of water-borne diseases (at least 25% in all survey areas).

Access to health facilities appear to be limited to a Clinic (located within Masiphumelele), with 80% of all residents having access to this service. The satisfaction levels associated with health facilities is low in the Wetland area and high in the Formal area. Over half of those surveyed in the TRA are dissatisfied with the service provision.

Access to emergency services is for most residents not possible. Very few residents say they have access to either a general practitioner or family planning services. The ill health and lack of services accessible to this community are justified by the statistics.

5.5 Summary

Results of survey data indicated that there is a correlation between the physical location and the level of vulnerability to flooding. There is also a link between the quality of homes and the number of flood-related incidents. Despite large numbers attempting at least one method of flood mitigation, flooding was still an issue. In calculating new population estimates, it became evident that the ratio of people per hectare was also high and therefore also an extenuating factor of the higher vulnerability levels, particularly in the Wetlands. A wealth of socio-economic statistics corroborated the fact that vulnerability to flooding is increased by low income levels, unemployment and ill health. Suitable sanitation in the Wetlands was found to be lacking and a relatively large amount of people complained of having contracted a water-borne disease and associated illnesses.

In Chapter 6 a more comprehensive analysis of the vulnerability to flooding is discussed incorporating both political and socio-economic information collected during the course of this study.

CHAPTER 6

DISCUSSION

"The difference between what we do and what we are capable of doing would suffice to solve most of the world's problems"

~Mahatma Gandhi ~

This chapter discusses vulnerability more comprehensively, in terms of institutional, social and environmental parameters. Comparisons with other literature are also made; this is discussed using other vulnerability case-studies as well as vulnerability theory. The concept of successfully utilizing local participants in acquiring the best possible research data is also discussed, including the pros and cons of local participation. In addition, the weakness of the existing data sets and the possibility of improving them are examined.

6.1 Application of BBC Vulnerability Framework

The BBC framework, a basis for this study, incorporates three aspects of vulnerability, namely intervention tools, susceptibility and coping capacity (Bogardi and Birkmann, 2006 and Bogardi and Birkmann, 2004). Table 6.1 summarises the parameters used in this study to assess these three aspects of vulnerability. The framework emphasises two ways of reducing disaster risk and vulnerability; a) by using preventative measures and b) by disaster management. Although it acknowledges that both are necessary, more emphasis is placed on preventative measures and taking the necessary action before a disastrous event. It is widely accepted that investing in mitigation and preparedness return greater profits than investing in relief and recovery (Bogardi and Birkmann, 2006). This study therefore focused on the Phase I stage of the disaster cycle (Table 6.2 highlights the three phases of the disaster cycle). Since flooding is already considered a problem in Masiphumelele, Phase III is also addressed.

SUSCEPTIBILITY	INTERVENTION TOOLS	COPING CAPACITIES (Resilience)
• Impact of flood on household members and assets • Structure of household • Housing conditions and impact of flooding • Direct losses of possessions	• Relocation of housing and infrastructure (inland) • Early warning systems • Buffer zones (implemented by the Government) • Evacuation of people	• Social networks • Knowledge about flooding • Financial support from formal and informal agencies • Access to information

Table 6.1 Parameters employed to assess three aspects of vulnerability to flooding

Source: Birkmann *et al.* 2007

The framework also considers the concurrent examination of other threats and their role in relation to vulnerability; these could include military conflict and xenephobia. Research conducted by Birkmann, in 2008, concluded that it was also crucial to assess vulnerability differently in the various phases of natural disasters (Birkmann, 2008). Another important conclusion reached, was that promoting disaster resilience was often difficult when low-frequency everyday risks, like unemployment, become more important than the risks from potential hazards like flooding.

PHASE I – BEFORE	PHASE II - DURING	PHASE III - AFTER
• Dependency ratio • Exposure • Housing standard • Poverty level • Education level • Level of preparedness	• Access to land • Access to disaster aid • Social network • Job-diversity • Access to credits	• Access to markets • Access to social and physical infrastructure • Ability and willingness to prepare for natural hazards • Wider circumstances (*eg.* conflict)

Table 6.2 Vulnerability Assessments During the Three Phases of the Disaster Cycle

Source: Birkmann, 2008

The framework also considers the importance of assessing vulnerability in terms of the overlap between the social, environmental and economic resources. Based on this, the framework therefore also considers sustainable development to be an important aspect in this assessment of vulnerability.

Social vulnerability is complex and transformations based on population size, economic conditions and social characteristics are its major driving forces; another feature is that it also changes over time (UNESCO, 2009). Factors such as age, income, health and education all influence the physical and economic conditions of an individual. Those households lacking financial capital and resources are more likely to be vulnerable. As is indicated in the surveys of Masiphumelele, vulnerability to flooding in informal settlements not only results from physical parameters, such as proximity to water bodies and poorly constructed housing but also arises from socio-economic circumstances, complicated further by historical and political influences. Informal settlements are proof of inadequate government housing strategies and high unemployment rates. Education levels, access to early warnings, and access to resources that could build resilience are also important facets of disaster risk reduction. Research has also shown that those considered most vulnerable are often from women-headed households, children, those with disabilities, the elderly and ethnic minorities, though this is not true in all situations (Zou and Thomalla, 2008). The study of existing vulnerability research in Asia however, revealed that assessing the underlying causes of vulnerability, in particular poverty, was noticeably absent (Zou and Thomalla, 2008). Current recommendations in the literature do not address the underlying systemic causes of vulnerability, especially poverty.

6.2 Susceptibility and Degree of Exposure affects Vulnerability

As shown in Chapter 5, there is overwhelming evidence from the quantitative GIS analysis to suggest that certain areas of Masiphumelele are more vulnerable than others. This higher level of vulnerability is due to physical location. Preferably, planning in flood susceptible areas should aim to prevent the amplification of existing flood risks resulting from further development (WMO, 2008). This notion is however not often practical in cities that have limited available land or high population growth where it is often difficult to avoid such increase in flood exposure. Delineation of zones to identify the degree of exposure is therefore an essential for future urban development.

Building regulations are also a means of decreasing the physical vulnerability of homes and therefore people (WMO, 2008). Building regulations provide mandatory advice on how to construct flood-resistant homes; they give an indication on appropriate construction materials and building methods. The enforcement of such building regulations, particularly in informal settlements is often inadequate or non-existent. In addition, land-use policies also influence the degree to which certain communities will be more vulnerable than others. These policies that aim to reduce the degree of exposure can be implemented in a number of ways, these are summarised below (Burby, 2000).

1. Restrictive Regulation (by relocation policies, enforcement of existing laws and guidelines)
2. Economic Incentives (lower taxation for correct use of land; higher taxation for incorrect land uses)
3. Risk Awareness (information about flood risks and awareness campaigns)
4. Investment in Infrastructure (purchase property, locate public facilities outside floodplain)

As Masiphumelele is predominantly a high-density residential area, therefore, point 2 of the above list is not relevant to this discussion. However, the other three points are relevant. Laws and guidelines restricting building in high-risk areas should therefore need to be applied in Masiphumelele. Risk awareness is clearly an important factor in the reduction of risk. Seemingly, the information about risk awareness is clearly lacking in this settlement. Investment from both government and private sector in less vulnerable areas has already occurred in Masiphumelele, notably, schools, a library and the Amakhaya Ngoku housing project (see Appendix V for more details on this initiative).

In Masiphumelele, these delineated zones essentially define the residents' degree of exposure to flood risks, based on its position to the Pick 'n Pay Reed Beds and the coast. These delineations include the areas below the flood lines, the minimum and maximum wetland buffer areas (32m to 75m) and the coastal risk zone. The entire TRA and Wetlands area (and a small portion of the Formal area) fall within this coastal-risk zone and subsequently are also vulnerable to sea-level rise

resulting from climate change. Although still in its infancy, research and debates around climate-change and its threats have been afforded more attention worldwide recently.

Based on these delineations, the Wetlands have varying levels of vulnerability The study revealed that 60% of those residing in the Wetlands have either extremely high or high levels of vulnerability, 32% of Wetland residents have moderate vulnerability and only 8% of Wetland residents have relatively lower vulnerability. This factor is a direct result of the low-lying land and the fact that portions of the settlement resides within the recommended wetland buffer area. Delineations in context to flood risk in Masiphumelele has been represented schematically in Figure 6.1 to show the implications of the physical vulnerability of residents located there.

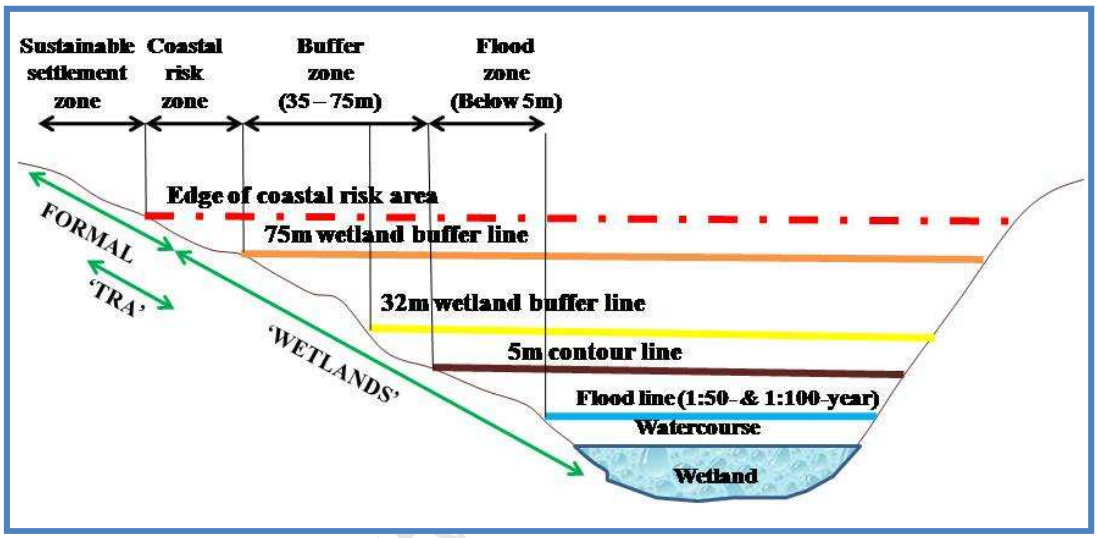


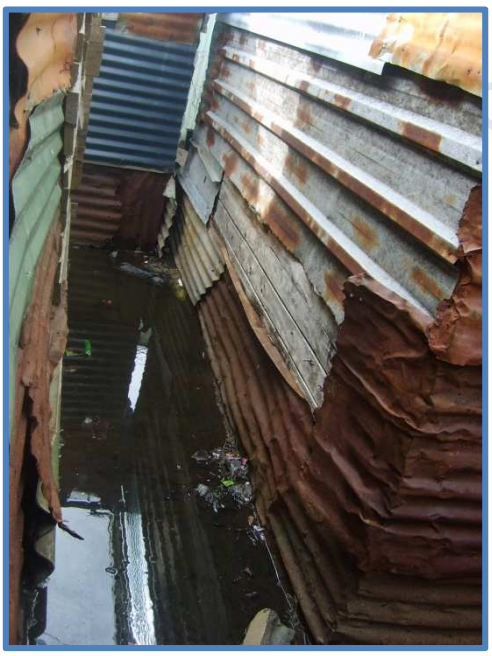
Figure 6.1 Schematic Buffer Zones in Masiphumelele

Ideally the sustainable settlement zone should lie beyond the coastal risk and various flood buffers

Not only is the degree of exposure a factor in vulnerability assessment, but the state of the drainage infrastructure also has an influencing effect. In functioning urban drainage systems, which includes channels, culverts, and sewers, local floods are prevented by moving storm-water away from vulnerable area. This is done with the aim of draining storm-water as fast as possible out of populated areas (WMO, 2008). If however populated areas upstream of other riverside settlements drain storm-water too quickly, this may cause urban floods downstream (WMO, 2008). The cleaning and maintenance of drainage facilities should therefore be an essential part of any flood-risk management policy.

Clogged drainage is a feature of the Wetlands in Masiphumelele, evident from photographs taken during transects walks (see Figure 5.5). Drainage in the Wetlands is in the form of open channels which lead directly into the wetlands. Spatial data from the City of Cape Town shows that adequate underground drainage infrastructure stops at the boundary of the Formal area.

There are various types of flooding in the Western Cape; these are amongst others, coastal or marine; riverine and estuarine; surface run-off, ponding, seepage and leakage (Holloway *et al*, 2008). Seepage, also known as 'rising flood' results in areas with high water tables, a feature of Masiphumelele and certain areas of the Cape Flats, in Cape Town. Ponding is a result of rain water standing in low-lying areas with poor drainage. Leakage is a direct consequence of poor building practices ((Holloway *et al*, 2008). Estuarine (or riverine) flooding which can take the form of flash flooding is caused by the rapid rising of water levels in waterbodies, including wetlands, due to storm activity. Surface run-off is a pervasive draining of water off surfaces, particularly hardened ones, exacerbated by the absence of proper drainage channels (Holloway *et al* , 2008). In the Phase 1 and Phase 2 surveys of Masiphumelele, flooding is experienced by residents, results from a combination off all of the above mentioned factors. In Phase 2 for example, over half of respondents, reported to have experienced complete inundation of their homes. Yet others indicated that either seepages from underground or leakages from both walls and ceilings were perceived to be the major cause of their flood-related problems. This factor provides an indication of housing that is not only poorly located but also inadequately flood-proofed. Additional evidence of ponding was also noted from the various transect walks (See Figure 6.2 and 6.3 for photographs of ponding in Masiphumelele).



Figures 6.2 and 6.3 Examples of Ponding in Masiphumelele

Two of numerous examples of ponding, a direct result of inadequate

6.2.1 Physical Mitigation Methods

Effective flood-proofing involves modifying the design of buildings to reduce flood damages and can include long-term permanent measures and contingency or minor structural measures to mitigate the effects of flooding (ADPC, 2005). The SEI/ASCE (2000) in their design standard

provides minimum requirements for flood-resistant design and construction of structures located in flood hazard areas.

The following are the main methods of flood proofing that may have application to Masiphumelele.

- Relocation: movement (sometimes temporary) of residents away from the flood-prone area.
- Elevation: raising the building above the flood level by piles or wooden stilts, as is common in Southeast Asia, land-fill, or making basements water tight.
- Flood walls: careful installation of concrete or steel walls to keep-out or divert flood waters.
- Dry flood proofing: sealing the property to prevent flood water from entering using waterproof sheeting and sandbags. Figure 6.4 gives a local example of sandbag housing in Masiphumelele.

Figure 6.4 Example of a Sandbag house being constructed in Masiphumelele
Source: Eternally Solar, Earthbag Housing

SANDBAG HOUSING

An innovative construction technique, which has been demonstrated already in Masiphumelele and has been used very successfully elsewhere in Africa, is the use of earth or sandbags filled with earth or sand as construction materials, inside a wood framework. Walls are covered by traditional mud-based plaster. It is possible with this technique to build better quality houses cheaply and quickly, by using ecologically sound and natural materials. They are environmentally, economically and socially sustainable, with low impact, low cost and create local jobs, whilst encouraging community participation.

- Demolition: demolishing a damaged property and rebuilding it more securely on the same site on a raised foundation.

There are several practical limitations with flood proofing. Firstly, flood proofing is not suitable in areas subjected to fast moving water (ADCP, 2005, UNESCO, 2009). The costs involved in land filling or reclamation, in informal settlements in particular, are often prohibitive, often caused by shortage of suitable local fill material (ADCP, 2005, UNESCO, 2009). Flood proofing may also cause further flooding problems, for example dykes may reduce the infiltration of the given area, but may also divert flood waters causing flooding elsewhere (ADCP, 2005, UNESCO, 2009).

In Masiphumelele, residents do show they have the ability to alleviate to a certain extent the physical effects of flooding, as can be seen by numerous flood-mitigation methods attempted by many in both in the Wetlands and TRA (over 70% have at least one method in place). Apart from putting plastic sheeting onto roofs, (plastic sheeting is provided for this purpose by the City of Cape Town) other methods of mitigation provided by individuals, included the provision of plastic

linoleum for use on the floors and in some cases the provision of cement to mix with sand to screed the floors. In addition residents use any sort of material they can find to push into leaking walls and ceilings. Diversion of the water during the wetter winter months is also attempted by some, though this temporary method is somewhat ineffective during heavy rains when water levels become too high for there to be any effect.

The survey indicated that not only is the physical location of dwellings a potential dilemma, but the type of material and method of construction of these dwellings are also cause for concern. The survey also revealed that mitigation methods, like diverting water by digging channels (a temporary measure) are erratically undertaken and ineffective in the long-term. Few residents appear to attempt to raise-up the floor level of dwellings, though according to some, raising structures, such as shacks, below the 5m contour above sea-level has been found to be an inadequate flood alleviation method as the ground is saturated (Roets-Wietche and Duffel-Canham, 2009). This method has however been successful in many Asian countries in alleviating flooding. A good example is the 'Handbook on Design and Construction of Housing in Flood-Prone Areas of Bangladesh' (ADPC, 2005). This is a very comprehensive self-help guide written for local people, with practical instructions on issues ranging from the construction of cheap but effective guttering to building raised foundations. No comparable examples have been identified that covers African conditions and culture. One example of a flood mitigation strategy found to be effective in Bangladesh was the 'do-it-yourself' guttering technique, illustrated in Figure 6.5.

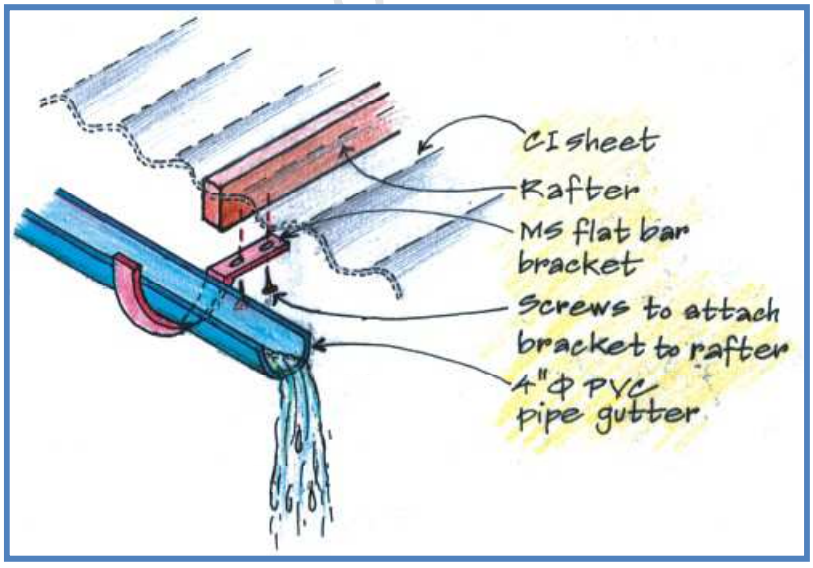


Figure 6.5 Example of do-it-yourself guttering

Source: Handbook Handbook on Design and Construction of Housing for Flood-prone Rural Areas of Bangladesh

What is of equal concern is the ineffective influence of institutions and policy on the vulnerability of those residing in informal settlements (Kasperson *et al*, 2005). Institutional policies not only affect the social capacity of communities, but their economic capacity too and in turn their poverty levels. Poverty levels and hazard vulnerability are linked and jointly strengthening leading to

situations where the poor have few options but to exploit environmental resources (such as occupying unsuitable areas of the wetland) as a means of survival (Kasperson *et al*, 2005).

6.3 Institutional Influences to Vulnerability Levels

A country's history and institutional policy, influenced from international, national and local levels, often dictates to what degree individuals and communities are vulnerable and continue to be vulnerable. In South Africa, informal settlements grew rapidly from the mid-1980s following the relaxation of influx controls that aimed to inhibit black Africans from settling into towns (Hunter, 2006). The numbers of residents increased further in the late 1990s and early twenty-first century due to legal and illegal migration. According to government statistics (census 2001 data), the number of shack dwellings in South Africa rose from 1,45-million in 1996 to 2,14-million in 2003, averaging 296 shacks per day, during the seven year period (Mail & Guardian, 2006). Table 6.3 illustrates the predicament of informal settlements in the Cape Town area.

Informal Settlement Statistics - Cape Town	
Inadequate housing	30% (approx. 1 million)
Number of Settlements	230 – 250
Informal + Backyard (in formal areas)	270 000 – 400 000
High density	140 homes per ha (or 476 people per ha)
Low density in the rest of Cape Town	1 154 people per km^2 (or 12 per ha)
Influx from Eastern Cape per annum	48 000 (7 700 households)
Increase in housing backlog	23 000 (1993) - 128 000 (2008)
Poverty levels have doubled over the last 10 years.	

Table 6.3 Informal Settlement Statistics Cape Town

Source: The Water Dialogues Synthesis Report, 2009 - Cape Town Case Study

Around 30% of people in Cape Town are living in inadequate housing, predominantly in informal settlements. Most residents of these settlements originated from poverty-stricken rural and urban areas of the Eastern Cape, and moved to Cape Town, in the expectation of finding jobs and an improved standard of living (as is the case in Masiphumelele). Unemployment rates have continued also to rise as a result of this urbanisation. Refugees fleeing from political turmoil in neighbouring countries, for example the Democratic Republic of Congo and Zimbabwe, of necessity migrate to informal settlements where they have no other option but to live in poverty. Tensions between

these migrants and local communities can often result in conflict, as witnessed by the xenophobic tensions in Masiphumelele in May 2008 (Umvoto, 2004). More than 6% of those surveyed in Masiphumelele were migrants from neighbouring countries. Although a minority group, vulnerability in this sector can be considered high.

Notwithstanding the increase in those migrating to informal settlements, there has been a subsequent decline in the average household size from 4.3 in 1995 to 3.8 in 2002 (Pirouz, 2004). Statistics from Masiphumelele reveal that numbers in households have reduced even lower (between 3 and 3.5 per household). This factor indicates that smaller and single occupancy households are becoming prevalent. In the Wetlands, almost 60% of all households surveyed had between 1 and 3 people per household of which 27% of these households were exclusively female.

Statistics from shack count data for Masiphumelele indicate that between 2003 and 2008, the percentage increase in shacks in the Wetlands was 275%. The increase can be attributed mainly to an influx of Xhosa-speakers from the Eastern Cape (72%); mostly in search of employment (80%) or to be closer to other family members (13%). A significant percentage also moved to Masiphumelele from other areas of the Western Cape (16%) in search of better living conditions.

A particularly significant initiative in relation to informal settlements and vulnerability are the Millennium Development Goals (MDGs). In the year 2000, South Africa, together with many other nations agreed to make efforts to achieve a set of 8 United Nations Millennium Development goals by 2015(United Nations, 2000). The goals of most relevance to informal settlements are those concerning poverty and environmental sustainability; specifically those targets outlined in Table 6.4 (Other recent initiatives relating to informal settlements are presented as Appendix I).

According to the World Health Organisation's guideline review committee, South Africa is falling behind in reaching most of its targets for the United Nation's Millennium Development Goals (MDGs) (www.polity.org.za). With less than five years to go before the 2015 MDG target, reaching the targets seems implausible for South Africa, as well as the African continent as a whole. The consequence to this being that poverty is not being alleviated at the required rate, which is adversely affecting the reduction of vulnerability for poor people living in informal settlements. In an address to members of the European Union and South African legislative sector in Cape Town during March 2011, Planning minister, Trevor Manuel was quoted as saying "*We must accept that despite the adequate allocation of funding, we fail to deliver quality services, especially to the poor,"* (Timeslive, 2011).

Millennium Development Goals (MDGs)		
Target	**Aim**	**Description**
Poverty: Target 1	To halve the proportion of people whose income is less than one US dollar a day (approximately R7) by 2015	• Proportion of population below US$1 per day • Poverty gap ratio • Share of poorest quintile in national consumption
Environmental Sustainability: Target 3	Reduce by half the proportion of people without sustainable access to safe drinking water and basic sanitation.	• Proportion of population using an improved drinking water source. • Proportion of population using an improved sanitation facility
Environmental Sustainability: Target 4	To achieve significant improvement to the lives of at least 100 million slum dwellers, by 2020	• Proportion of urban population living in slums. (in conjunction with poverty levels of a particular country)

Table 6.4 Millennium Development Goals in Relation to Informal Settlements

The MDGs include three specific targets that relate to poverty and environmental sustainability.

In South Africa, the 2002 'Grootboom judgement' became internationally acclaimed; it dictated that local authorities had a duty to provide communities with temporary accommodation and sanitation, basic services, and running water (Graham, 2004). The Grootboom judgement marked a turning point in the City of Cape Town's attitude towards informal settlements. Basic servicing of existing settlements is now not only a legal obligation, but was in-step with the political agenda expounded by the African National Congress (ANC) when it won control of the City Council in 2002. Although the City had already provided basic services in many informal settlements, the process only started as a planned strategy across the city in 2004 (Graham, 2004).

The aim of the Emergency Servicing of Informal Settlements project (ESIS), in accordance with the City's *Framework for Upgrading Informal Settlements* was to provide basic services (water, sanitation and refuse removal) to all informal settlements within the city (as cited by Graham, 2004). During this project, informal settlements were classified into two divisions; those that could be upgraded and those that could not due to their physical setting (*i.e.* floodplain or landfill sites). Those in the latter category were allocated 'temporary' emergency services. Settlements considered suitable for upgrade were meant to receive full services and tenure rights during the second phase of the ESIS project, with formal housing being completed in the final phase. The Wetlands of Masiphumelele therefore were afforded only temporary emergency services, meaning that the area is unsuitable for upgrade; the implication being that residents would ideally need to be re-located to an alternative location.

Phase 1 and 2 surveys revealed that not only is basic sanitation lacking, but what is there, is perceived to be poor in quality. Illnesses are prevalent in all three survey area, including water-borne illnesses. This emergency sanitation is generally unable to adequately service the needs of

the residents; toilets' discharges are often blocked and there are not enough toilets to service the whole community. During the Phase 2 community mapping exercise in Masiphumelele, available sanitation-infrastructure information was recorded in the Wetlands and TRA. The results of the exercise, together with verification from aerial imagery, indicated that approximately 54 toilets are available in the Wetlands, servicing the entire population housed there. This calculates at over 100 people per toilet. Many of these toilets are broken, blocked or locked, resulting in an even higher number of people using each functioning toilet. Locked toilets were particularly noticeable; according to some residents, the reason for this is to prevent vandalism. In the Wetlands, certain residents have taken control of the toilets and keep the keys and also take responsibility for cleaning them. The toilets are spaced between 100 to150 metres apart. Most of the functioning toilets are located in the Zululand area, which lies on the north-eastern side, therefore not readily accessible for most residents of the Wetlands.

The sanitation service levels in the City of Cape Town are described in Table 6.5.

Sanitation Service Level Categories - City of Cape Town	
Inadequate	No access to sanitation as defined below. (Residents would either share with other residents, supplied at a basic or full level of supply, their sanitation facilities, or would provide for themselves – often through unhygienic means. In many instances these residents are being serviced by the CCT through the weekly removal of 20 litres open stercus "black bucket" containers, a service which is to be replaced.)
Emergency	Partial access to sanitation (more than 5 households per toilet), as dictated by site-specific constraints (e.g., high dwelling densities).
Basic	a) The provision of a shared toilet (at a ratio of not more than 5 families per toilet) that is safe, reliable, environmentally sound, and easy to keep clean, provides privacy and protection against the weather, well ventilated, keeps smells to a minimum and prevents the entry and exit of flies and other disease-carrying pests. b) The provision of appropriate health and hygiene education.
Full	On-site Waterborne, Septic Tank or French Drain

Table 6.5 Sanitation Service Level Categories – City of Cape Town
Four levels of services exist within the City of Cape Town for informal settlements. Most settlements, including Masiphumelele however have only emergency level services.

(Source: City of Cape Town, 2008 – from the report, Water Services Development Plan for the City of Cape Town 2008/2009. Draft Report) as reported in Goldberg *et al* 2009, the Water Dialogues Cape Town Case Study.

The basic level of sanitation entails a ratio of not more than 5 families per toilet (approximately 20 people, if based on 3.4 people per house). This basic level of sanitation has therefore been achieved in the TRA, where toilets were installed out on a regular grid with approximately 14 residents per toilet. This area is a good example of how proper planning and the prevention of uncontrolled influxes of people into specific areas, can lead to an improvement in living conditions, even if only temporarily. The sanitation services in the TRA were however prepared in advance of residents being allowed to move in. This area is surrounded by a fence and security has been put in place to control illegal occupation. Movement from the 'School Site' was similarly planned and residents

who were relocated to this TRA area were assisted with building materials and allocated specific parcels of land.

The Western Cape Human Settlement strategy, known as ISIDIMA, was initiated in 2007 by the Department of Local Government of the Western Cape. ISIDIMA, a long-term strategy for sustainable settlement, means 'enabling dignified communities' (ISIDIMA, 2007). This strategy is a way in which poor families living on the periphery of urban centres far from employment opportunities and dependent on costly transport can be more effectively integrated within the community at large.

The ISIDIMA strategy shifts from conventional housing construction towards sustainable human settlements with empowered communities; the idea of this concept being to fully integrate the poor into existing urban environments and maintain population densities of 25 dwellings per hectare (or 100 people per ha). In Masiphumelele, shack count data revealed that currently 289 dwellings in a 1hectare block were counted the Wetlands area alone, calculating to almost 1 000 people per ha. The ISIDIMA strategy is based on the *sustainable livelihoods framework* (SLF) (ISIMDA, 2007). The SLF framework highlights the vulnerability of poor households within the broader setting of government policy. Local infrastructure and its access to social, political, physical, financial and natural capital are also facets. These factors all play a role in determining the level of poverty and vulnerability of informal settlement communities. Objectives 7 and 8 of the ISIDIMA strategy are particularly relevant to the concept of social vulnerability; the notion behind both imply co-operation between vulnerable communities, government and other relevant parties, which could lead ultimately to a better quality of life. Table 6.6 summarises these objectives.

Until recently, policies aimed at mitigating the problems associated with informal settlements within South Africa, have concentrated primarily on national housing programmes (Misselhorn, 2008). The change in focus that has occurred in recent years is due largely to policies such as the Upgrading of Informal Settlements Programme and the Sustainable Settlements Programme (which is also known as Breaking New Ground). These approaches incorporate aspects such as alternative tenure options and phased upgrading approaches; emphasis is now being placed on community participation (Misselhorn, 2008). Unfortunately however, adoption of these policies has been sporadic; many municipalities are using funding allocated for these new programmes to continue with the old conventional housing schemes.

ISIDIMA Strategy – Western Cape Local Government		
Number	**Objective**	**Aim / Method of Achievement**
No. 7	Pact between Government & society to build trust, reciprocity and development practices required to design and implement sustainable neighbourhoods	Achieved by cleaning up river and wetland systems, strengthening existing 'green' by-laws particularly with regards to both solid and liquid waste recycling. In addition there is a commitment to a bus-rail-taxi public transport system
No. 8	Western Cape towns and cities to become global leaders in sustainable resources by making sure all new buildings, infrastructure and open spaces are planned in accordance with ecological design principles & owners of existing buildings respond to incentives to retrofit buildings in accordance with principles of ecological design principles.	Aims to foster co-operation between municipalities, NGOs, CBOs and technical consultants to develop ecologically sound housing.

Table 6.6 ISIDIMA Strategy

The ISIDIMA strategy is based on the Sustainable Livelihoods Framework (SLF) and aims to foster cooperation between stakeholders.

Indeed there is now an expectation that Government will provide houses for all. Statistics from Masiphumelele show that over 80% of those households surveyed expected government to provide suitable housing.

6.4 Government Response to Vulnerability in Masiphumelele

Three sectors of government were interviewed during the course of this study. The following key points highlight their responses and emphasise the problems and issues related to social vulnerability in Masiphumelele.

6.4.1 Local Government: Alderman Holderness in response to flooding in the Wetlands.

In response to an interview with Alderman Holderness (who's Ward includes Masiphumelele), the following important aspects were discussed;

A major problem experienced by government is the prevention of further encroachment of people into the wetlands, but nothing is being done about the influx of people into Masiphumelele at the moment. The original intention was to move some of the people to the West Coast or Steenberg. The problem with this is that it would mean residents would be relocated far from their families and / or workplace. It was explained that the School Site occupants had already been relocated to the temporary relocation area to the west (TRA). This area, which forms part of the National Parks land, was originally, however, intended to be used for playgrounds and allotments. This temporary relocation area has also been proposed as the site for the Phase IV development of Masiphumelele, though nothing as yet has happened in this regard - see Appendix IV for an overview of these plans).

Alternative land for housing development is being actively sought after in the Southern Peninsula. An analysis of the whole valley was undertaken and the results thereof indicate that the government

does not own enough land and private land is too expensive given budgetary constraints, although a new committee has recently been formed that searches for suitable land alternatives. (Appendix IV contains a map of the various alternatives that have been found). The City of Cape Town's budget of R68 million for housing is insufficient to buy additional land. Additionally, the cost of development would be in excess of R14 million (This is based on the estimated costs of relocating residents from the Red Hill, a settlement near Simon's Town to Dido valley, an area that has been allocated as a mixed-use residential and commercial development).

Geo-technical survey costs are very expensive; environmental policies however, impose restrictions and therefore such surveys are usually a requirement before any building can take place. The government considered purchasing Hillside Farm on Red Hill, but unfortunately the cost of this would be in excess of R10 million; and not therefore feasible considering the budgetary constraints.

Gap housing has also not been a success story in this area; alternative housing arrangements will therefore need to be considered. Gap housing is defined by the City of Cape Town as a '*shortfall or 'gap' in the market between residential units supplied by the state (which cost R100 000 or less) and houses delivered by the private sector (which are not less than R250 000). The gap housing market comprises people who typically earn between R3 500 and R10 000 per month, which is too little to enable them to participate in the private property market, yet too much to qualify for state assistance*' (City of Cape Town, 2011).

A possible solution therefore is to build more multi-story flats similar to those of the successful positive Amakhaya Ngoku community housing (see Appendix V). As with the Amakhaya Ngoku project, significant success stories have mainly resulted because of foreign investment into Masiphumelele. The People's Housing Process development (PHP) for example, was responsible for the development of 50 houses in this settlement. An additional 132 are to follow these successes in Phase II of the project, followed by 150 more during Phase III.

With respect to services such as the electricity supply, roads and other infrastructures are seemingly all in the process of being upgraded in the settlement. Alderman Holderness repeated the assertion that crime was a real issue, with R2 of every R3 being used to repair and/or replace stolen or vandalised infrastructure. This statement can certainly be verified by the recent fieldwork in Masiphumelele, whereby it was noted that toilets had been vandalised. Residents had also been forced to put locks on toilets in order to reduce this vandalism.

Physical mitigation in the form of raising-up the foundations of the shacks in the Wetlands on top of used tyres was proposed by Alderman Holderness, this has not as yet been approved. The idea was formulated because old tyres are plentiful within Masiphumelele. The problem with this

method though might be the susceptibility of tyres to fire. She was however open to any other suggestions that might be potentially useful.

She acknowledged the vital importance of NGO and charity organisations, who are trying to improve the conditions within Masiphumelele. Noteworthy examples include amongst others, Masiphumelele Corporation and Trust and the Red Cross.

6.4.2 Disaster Risk Management Response: Mark Pluke in response to the issue of flooding in Masiphumele.

According to a report by Derrick Williams of Development Services, City of Cape Town, obtained from the DRM in 2009, all informal settlements are required to receive awareness workshops every three months. The DRM team responsible for Masiphumelele reported a 100% readiness for any flooding event in the Wetlands in 2009. The DRM team apparently works closely with Masiphumelele residents; every few months a representative is sent out into the field to assess the situation. There have been a number of programmes in Masiphumelele that have been implemented by the DRM, a number of NGOs and research institutions.

During February 2010, a 'transect walk' was taken with a representative from the DRM together with a community leader from Masiphumelele. The aim of this walk was to obtain first-hand knowledge about problems related to flooding. It was noted that the ground was damp and sodden even during the drier summer months. Residents indicated the high level of flood waters during winter rains. Random questioning of residents revealed that water seeping from underground was the major problem. Flooding problems are widespread throughout the Wetlands, with those residing closest to the wetland having the highest number of incidents (*i.e.* the area originally designated as the ecological buffer between the wetlands and land allocated for human habitation). Any facilities would therefore have to be located on the peripheries or in the Formal area. Rubbish collection was found to take place once a week, though 64% say that it is not frequent enough. The City does however supply the area with rubbish bags, which are left on the side of the roads.

The DRM say that the unblocking of storm water channels is outsourced to a private contractor, and is a very costly process. It is therefore not undertaken very frequently. Clearly this is an area where proactive rather than reactive measures need to take place; additional community awareness campaigns would be very important. Figure 6.6 shows contractors clearing one of the drainage channels in the Wetlands on the day of the Phase 2 mapping exercise. The scholars who took part in the Phase 2 survey noted that the school children were involved in the clearing of these channels from time-to-time. On this same day, the drainage channels were also being cleared by contractors to the City of Cape Town. The fact that residents there have no large rubbish skips (only one was found in the Wetlands area), possibly accounts for large amounts of litter ending up in the drainage channels, though lack of education on sanitation might also be a cause. It has to be noted though,

that there are not many areas where rubbish skips could in fact be installed due to high population densities causing the close proximity of shacks to each other. Any facilities would therefore have to be located on the peripheries or in the Formal area. Rubbish collection was found to take place once a week, though 64% say that it is not frequent enough. The City does however supply the area with rubbish bags, which are left on the side of the roads.

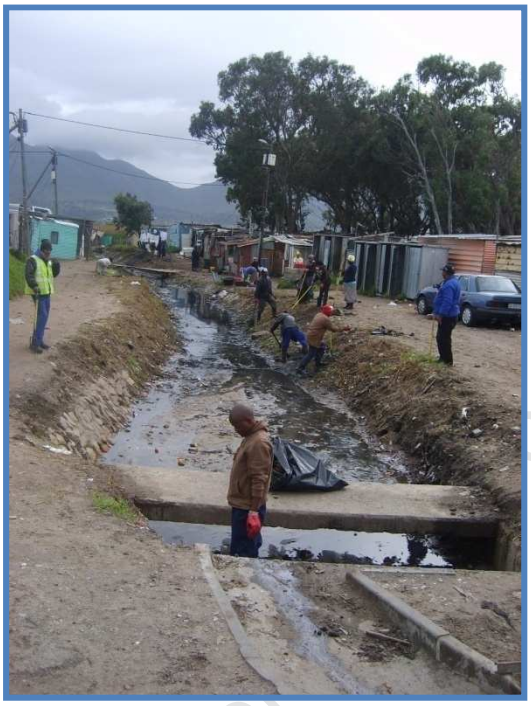


Figure 6.6 City of Cape Town Contractors clearing Drainage Channels in Masiphumelele

Although channels are being cleared relatively regularly, it appears not to occur with enough regularity

The DRM is tasked with finalising and co-ordinating risk reduction and response programmes related to flooding and storms between all parties involved. They are also responsible not only for advising on risk reduction measures, but also with issuing early warnings for approaching severe weather and advising the public of safety precautions and status reports regarding the City's response to the situation. According to Charlotte Powel of the DRM, warnings are only given to residents of informal settlements if area managers have made arrangements for warnings to be given with community groups within these settlements, though apparently this does not occur very frequently. She also believes that weather warnings are often ignored or do not register in the informal settlements as residents are more concerned with daily survival; the notion of acceptance of the *status quo* and complacency appears to be the norm (Powell, 2010). Because disaster risk management is the responsibility of a number of departments, there needs to be regular discussions and meetings between all parties involved.

Despite the brochure entitled "Protect yourself from Floods" produced by the Disaster Risk Management Centre (DRM), the message contained within it is certainly not getting through to the

residents of the informal areas in Masiphumelele. Figure 6.7 shows a copy of this brochure. The ineffectiveness of the brochure distributed by the DRM clearly needs to be addressed. Many of those interviewed said they were not even aware of the fact that the area was potentially dangerous before they built there (72%), whilst most reported that they had never received any warnings prior to extreme weather events or regarding the dangers associated with building near a wetland (86%). Most had no idea who to contact during an emergency (80%) and not one person interviewed could give the emergency telephone number.

After numerous visits to the field, it was noticeable that not one sign, poster or brochure was evident anywhere in the area to warn residents of the potential danger of flooding. Many residents opt to stay with friends or neighbours until flood-waters have subsided. Yet others were wary of leaving their homes at all, worried that their possessions would be stolen.

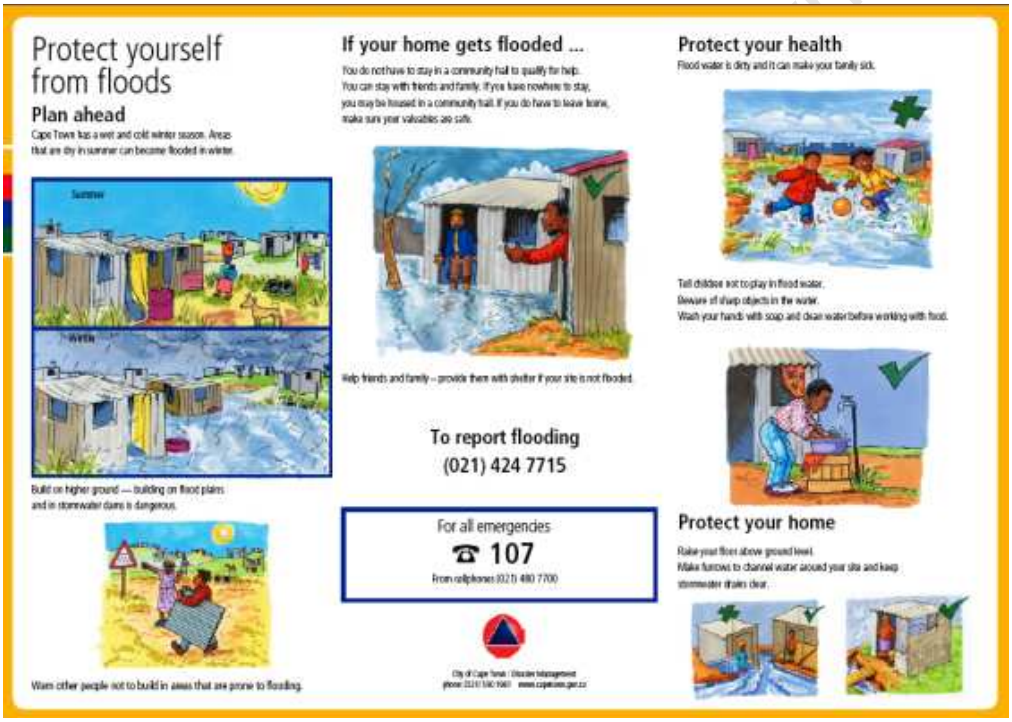


Figure 6.7 Scan of Flood Risk Brochure produced by the Disaster Risk Management

During Phase 2 of the Survey, not one person surveyed was able to give, or was aware of the emergency number.

Information of weather warnings is usually only relayed to residents of informal settlements if operational or area disaster managers have their own mechanisms in place to do so, though this is unusual. In fact weather warnings usually go unnoticed in informal settlements as residents there have other priorities. Residents have therefore adopted an 'acceptance' to flood-risk, which often results in their being unresponsive to warnings. In the past, early warnings have not been designed in consultation with those communities that are vulnerable. A flag-warning system was implemented in Masiphumelele at one stage, but the flag pole was stolen and so this system failed. During the Phase 2 survey, a number of residents of Masiphumelele however, feel that the DRM's

presence is limited and that they specifically are not doing enough to provide assistance prior to the winter rainfall season. However, a number of awareness programmes initiated and implemented by disaster managers, NGOs and other role players are available at the DRM.

The City of Cape Town's GIS Department compile informal settlement maps, (14 of which have already been created) which provide information regarding high-risk areas, areas to be upgraded and those that will be relocated. These maps include problem areas related to settlements' physical, environmental, and geographical features. Socio-economic data however is not a feature of the maps. Residents of these high-risk areas (which includes Masiphumelele) are not however partial to this information and there is no evidence of any maps, either in community centres or at schools. The DRM relies on NGOs (NPOs) to initiate relief operations and communicate with residents who experience flooding.

Table 6.7 summarises the responsibilities of the various government departments involved in the disaster risk process; the report obtained from the DRM outlines responsibilities for each department applicable to Masiphumelele.

6.4.3 New Housing Directorate: Bernie Wentzel (2009) in response to new housing plans for Masiphumelele.

Bernie Wentzel gave an update on the new housing initiatives and associated problems in Masiphumelele. A noteworthy issue is the fact that the residents believe that land allocated for housing development, *i.e.* the land allocated for the Amakhaya Ngoku Housing project, has been stolen from them. Some residents are therefore trying to block housing development.

Phase IV plans involve construction of either 174 single storey units or 252 double storey units on a 3.1 Ha plot (a summary of Phase IV can be found in Appendix IV).

The so called 'Zululand' area, located in the north-east corner of Masiphumelele, the site of a planned new development is being occupied by 23 illegal households. 80 households from the TRA (*ex* 'School Site') qualify for this new development. A project steering committee is in the process of choosing 252 households from the Wetlands and Backyard residents from the Formal area to be housed in the new development to be located in 'Zululand'.

Financial constraints of local government were highlighted by the fact that only 30 – 35% of rentals in total are collected by the City of Cape Town, In other words, 70% of residents are not paying and maintenance of this rental stock is expensive.

Disaster Risk Management Responsibilities - Masiphumelele

Government Department	Responsibility
Disaster Risk Management Manager: Mark Pluke	• Masiphumelele wetlands • Awareness workshops
Transport, Road & Storm water Manager: R Hector	• Access the roads that need to be graded and stabilised • Unblock and clean the existing formal and informal storm water systems • Effect temporary storm water drainage where required
Housing Gerald Mathee	• Assisting residents in relocation to higher ground where at all possible
Solid Waste Stephan Morkel	• Frequent removal of solid waste (to be maintained over the duration of the winter period)
Water and Sanitation Garnett Jefferies	• Sewerage systems • Ensure that they are kept unblocked and clean • Effect general maintenance and housekeeping of toilet infrastructure

Table 6.7 Disaster Risk Management Responsibilities (2009)

Various departments are involved in the management of disasters within informal settlements

6.5 Coping Capacity and the Impact of Socio-Economic Factors on Vulnerability

Coping is the manner in which people use their available resources, often during unfavourable conditions when disaster strikes to recover their normal lives (UNISDR, 2009). A community's coping capacity is effectively a combination of all the strengths and resources available (social, physical and economic) used together to reduce the frequency and impacts of disasters. Poverty is associated with deteriorating infrastructure and inadequate finances to recover easily from disasters. This lowers a community's coping capacity and increases the impacts of disasters. Subsequently, poverty reduction must be a major goal if a meaningful increase in a community's coping capacity is desired. Although poverty is not the only cause of vulnerability, it exacerbates the situation by fuelling other related causes, such as migrations from poorer areas and rapid population influxes into urban areas that are often high-risk coastal areas (Zou and Thomalla, 2008). Consequently, it would therefore seem appropriate to address the underlying problems associated with poverty. Poverty also encourages insecure tenure, which also exacerbates increased levels of poverty in informal settlements (Lasserve, 2006). Insecure tenure negatively impacts the provision of urban services and subsequently the economic welfare of the poor. Governments are therefore reluctant to provide for basic services in informal settlements as it is often viewed as legalizing tenure in these areas. In South Africa, poverty levels have increased between 1995 and 2002 and already poor households are even poorer (ILO, 2006). Addressing socio-economic factors such as unemployment and education should therefore be considered a priority.

The social resource of any community consists of people, their skills, as well as democratic governance, and the quality of the civil services and other community organisations, including NGOs (Kasperson *et al.*, 2005). Without these, a community's natural and economic resources cannot be adequately or efficiently used. Communities with strong social resources, but poor natural and economic resources can still however become sustainable societies.

Levels of vulnerability are highly dependent on the economic status of individuals and communities, with the poor usually the most vulnerable sector of society (Umvoto, 2004) .The higher the level of a community's economic resources, the more it will be able to tolerate and recover from hazards and disasters (Umvoto, 2004). The poor have proportionally higher losses when a disaster strikes and have less capacity to recover. In addition, inadequate infrastructure, particularly transportation and health care increases vulnerability to hazards. Inability to access credit facilities can prevent people from escaping temporary poverty caused by disasters and lead to a permanent poverty trap (Umvoto, 2004) One way of increasing a community's economic resources is the process of skills development through education and training. By learning new skills, people are able to potentially increase their income levels and also increase their skill levels and economic potential.

Although there are some programmes that have been implemented in Masiphumelele, skills development appear to be lacking (see Table 6.8 for some of the skills development programmes in the Masiphumelele area).

This is evident in the survey results with the number of self-employed individuals only accounting for 4% of the total. Due to its scenic beauty, tourism in areas close to Masiphumelele is significant; it is particularly noticeable how few residents were involved in this industry (tourism was included in the self-employed category). It is also noticeable that very few residents are employed in the 'white collar' or skilled artisan categories (only 3%).

Skills Development - Masiphumelele
Masiphumelele Corporation and Trust: Non-Profit Organisation Involved in Masiphumelele for over 11 years • Built 23 houses, 2 community centres, 2 crèches and a library. • They support 19 education programmes. • Sponsor more than 30 students with bursaries for secondary and tertiary education. • Support the primary school with a sports coach and sports equipment. • Assisted budding entrepreneurs in business start-ups in the township. • Built up a committed team of over 80 volunteers who deliver all the above programmes.
Work for Love: Non-Profit Organisation • Connecting and uplifting the local communities through initiatives focused on education & health care.
Wheat Woman's Fund: Non-Profit Organisation (involved in Masiphumelele for over 11 years) • Provide training grants to woman-based community initiatives and bring woman into the economy through skills development. • Given grants to over 600 groups of woman.
Training Educating Awareness Marketing (TEAM) Programme • A collaborative initiative between the Provincial Disaster Management Centre (PDMC) and the Development Fund of the Development Bank of Southern Africa (DBSA) and the Disaster Mitigation for Sustainable Livelihoods Project (DiMP). • Took place in 2005/2006; it targeted 11 of the most vulnerable communities within the Western Cape, including Masiphumelele. • Its purpose was to enhance risk reduction and coping capacities. • A Community Risk Assessment (CRA) was held in Masiphumelele on the 18 – 20 January 2006. • The workshop was attended by 28 participants, the majority of whom were community members and community-based organizations, one NGO and two government departments (DIMP, 2007).
Primary School Basic Education Kit for Resilient Behaviour • The Provincial Disaster Management Centre (PDMC) together with the Department of Education launched the *Basic Education Kit* in Masiphumelele in May 2008 (City of Cape Town, 2011). • The aim of this programme was to target the learners of primary schools to teach them how to become resilient to any sort of natural disaster; initially this programme was directed at four pilot schools, including Ukhanyo Primary in Masiphumelele. • The Initiative is funded by the Development Fund of the Development Bank of Southern Africa (DBSA). It will be incorporated into the school curriculum in the social science, emergency medical rescue and life orientation subjects. • The kit consists of an educators study guide; learner's workbooks a) Grade 5 (fire), Grade 6 (floods), b) Grade 7 (evacuation plan); Song; A2 poster; Risk-land board game; Risk-land activity book and a capacity building workshop for educators.

Table 6.8 Skills Development Programmes offered by various Institutions

Some examples of organisations offering skills development in Masiphumelele.

Most residents are predominantly employed in the domestic services, construction or retail industries. This is mainly a factor of the settlement's proximity to the surrounding residential areas. Although high employment rates exist within this settlement (94% of all households claim to have at least one member of the household working), a high proportion tends to be in the form of casual labour (approximately 33%) and over half are working some distance from the settlement (64%). The household subsistence level is one measure of poverty and is the level below which households are unable to meet their basic needs for clothing, food, cleansing and transport (This figure was less than R 1 900 per month in 2008 – Goldberg *et al*, 2009). 78% of the population surveyed had an income level of R 1 499 or less; which is substantially less than the recommended household subsistence level.

When compared to many developed areas (like Western Europe), social grants in South Africa form a relatively large proportion of the GDP (3.5% in 2006). In Italy and Switzerland in contrast, for example, the proportion of GDP allocated to social grants is 0.66% and 0.69% respectively (Armstrong and Burger, 2009). There are a number of different social grants available in South Africa, of which, over 66% are child support grants; old-age pensions (17%) and disability grants (11%) of the total expenditure (Armstrong and Burger, 2009) support grants only paid out R240 per child in 2009). Table 6.9 extracted from (Armstrong and Burger, 2009), gives approximate monthly values of social grants available to those who qualify for them.

MONTHLY VALUES OF SOCIAL GRANTS	
Old-Age Pension	R1010 (2010)
War Veterans Grant	R960 (2008)
Disability Grant	R940 (2008)
Care Dependency Grant	R940 (2008)
Foster-Care Grant	R650 (2008)
Child Support Grant	R240 (2009)
Grant-In-Aid	R210 (2008)

Table 6.9 Monthly Values of Social Grants

Source: Modified from Lekezwa and Siebrits, 2008
(From Armstrong *et al*, 2009)

The benefits of social grants on household and family formation extend further than simply to those who receive them (Woolard *et al*, 2002). The phenomenon of people moving into households in which grants are received (notably old-age pensions) has consequences towards alleviating poverty for the extended family. This development of extended households around social grant income has kept old people in the community; it has also empowered them and reduces their dependence on their children (Van der Berg, Lekezwa and Siebrits, 2008). Research has shown that children who

live together with a pensioner attend school more regularly, are taller than those who do not enjoy such a privilege and they are less prone to illness (ILO, 2006). Grants have reduced the South African poverty gap by 47% (ILO, 2006). Social grants in South Africa are clearly an important tool in reducing poverty.

In the study areas, the statistics indicate that only 24% of residents received some form of social welfare grant. Of those who receive grants, child support is the most predominant making up 72% of the total of all grants received; some residents do however receive both disability and pension grants (28%). Despite these grants however, there was little impact on the average monthly income and therefore poverty levels.

6.6 Sustainable Development

Development plans that ignore poverty and take no account of environmental issues increase the risk of disaster and subsequently increase communities' vulnerability to hazards such as flooding (UNDSR, 2004). A community generally has the capacity to build-up three broad types of resources, namely social, economic and natural (Allen, 2007). Masiphumelele does not possess any natural resources and its location is causing environmental degradation to the adjoining wetlands. Because of the lack of natural resources, even more priority must therefore be focused on social and economic wealth development. Studies indicate that sustainable development of these resources is likely to lead to longer-term reductions in poverty as well as reduced risks to disasters in communities (Adams, 2006). Figure 6.8 illustrates that sustainable development depends on the effective interaction of social, economic and natural resources.

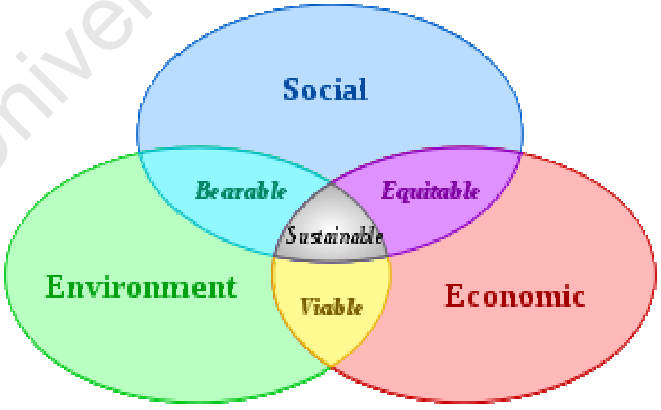


Figure 6.8 Sustainable Development

The three overlapping sectors of sustainable development emphasise the need for holistic approach to assessing vulnerability.
(Source: Adams, 2006)

A sustainable development approach acknowledges that addressing poverty is not just the provision of basic infrastructure (Madell and Cullinan, 2007). It also focuses on the importance of having adequate access to education and training programmes as well as having the necessary financial

and social means to thrive. In order to reduce poverty levels therefore, prolonged efforts from various stakeholders, including public, private, NGO and CBO is essential over lengthy time-periods. Sustainable development also places importance on the development of a households' access to resources, from socio-economic, political and environmental sources in order to increase their abilities to cope during hazards such as flooding (Madell and Cullinan, 2007).

Masiphumelele, in particular the Wetlands, demonstrates the ineffectiveness of policy with regard to this sustainable development approach. Although policies do exist in theory, they are not often translated into practice on the ground; this is evident from the surveys and interviews with local residents. Empirical data suggest that, together with other factors; the quality and quantity of basic services, the standard of health in the community and the low-level of income common in the survey areas, that these policies are not being implemented fully.

6.7 Community Participation in Data Acquisition

An important aim of this study was to assess the efficacy of using local people in data gathering. The integration of local and expert knowledge with a Participatory GIS has been demonstrated to be very useful for assessing flood hazards within their geographic, socioeconomic and political context (Nethengwe, 2007). In order to increase the validity of data, local communities should be involved in its collection, collation and dissemination (Barry and Ruther, 2002). In this regard, the validity is further augmented by the information being easily interpretable by those who are vulnerable. In addition, the collection of data in informal settlements needs to be cheap, achieved quickly, updated frequently and ideally employing local members of the community (Barry and Ruther, 2002). One particular benefit of using local residents in social surveys is the fact that fictitious information might be given to outsiders due to a number of reasons, including politically motivated factors (Barry and Ruther, 2002). Therefore, because local residents are more likely to have increase knowledge of their own residential areas, a much higher level of accuracy is warranted if the information is gathered using local participants. One particular drawback though might be the data collectors themselves deciding to provide fictitious information.

In a study undertaken by the Geomatics department of UCT in 2004, in Imizamo Yethu an informal settlement of Hout Bay, Cape Town, local residents were utilized in a social survey to gather socio-economic data (Barry and Ruther, 2002). The study found that using palmtop computers that incorporated GPS capability was a plausible method of collecting data. Utilizing the local community in order to gather this data effectively was also found to be feasible, provided that they had a suitable enough level of education which allowing them to undertake basic computer skills. As is discussed in sections 6.7.1 and 6.7.2 the utilization of the local community, particularly High School students during the Phase 1 and 2 surveys in Masiphumelele proved to have more advantages than disadvantages. It became quickly apparent however that there was insufficient time and resources to train local people to be effectively involved in actual participatory GIS

(PGIS). Although the scholars participating in Phase 2 were already receiving some basic instruction of GIS in the classroom curriculum, this was generally limited to theory, with little practical experience common. The level of GIS training was therefore low and would indeed require more extensive training for it to be effectively incorporated into any further studies. GIS applications and interpretations were therefore undertaken by the author. Copies of the socio-economic data (including GPS positional data and database), together with imagery and additional spatial data (such as infrastructure and drainage) associated with this study were however given to the geography department of the Masiphumelele High School. Copies of the hardcopy maps used during field-work were also donated to the school. The school has been already been provided with GIS software (Arcview version 3.3) from the Department of Education, this software has been installed on a number of computers, though it would appear that not much practical training is given.

6.7.1 Strengths and Weaknesses of using Local Participation in Data Acquisition

The following lists of strengths and weaknesses were found to be valid from the research undertaken in Masiphumelele.

Strengths:

- Increases the reliability of a vulnerability analysis as the opinions of residents.
- Involvement of residents in actual data gathering is a skill acquisition
- Learn how to use new technologies (GPS units, maps, GIS)
- Collaboration between researcher and residents leads to more reliable data.
- Researcher sees first-hand living conditions of residents
- Better understanding of their home environment and any problems associated with it, than an outsider necessarily can be expected to have.
- Language barriers fall away. Local participants can converse easily in the residents' own language and translate or explain any questions that may not have been understood.
- A form of employment if remuneration is given – therefore an incentive to cooperate.
- Benefits of having monetary incentives for work satisfactorily done might encourage field workers to complete questionnaires more meticulously.
- Empowers local residents (learn about the problems of their settlement)
- Encourages other residents to get involved. Having hardcopy maps made more people interested in the survey.
- Receive feedback on efficacy of DRM and local government mitigation methods.

When asked their opinions of the Phase 2 mapping exercise, students commented that they enjoyed the format of teaching as it gave them a practical demonstration of the theory encountered in the classroom, which enabled them to understand it easily. For all the scholars who participated in this exercise, it provided them with an opportunity of using a GPS and working with coordinates for the

first time. One scholar commented that although having lived in Masiphumelele for over eleven years, he was not aware of the extent of the overpopulation and poverty of those living in the Wetlands area. The fact that scholars were not even aware of the plight of residents in other areas of their settlement demonstrates the need for increased awareness campaigns and education programmes.

Weaknesses:

- Time-consuming (training and supervision)
- Can be dangerous (racial tensions)
- Errors can occur (learning new techniques)
- Bias of interviewer (in selecting one resident over another and in answering questions a certain way, especially politically motivated questions)
- Illiteracy leading to errors in answering questions as questions not understood
- Offering remuneration could be a cause of adopting a speed *vs* quality approach when gathering information (if unsupervised)

Because of time constraints, the survey had out of necessity to limit its focus to certain areas of the settlement only. Therefore, large areas of the TRA were not included and the Formal area was not a focus either. Although it has been stated that outsiders could lead to fictitious data, the outsiders in this survey were only involved in supervision, they were not directly involved in the questioning of residents; most of the residents were eager to be interviewed and in no way was any animosity felt during this process. In Phase 1, however, no direct supervision was given during the actual data collection segment. The rationale behind this was to gather information that was an accurate reflection of the settlement as a whole, without the influence of an outsider present. A local supervisor however checked all survey questionnaires prior to their approval and return to the author. In one incident, the completed survey questionnaires were deemed a fabrication by the local supervisor; this therefore required a new set of survey questionnaires to be collected by an alternative local resident.

Utilizing a GPS unit to gather information is highly effective as it provides positional information quickly and accurately and they can later be used as control points, however due to frequent changes in a settlement, these control points might move. This could be resolved by more frequent surveys being undertaken and the active participation of the community in data acquisition. To actively include local communities in PGIS though would involve a significant investment in resources such as suitable hardware, software and training. Although PGIS in this format was beyond the scope of this study, it is considered to be an important aspect of social vulnerability assessments and the incorporation of PGIS into further studies and surveys is highly recommended.

6.7.2 Data Limitations and Areas for Improvement

Because information collected in the form of household questionnaires was not collected with the aid of a GPS during Phase 1, the information could not be mapped spatially. Information from the Formal area does afford limited mapping capability, due to the fact that cadastral information was available for particular Erf numbers. Erf numbers have unique address numbering systems; subsequently the data obtained for the Formal area was able to be mapped with the aid of GIS and also incorporated with the Phase 2 mapping data. This spatial component could have been achieved had GPS units been used and trained operators available, but time and training constraints were also a factor. The intention of the Phase 1 survey was however; to obtain updated information for the three survey areas as a whole, rather than at shack level, and in so doing, reveal the prominent trends and perceptions common to the study area. Phase 2 did however; address the issue of the spatial mapping of dwellings.

Due to insufficient population statistics, the number of households interviewed in the Formal area therefore was substantially less than 10%, which is considered an accurate representation of the total, sampling would give a more accurate result; the Wetlands and TRA areas however were an accurate representation. Because the primary focus was the Wetlands, the insufficient numbers of households interviewed in the Formal area were not considered to be relevant.

6.7.3 Summary

In this chapter, an attempt was made to incorporate the BBC framework of vulnerability by assessing the susceptibility, coping capacity and intervention tools in the local context of Masiphumelele. The physical susceptibility of certain areas of Masiphumelele to flooding was clearly evident from both the GIS-based quantitative analysis and the two surveys, together with a transect walk. Intervention tools such as early warning systems, buffer zone application, and relocation of housing or evacuation of those most vulnerable was seen to be somewhat lacking. Although some intervention tools are documented in theory in the form of various policies and strategies, the practical implications are not necessarily being felt by those communities most vulnerable. Institutional influences therefore are an important influencing factor on the levels of vulnerability in communities. The coping capacity of residents was also found to be diminished, with poverty being the major determining factor. Although non-profit organisations do what they can to alleviate the effects of poverty and flood-related incidents, they lack the financial resources to be able to achieve this effectively. In addition, many skills-development programmes have already been implemented in Masiphumelele in the past.

The pros and cons of utilizing local residents in gathering data were discussed. This method of data acquisition not only proved to be effective, but also empowered local people both financially and practically and therefore increased the reliability of this study.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

Nothing is impossible for the man that does not have to do it himself.

~ A. H. Weiler ~

7.1 Conclusions

The nature of the vulnerability of the poor is complex and diverse; therefore there are no simple solutions for reducing risk. It necessitates multi-faceted approaches and innovative institutional procedures to accomplish this task. In assessing vulnerability in Masiphumelele, the BBC framework was incorporated. The framework is in favour of focusing primarily on preparedness and then secondarily on disaster management. It also encompasses the concept of sustainable development and believes researchers need to focus on the holistic integration of social, economic and environmental elements into vulnerability studies. Susceptibility, coping capacity and intervention tools are features of this framework. This research focused predominantly on susceptibility and coping capacity rather than intervention tools, although elements of the latter are considered with respect to buffer zones and certain mitigation methods.

7.2 Objectives of the Research Answered

This study had three major objectives, and the conclusions for each are considered in turn in the following sections;

7.2.1 Physical Vulnerability Varies across Masiphumelele

Flooding is widespread and usually occurs during every rainfall event, but is most characteristic in the wetter winter months. The naturally high water table, together with additional runoff from extensive new housing developments in the surrounding areas and the settlements' close proximity to the adjacent wetlands / reed beds have also increased the risks to flooding. Another important consideration is the fact that Wetland residents have already encroached upon the 1:50 and 1:100-year flood-lines. The quantitative assessment of physical vulnerability was achieved initially by estimation of current population densities, based on shack count data and the weighted average people per household (calculated during Phase 1).

The new estimation of the population revealed that numbers are indeed much higher than initially thought; high density levels are prevalent in this community and have been increasing steadily over the last ten years. In South Africa figures of 4.3 people per household were estimated in 1995 dropping to 3.8 people per household by 2002. The following density figures were estimated for Masiphumelele in 2009:

- Wetlands: just under 300 dwellings per hectare (or around 1 000 people based on an average of 3.5 per household).
- TRA: over 150 dwellings per hectare (or around 500 people based on an average 3.2 per household).
- Formal area: around 250 dwellings per hectare (approximately 750 people based on 3.0 per household).

The estimation of the population residing there was achieved by using previous shack count data, obtained from the City of Cape Town, and calculations based on Phase 1 survey data. The application of setback methodology revealed that large numbers of the population are vulnerable to estuarine flooding; varying in degree from extreme vulnerability below the flood lines of the Wetland areas to the north, to a much lower vulnerability in the Formal area to the south of the settlement. In fact, if consideration is given to the coastal risk area (where sea-level rise events due to climate change are likely) the entire TRA and Wetlands and a small portion of the Formal area can also be considered to be highly vulnerable to coastal flooding.

These estimations together with the application of setback lines using GIS allowed for the demarcation of five varying zones of vulnerability based. This project involved the extensive use of GIS as a means of displaying and analysing geo-spatial data. One important GIS capability is its ability to handle both digital cartographic data and associated databases containing meta-data [meta-data stores data about the structure, context and meaning of raw data] information. In order to assess vulnerability, a wide-variety of information is required. Data for this project included collation of environmental, topographic data and aerial imagery. With GIS it is possible to easily analyse large volumes of data, and in so doing demarcate areas of physical vulnerability. Because some of the data collected during the surveys had a geo-spatial component, notably data from the Formal area in Phase 1 and all the information collected during Phase 2, it was possible for this information to be incorporated them into a GIS. Spatial information required for this assessment included; the 1:50 and 1:100-year floodlines which, were found to be at 4.8 and 4.9masl respectively, for practical purposes the 5m contour line, the coastal risk zone (to sea-level rise) and delineations of both the 32 and 75m minimum and maximum wetland buffer zones. The following five zones of physical vulnerability were demarcated in Masiphumelele. Figure 7.1 illustrates these areas:

- **Most vulnerable/ No-go zone**

  This area is situated below the 50 and 100-year floodlines, therefore households in this zone are extremely vulnerable to wetland flooding, and currently affects approximately 18% of Wetland residents (just over 1 000 people).

- **Highly vulnerable**

  The area situated between the floodlines and the 5m contour line affecting around 42% of all Wetland residents (almost 2 500 people) .

- **Moderately vulnerable**

  The area is situated between the 32 and 75m buffer zone, but not within the 5m contour line, affecting 32% of Wetland Residents (almost 2 000 people).

- **Moderate to low vulnerability**

  The area beyond the 75m buffer but within the coastal risk zone, this affects 8% of Wetland residents, all TRA residents and 5% of Formal area residents (just over 3 500 people).

- **Lowest vulnerability**

  The area beyond the coastal risk zone is considered the most suitable for habitation and sustainable development, in which 95% of the Formal area is situated (almost 30 000).

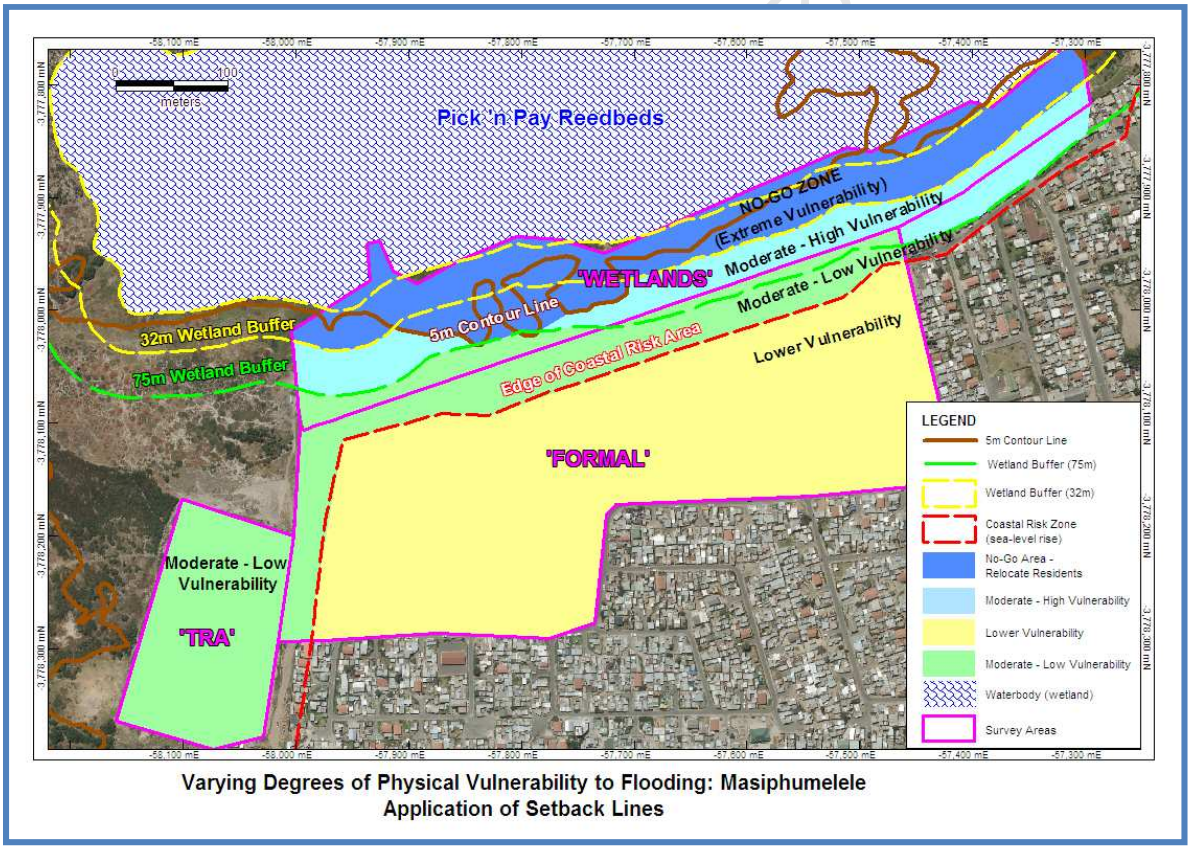


Figure 7.1 Varying Degrees of Physical Vulnerability

The area below the 5m contour line is considered a 'NO-GO' for development; ideally these residents should be relocated to more suitable living areas.

Based on these delineations, it can be shown that certain areas are more vulnerable than others in Masiphumelele. This is corroborated by the results of the Phase 2 survey where 94% of residents in the Wetlands have suffered flooding. The area most vulnerable is situated in the Wetlands and the least in the Formal. Although 77% of all residents in the settlement's Formal area can be

considered to have the least physical vulnerability, this does not necessarily mean that these residents are not vulnerable in other ways. 23% (or around 9 000) of all Masiphumelele residents are exposed to moderate to extreme levels of vulnerability and this is reason for concern because of the high density levels of the settlement. There is no economically viable way of preparing this ground for the construction of formal housing; although one plausible option, albeit expensive would be to re-locate the residents and undertake a major infill programme to raise-up the ground level. Adoption of setback-lines in order to create buffer zones, designed to protect not only the environment from people, but people from the environment would therefore leave large areas with no development according to the principles of the policy. The quality of housing and the materials used, together with a lack of adequate flood intervention tools all play a role in increasing vulnerability. Results of the surveys confirmed that the worst quality homes are also those that are geographically located in areas that are at most risk to flooding. Physical vulnerability was only one determinant of vulnerability to flooding. Socio-economic and institutional factors all play a role in compounding the analysis of vulnerability.

7.2.2 Physical Vulnerability Relates to Socio-Economic and Institutional Vulnerability

Socio-economic and institutional vulnerability was assessed by conducting a two-phased survey, transect walks, interviews with various institutions and local residents. The coping capacity of the residents living in this settlement is considerably diminished; this originates from the general poverty levels of the community. Low-income levels, unemployment and lack of access to proper infrastructure (such as toilet and tap facilities), poor sanitary habits as well as relatively low education levels are all influencing factors. Many residents are employed in low-paying jobs and a large percentage only work part-time, many are employed far from their homes leading to increased transportation costs. Sanitation is insufficient and poorly maintained with over 100 people having to share each toilet in the Wetlands. Not only are these issues of major concern, housing is also of a very poor quality leading to leaking roofs and walls, and seepage and sometimes inundation through the floors. The dwellings are also within very close proximity to each other, which often causes secondary problems, notably fire risks, contagious diseases and impossibility of emergency vehicle access. There are genuine health concerns, evident from the statistics generated from Phase 1 survey data, particularly to waterborne diseases, exacerbated by blocked drains and standing stagnant water. The vulnerability to flooding can be seen as a particular drawback of living in this area, although from the opinions of residents, they themselves have in part at least become complacent to their plight and focus their attention more on daily survival than effective flood mitigation, the major determinant factor being poverty.

The study considered and compared the socio-economic results of the three different residential areas, namely the Wetlands, the TRA and Formal area. The study revealed that the spread of income, gender and age distribution, employment type and ethnic origin across these different areas

was essentially similar. More people in the Formal area however, have full-time employment. They are also happier with their living conditions and access to services.

The continued influx of illegal squatters is seemingly un-abatable according to the City's current response. The uncontrolled influx of people into the Wetlands has caused numerous problems. People are now living in truly squalid conditions; there seems to be little hope of any feasible solution that would be beneficial to all stakeholders. It must also be stated that the wetland is now being polluted with human waste and rubbish which is entering via the drainage channels. The Prevention of Illegal Eviction and Unlawful Occupation of Land Act of 1998 (amended in 2005), focused on establishing rights for informal occupiers, protecting them from forceful and undignified removal as occurred with the original settlers of Masiphumelele.

The search for suitable land to resettle vulnerable squatters is ongoing in Cape Town, but most potential sites unfortunately do not belong to the City of Cape Town and are often too expensive for the city to buy. Environmental impact assessments are also a legal requirement and these increase the costs of any *Green Fields* housing development. In the case of Masiphumelele and surrounds, a few pockets of land have nevertheless been identified as possible high and medium density housing development areas. These include Solele, immediately to the south of Masiphumelele, off the Kommetjie road and Imhoff's Gift, a few kilometres west down the Kommetjie road.

7.2.3 Local Participation (PGIS) is a Successful Method for Acquiring Data

The use of local residents into data acquisition was considered important and beneficial to the study; this was achieved during both Phase 1 and 2. This form of data acquisition has various benefits, including the fact that local people have a better understanding of conditions in their day-to-day lives. It proved vital for interviewers in gaining the trust of their fellow residents during the interviews. For the school children involved in Phase 2, the opportunities to use new techniques in a manner that could prove beneficial for their community, as well as their education, were powerful motivating factors. Community involvement is a key issue, and together with financial inducement can be an effective means of gathering vulnerability data; as was seen by the use of the *Men-on-the-Side-of-the-Road* organisation during Phase 1. Although there were clearly some misunderstandings about some of the questions posed which resulted in some incompletely filled-in questionnaires, the vast majority of the data collected proved plausible and was thus useful. This study certainly demonstrated the merits of using PGIS in data gathering.

To actively include local communities in data interpretation would involve a significant investment in resources such as suitable hardware, software and training. Although PGIS in this format was beyond the scope of this study, it could be an important aspect of future detailed social vulnerability assessments.

The results of the surveys have been made available to interested stakeholders, including the Masiphumelele Corporation & Trust and the local High School that provided the enthusiastic field workers for the Phase 2 work. This research could certainly be continued and expanded in scope by formally presenting the data to some of the stakeholders, particularly the scholars, possibly in a workshop and incorporating their comments into account when designing any Phase 3 work.

7.3 Recommendations to Policy

Based on the results of this study the following practical and achievable courses of action are recommended.

7.3.1 Enforcement of Setback Lines

Delineating and enforcing setback lines is a practical way of ensuring that development stays within acceptable areas that have the minimum effect on the environment. Realistic setback lines can form buffers around aquatic ecosystems, which can then act as important ecological corridors. With the uncertainties of determining the exact location of the various hypothetical floodlines, it makes sense to include a safe and environmentally acceptable buffer around these lines. Buildings should ideally therefore, not be within the 1:100-year flood line, and not allowed at all below the 5m amsl contour.

7.3.2 Reduce Population Density

A reduction of the population density, by the relocation of part of the settlement elsewhere is essential. At the same time measures need to be put in place to limit and regulate any further influxes into this area. As demonstrated by the success of the Amakhaya Ngoku Community Housing project, the building of flats has proved to be a viable option to the reduction of population density in the former 'School Site' area. Despite initial objections, it would appear that these flats have been accepted by the community, and provided decent homes for the occupiers. The area within the existing Masiphumelele for the construction of more flats is extremely limited however, and any removal of existing residents to make way for them would be fraught with difficulties.

High densities also make the conventional *in-situ* methods of upgrade almost impossible. The only plausible option to reduce population densities appears to therefore be the acquisition of alternative suitable land identified by local government as summarized in Appendix IV. The results of this study indicated that almost 2/3 of residents would voluntarily re-locate from Masiphumelele, if there was somewhere else for them to move to.

7.3.3 Coordinated Plan of Action involving all Stakeholders

Findings from this study should be used to assist in initiating dialogue with all interested parties. The primary objective of this dialogue would be to establish a broad consensus for action, both for

flood-alleviation and other risks and critically to coordinate efforts in acquiring necessary funds for future building developments. The resultant action plan should involve government, residents and NGOs, to produce a consensus on a coordinated, dynamic, but realistic plan.

It is recommended that any such plan look seriously at the dissemination of information on practical mitigation methods for those who will still be living in flood-prone areas. The guidebook to practical flood mitigation methods produced for Bangladesh provides a good blue print.

7.3.4 Raising Awareness of Flooding

Raising the awareness of flooding by the identification of those individuals most vulnerable and finding a means of communicating the risk to them is essential. The need for a political support base system which includes laws and regulations, institutional responsibility, and trained people is also important. Risk awareness campaigns need to endorse the importance of preparedness in order to reduce future risks and potential catastrophic losses. Information needs to be transmitted in a clear and unambiguous manner (including in local languages). Consideration should be given to local experience, education, traditions and culture, with the method of communication being tailored to the community's needs. Risk maps should be displayed clearly visible in public places, such as pasted onto the walls of community centres and schools. Other forms could include posters and leaflets, although this format proved to be somewhat inefficient from the results of the survey. Increasing awareness in schools would perhaps be an obvious starting point.

7.3.5 Integrating Poverty Reduction Programmes with Disaster Management

Poverty was found to be one of the determining factors in flood vulnerability and in accordance with the Millennium Development Goals, is also a priority for local government. Frameworks need to be developed that describe people's vulnerability in terms of social, political and economic processes to promote sustainable livelihoods for the poor. This process would require the co-operation and collaboration of all stakeholders. Poverty reduction processes also involve the diversification of livelihoods in order to increase people's capacity to cope with disasters and their ability to recover from them. Diversification and strengthening the sources of livelihoods could be an effective strategy for disaster risk reduction.

The Phase 1 survey high-lighted the preponderance of temporary and low-paid service jobs, notably domestic work. Considering the importance of the tourist industry to the Southern Peninsula, it was telling how few of the residents of Masiphumelele were employed by it.

In addition, failures of top-down management approaches, have led to the widely accepted notion that bottom-up community-based disaster management would be more appropriate. In so doing, communities are better equipped to evaluate their own vulnerabilities and make appropriate decisions to be able to reduce this vulnerability.

Priority should be afforded to those most vulnerable and their inclusion in the process of disaster risk reduction. A community-based system means that the community participates in the whole process, from the analysis and planning to the implementation of such programmes.

Education, although not a focus of this study, with results from the study merely giving an estimate of the numbers of children at school rather than the level of literacy, education and skills of the adult population. Skill development and diversification as already stated is a vital component of social resource augmentation and could therefore be a potential route out of poverty.

7.4 Recommendations for Further Study

The Phase 1 questionnaires were formulated to gather as much information as quickly as possible, by people with no previous surveying (including GPS) experience. The socio-economic data produced is considered to be very useful, particularly in establishing a demographic profile of the community; however the lack of co-ordinate data means that the results could not be positioned accurately in a GIS.

It was also obvious that the some of the questions had proved overly complicated, and as result some of the answers notably on education levels and monthly expenditure were ambiguous. The Phase 2 was a deliberate attempt to produce a more concise set of data that largely concentrated on flooding. The use of High School students to undertake the survey provided plausible, useful data which was incorporated successfully into the study.

With more time and resources it is highly recommended that any future surveys always have a GIS component. The success of using the High School students indicates strongly that with minimal training and supervision would be required for an expanded GIS based survey. It would be very useful to have any future survey questionnaire, intermediate in size and scope to the Phase 1 and 2 surveys. This would combine most of the socio-economic questions and other hazard information with the GIS component.

7.4.1. Flooding and Poor Health are Interrelated – Health Concerns Need to be Studied

During the course of this project, concerned as it was primarily with flooding, it became clear that the health of the community was a major concern, particularly with respect to susceptibility to waterborne diseases. Since a significant number of those living in Masiphumelele were found to be subject to various illnesses, it would seem critical that more research to reduce or even alleviate this current reality and concern, should be undertaken.

This study found that the wetlands are being polluted through discharged human waste, either directly from using ‘the bush’ as a toilet, or from leaking drainage pipes and channels. It is therefore recommended that research into the placing of formalin-based portable toilets with

subsequent removal of their contents to a municipal treatment facility, be undertaken. The costs involved, their location outside the buffer zones to best serve the community, and other relevant aspects would need to be included.

7.4.2 Research in Masiphumelele should be Broadened

This study was limited to studying the flood-potential of Masiphumelele; to obtain *inter alia*, data through GIS and other computer-driven surveys; to collate the opinions on a number of aspects of interest to local residents of the *status quo*; and to understand the causes and reasons for the current problems associated with flooding. It is recommended that further studies in Masiphumelele be broadened to include identifying other practical solutions toward improving the living conditions of residents.

Since this study found that the area is overcrowded, with shacks having been built too closely together and in many cases in low-lying areas, flood-prone areas, the conclusions reached in the study, that residential development be contained to within areas outside the buffer zones is impossible without relocating many residents. Should this ideal situation ever occur, it is unlikely to be within the foreseeable future. For this reason, research into how better to provide for residents' needs within this current situation is recommended. Of necessity, such research must therefore be much more broad-based than this study of flooding.

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APPENDIX I: INITIATIVES IN DISASTER RISK REDUCTION

1. Current International Initiatives

There are many initiatives in the field of disaster risk management, the major ones being under the auspices of the United Nations. Some of these initiatives are summarised below:

1.1 United Nations System:

1.1.1 International Strategy for Disaster Reduction (ISDR)

The International Strategy for Disaster Reduction (ISDR) was established within the United Nations as the successor initiative to the International Decade for Natural Disaster Reduction (IDNDR) and was established at the final forum of the IDNDR in July 1999. ISDR's main goal is to locate and reduce vulnerability to natural disasters within the context of sustainable development strategies (www.unisdr.org/).

1.1.2 United Nations Environment Programme (UNEP)

UNEP is particularly concerned with the relationship between the environment and natural disasters. Its global environment outlook project has supplied efficient scientific assessments of vulnerability to natural disasters for many regions of the world (www.unep.org).

1.1.3 UNESCO (United Nations Educational Scientific and Cultural Organisation)

UNESCO deals with scientific and engineering programmes related to earth, water, ecological and oceanographic sciences that contribute to the study and mitigation of natural hazards. Its aim is to encourage co-operation between governments and help support policy production and establish early warning systems for natural hazards, including flooding. It also supports disaster awareness and education strategies, particularly in communities at risk located in Africa (www.unesco.org).

1.1.4 Hyogo Framework (HFA)

A fundamental concern is the coordination of global implementation of the Hyogo Framework for Action 2005-2015. The Hyogo Framework originated after a conference, held in Kobe, Hyogo, Japan in 2005. Its theme: Building the Resilience of Nations and Communities to Disasters (HFA, 2005).

The Hyogo Framework (HFA) is an international strategy to minimise the risks from natural disasters. This strategy was adopted by 167 countries, including South Africa. The framework essentially has five major priorities for action, namely:

- To prioritise disaster risk reduction (DRR). Countries should incorporate disaster risk into their development policies and planning. They should also ensure that community participation is prioritised.
- To spread awareness and develop co-operation with disaster risk.
- To promote the exchange of ideas amongst stakeholders. This should include disaster risk training and education; community-based risk programmes and interaction with the media to increase awareness.
- To reduce risk. The Hyogo Framework believes that vulnerability is increased by amongst other things the following:
  - Locating communities in hazard-prone areas like flood plains.
  - By destroying forest and wetlands.
  - By building facilities and housing not able to withstand the impacts of hazards.
  - By not having social and financial safety mechanisms in place.

- To be prepared and ready to act by conducting risk assessments, establishing emergency funds and co-ordinated effective disaster response by continuous dialogue between stakeholders (www.unisdr.org).

1.1.5 World Meteorological Organization (WMO)

This is a consortium of National Meteorological and Hydrological Services comprised of 188 countries and operates as part of the United Nations (UN). Established in 1950, it specializes in the behaviour of the Earth's atmosphere and the state of its water resources. The WMO initiated the Natural Disaster Prevention and Mitigation Programme (DPM) in 2003. This is a country and regional-level programme that maps scientific and technical capabilities relevant to disaster risk reduction *(*www.wmo.int/*)*

1.1.6 World Climate Research Programme (WCRP)

The World Climate Research Programme (WCRP) was established by the International Council for Research (ICSU) and the World Meteorological Organization (WMO). It aims to increase scientific understanding of the climate processes. The two major objectives of this organisation are to determine the level at which climate can be predicted and the degree to which humans influence it. WCRP research provides quantitative scientific answers to questions related to climate change as well as global and regional climate change predictions, variations, frequency and severity of extreme events (http://wcrp.wmo.int).

1.2 Other International Initiatives:

1.2.1 The ProVention Consortium

This global partnership was launched in February 2000, its purpose to reduce risk and impacts of natural hazards on vulnerable populations in developing countries. It promotes sustainable development and supports poverty reduction strategies through co-operation, communication and data sharing between stakeholders. All ProVention initiatives are expected to make a contribution towards the objectives of the Hyogo Framework mentioned earlier. ProVention is currently hosted by the International Federation of Red Cross and Red Crescent Societies (www.proventionconsortium.org/*)*.

1.2.2 Global Risk Identification Programme (GRIP)

GRIP is an initiative in alignment with the Hyogo Framework, dealing with risk identification, assessment and monitoring. Its goal is to reduce losses from natural hazards in high risk areas and promote sustainable development. The main objectives are to increase the implementation disaster risk management instead of depending solely on emergency management (www.gripweb.org/*)*.

1.2.3 Centre for Research on the Epidemiology of Disasters (CRED)

CRED, based at the University of Louvain in Belgium undertakes research, training, and data distribution on disasters. It specializes in public health, epidemiology, structural and socio-economic aspects. It aspires to enhance the effectiveness of developing countries' disaster management capabilities and promoting research. The international disaster database (EM-DAT) available on the CRED webpage provides data on global disaster occurrence and impacts (www.cred.be/).

2. Current South African Initiatives

2.1 South African Risk and Vulnerability Atlas (SARVA)

The new SARVA project is sponsored by the Department of Science and Technology (DST) and is project managed by the Council for Scientific and Industrial Research (CSIR). Its aim is to provide an electronic atlas or GIS of local risk and vulnerability related to global environmental change. Being fully operational in January 2010, it provided global change sensitivity and vulnerability information at regional, national and municipal levels. It captures data related to aspects such as groundwater, surface water, forests, biodiversity, human health, crops, demographics, economics and social dimensions. The Atlas provided an electronic geographical information system and involves South African researchers from various disciplines to continuously update data on climate change. It also helps support national initiatives such as the National Disaster Management Framework (www.rvatlas.org).

2.2 Flash Flood Guidance System (FFG)

The Flash Flood Guidance system (FFG) which has been successfully introduced into the United States, Central America, Romania and parts of China, was planned to be implemented into South Africa in May 2010. The FFG system is a modelling system that uses hydrological and meteorological data that estimates the amount of rainfall required to cause flooding in drainage basins less than 70 km^2. This system will be managed by SAWS (South African Weather Services) and the National Disaster Management Centre. (NDMC) Once fully operative, two levels of warnings will be issued, one up to two days in advance and the other immediately after the rainfall, giving a 0-6 hour advance notification of possible flooding (Smit, 2009). In the case of flash floods, even a small amount of lead-time (a few hours) can allow disaster managers to take steps, which may significantly reduce loss of life and damage to property. The methodology prescribed for this system has proven to be feasible, although improvements were suggested for training disaster managers and for methods of data distribution (Pegram *et al* 2007).

2.3 The South African Disaster Hazard and Vulnerability Atlas

This Atlas was developed by Dušan Sakulski using *webMathematica* Technology. It is a web enabled GIS and consists of various chapters such as drought, flood, cyclones, storms, severe weather and fires. It allows users to search and select data, maps, and graphs; perform calculations and run models 'on the fly'. Its aim is firstly to research disaster hazard and vulnerability and address ways in which to reduce vulnerability. Secondly, to develop and distribute methodologies and results that will lead to improve disaster management, and thirdly to act as the National early warning system. According to Sakulski, the *webMathematica* applications are some of the only technical environments that enable seamless integration of symbolic and numeric components. Currently, Sakulski is starting work on the Global Atlas, a venture undertaken by NASA and the United Nations (http://edmc1.dwaf.gov.za/dwaf/).

2.4 South African National Disaster Management Framework (NDMF)

The South African Disaster Management Act, 2002 (Act No. 57 of 2002) was promulgated on 15 January 2003. The National Disaster Management Framework (NDMF) forms the legal instrument specified by the act and provides appropriate policy for all groups involved. This framework consists of four key performance areas (KPAs) and three supporting enablers required to achieve the objectives of these KPAs. (Summarised below)

KPA 1: National, provincial and municipal focuses on establishing the necessary institutional Capacity for implementing disaster risk management.
KPA 2: Highlights the need for disaster risk assessment and monitoring to reduce and monitor risk.
KPA 3: Disaster risk management planning and implementation.
KPA 4: Disaster response, recovery and rehabilitation.
Enabler 1: Information management and communication
Enabler 2: Risk management in education, training, public awareness and research.
Enabler 3: Methods for funding disaster risk management in South Africa
(www.ndmc.gov.za/comp/Framework.htm).

2.5 Wide Area (Satellite) Monitoring Information System (WAMIS)

It is a webpage, developed and maintained by the Meraka Institute in Pretoria and provides near real-time public access to a number of satellite–based information services. Natural events such as fires, floods and droughts within Southern Africa are monitored and mapped on this site. Continuous data is gathered by the Terra and Aqua MODIS polar orbiting satellites and the Meteosat Second Generation (MSG). This data is then streamed and processed by the CSIR Satellite Application Centre (SAC) at Hartbeeshoek together with the Meraka Institute in Pretoria (http://www.wamis.co.za/).

2.6 The Disaster Management Institute of Southern Africa (DMISA) is a self funding non-profit organisation which aims to advance the discipline and improve communication between stakeholders. DMISA, which was founded in 1985 as the Civil Defence Association of South Africa has engaged with the South African National Disaster Management Centre (NDMC) on

various occasions. Regular meetings between DMISA leadership and the NDMC seeks to ensure a constant flow of relevant information from various civil servants; cutting red tape and improving co-operation.

Until recently, civil defence services were catered for under the provisions of the Civil Defence Act 67 of 1977 and the Fund Raising Act of 1978. Following a DMISA organised study tour to Europe and Britain in 1990, a significant shift from civil defence and protection to disaster management in South Africa occurred. The International Decade for Disaster Reduction (IDNDR) introduced by the United Nations during the 1990s signalled a shift in focus away from reactive disaster responses onto prevention, preparedness and strengthening resilience or capacity. These changes in thinking among practitioners in the field coincided in South Africa with a move from military influence towards real civilian control at the end of apartheid.

As a result of these changes, the UN Disaster Management Training Programme was introduced to South Africa, leading in 1996 to a partnership with Technikon SA to offer Certificate Courses in Disaster Management (www.disaster.co.za).

2.7 'Caelum' Database This publicly available database has the most up to date and comprehensive weather related hazard database in South Africa, developed by the South African Weather Service. The database, which is updated regularly, comprises a list of major weather events in South Africa from 1961. Although this database is comprehensive in terms of national scale, it falls short on a local level (Extracted from: Towards a methodology for the use of geo-information technology in disaster assessment, van Vuuren, 2008).

2.8 The Training, Education, Awareness and Marketing (TEAM) Project
A collaborative initiative between the Western Cape Provincial Disaster Management Centre (PDMC) and the Development Fund of the Development Bank of Southern Africa (DBSA). The TEAM project was an 18 month project, started in October 2005 that focused on capacity building in 11 informal settlements in the Western Cape, including Masiphumelele.

As part of the TEAM project, a three day community risk assessment workshop was held in Masiphumelele from 18 - 20th January 2006, hosted by the Disaster Mitigation for Sustainable Livelihoods Programme (DiMP), University of Cape Town, in collaboration with the Development Action Group and Disaster Management City of Cape Town. The workshop was attended by 28 participants, the majority of whom were community members and community-based organisations, one NGO and two government departments. The aim of the Community Risk Assessment (CRA) workshop was to explore in a participatory way the priority risks and at the same time for participants to gain an understanding of what CRA is about and how to conduct a CRA (www.capegateway.gov.za.)

2.9 PERIPERI
Periperi is an acronym for *'partners enhancing resilience for people exposed to risks'*.
In 1997, DiMP received funding from the British Department for International Development (DFID) approved funding to DiMP to establish a network of agencies committed to strengthening disaster mitigation research, training, education and practice. This resulted in cooperation between sixteen different organisations from five Southern African countries. These are involved in different spheres, notably developmental agencies, public health practitioners, rural water supplies, urban planners and university researchers. The resultant Periperi network is committed to risk reduction in southern Africa (www.egs.uct.ac.za/dimp/periperi.htm).

2.10 MANDISA (Monitoring and Mapping of Disaster Incidents in South Africa)
MANDISA is a database developed by DiMP in 1999. This was initiated as a pilot study in the Cape Town municipality. Its aim is to monitor declared disasters as well as small and medium scale events. It contains over 19,000 geo-referenced incidents including floods, wildfires and extreme wind events. It relies on data collected from fire services, disaster management agencies and NGOs like the South African Red Cross amongst others. The data is however not available to the public due to its size and sensitivity (DiMP, 2006).

2.11 Open Access IT Infrastructure for Flood Risk

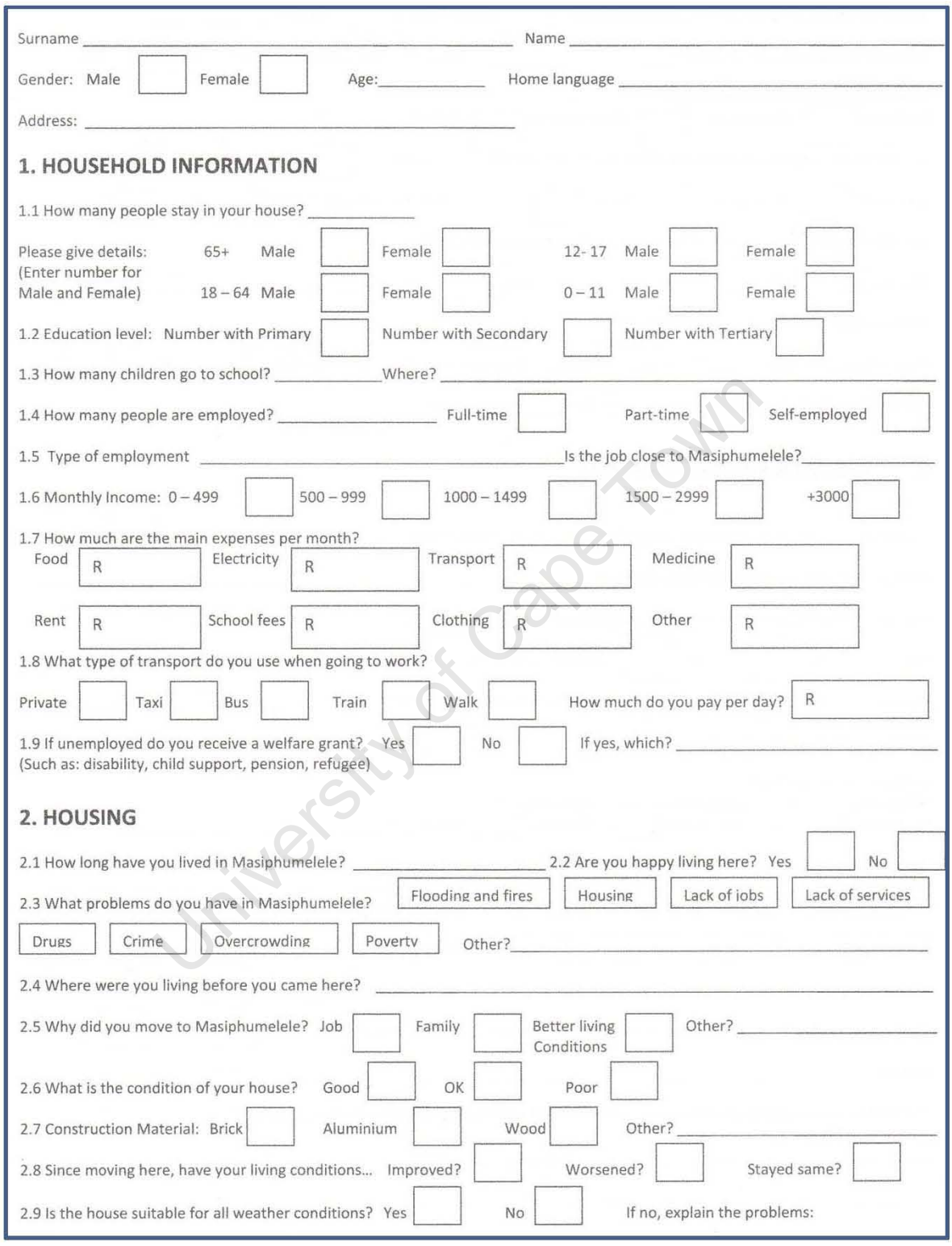
Terrence L. Van Zyl *et al* presented the paper, *IT Infrastructure Enabling Open Access for Flood Risk Preparedness in South Africa* at *the 6th International ISCRAM Conference in Gothenburg, Sweden, May 2009.*

The paper focuses on the information technology infrastructure required for the evaluation and monitoring of risk relating to floods in South Africa. It proposes an information technology infrastructure alerting decision makers of possible high risk flood areas and thereby increasing their preparedness. According to Van Zyl *et al*, it is believed that the best solution of improving preparedness for disasters is by the integration of scientific knowledge with social impact studies into an IT framework.

The framework would rely on the use of open service oriented architecture (OSA), such as the Sensor Web. Standardization within the Open Geospatial Consortium (OGC) under the name Sensor Web Enablement (SWE) has led to the success of the Sensor Web. SWE consists of three standardized service interfaces and three standard data encodings. The service interfaces take the form of; Sensor Observation Service (SOS), Sensor Planning Service (SPS), and Sensor Alerting Service (SAS). The data encoding are Observations and Measurements (O&M), Transducer Markup Language (TML), and Sensor Modelling Language (SensorML).

The Integrated Risk Management in Africa project (IRMA) is a pre-operational open infrastructure and access-platform, assessed by end-users in operational scenarios. It hopes to assist decision makers in measuring and evaluating potential flood risks on a continual basis and thereby improve preparedness in the event of a disaster (Van Zyl *et al*, 2009).

APPENDIX II: ADDITIONAL PHASE 1 AND 2 SURVEY INFORMATION



Surname _____ Name _____

Gender: Male ☐ Female ☐ Age:_____ Home language _____

Address: _____

1. HOUSEHOLD INFORMATION

1.1 How many people stay in your house? _____

Please give details: (Enter number for Male and Female)
65+ Male ☐ Female ☐ 12- 17 Male ☐ Female ☐
18 – 64 Male ☐ Female ☐ 0 – 11 Male ☐ Female ☐

1.2 Education level: Number with Primary ☐ Number with Secondary ☐ Number with Tertiary ☐

1.3 How many children go to school? _____ Where? _____

1.4 How many people are employed? _____ Full-time ☐ Part-time ☐ Self-employed ☐

1.5 Type of employment _____ Is the job close to Masiphumelele? _____

1.6 Monthly Income: 0 – 499 ☐ 500 – 999 ☐ 1000 – 1499 ☐ 1500 – 2999 ☐ +3000 ☐

1.7 How much are the main expenses per month?
Food R ☐ Electricity R ☐ Transport R ☐ Medicine R ☐
Rent R ☐ School fees R ☐ Clothing R ☐ Other R ☐

1.8 What type of transport do you use when going to work?
Private ☐ Taxi ☐ Bus ☐ Train ☐ Walk ☐ How much do you pay per day? R ☐

1.9 If unemployed do you receive a welfare grant? Yes ☐ No ☐ If yes, which? _____
(Such as: disability, child support, pension, refugee)

2. HOUSING

2.1 How long have you lived in Masiphumelele? _____ 2.2 Are you happy living here? Yes ☐ No ☐

2.3 What problems do you have in Masiphumelele? Flooding and fires ☐ Housing ☐ Lack of jobs ☐ Lack of services ☐
Drugs ☐ Crime ☐ Overcrowding ☐ Poverty ☐ Other? _____

2.4 Where were you living before you came here? _____

2.5 Why did you move to Masiphumelele? Job ☐ Family ☐ Better living Conditions ☐ Other? _____

2.6 What is the condition of your house? Good ☐ OK ☐ Poor ☐

2.7 Construction Material: Brick ☐ Aluminium ☐ Wood ☐ Other? _____

2.8 Since moving here, have your living conditions... Improved? ☐ Worsened? ☐ Stayed same? ☐

2.9 Is the house suitable for all weather conditions? Yes ☐ No ☐ If no, explain the problems:

Wetlands and TRA Survey Questionnaire (Page 1)

3. WATER, SANITATION AND HEALTH

3.1 Where do you go to the toilet? Communal toilet ☐ House toilet ☐ Other? _____

3.2 How many people use this toilet? _____ 3.3 Is the toilet in good condition? Yes ☐ No ☐

3.4 Where do you get your water from?
Inside tap ☐ Outside tap ☐ Communal tap ☐ Other? _____

3.5 How many times is the refuse collected in your community? 1 x week ☐ 2 x week ☐ 1 x month ☐
2 x month ☐ Never ☐ Is it often enough? Yes ☐ No ☐

3.6 What illnesses have you or your family had while living in Masiphumelele?
Cholera ☐ Typhoid ☐ Hepatitis ☐ T.B ☐ Other? _____

3.7 What health facilities do you have access to?
Hospital ☐ Clinic ☐ Traditional Healer ☐ General Practitioner (G.P) ☐ Emergency services ☐ Family planning ☐

3.8 Are theses facilities adequate? Yes ☐ No ☐ If no, why? _____

4. DISASTER RISK MANAGEMENT

4.1 Do you think you are at risk to the following in Masiphumelele? Fires Floods Other? _____

4.2 Have you ever experienced fires or flooding at your home?
Fires Yes ☐ No ☐ How many times? ☐ When last? _____
Flooding Yes ☐ No ☐ How many times? ☐ When last? _____

4.3 What can be done to reduce these risks? Rebuild better houses Relocate Improvement of services
Community participation Awareness / Education programmes Other? _____

4.4 What do you do to protect yourself from flooding? _____

4.5 What do you do to protect yourself from fires? _____

4.6 Are you given any warnings about flood risks or before major storms? Yes ☐ No ☐

4.7 If you were able to move to a place, other than Masiphumelele, would you move? Yes ☐ No ☐

Where? _____

4.8 What do you suggest government do to reduce the risks such as flooding and fires in Masiphumelele? _____

_____

_____

Wetlands and TRA Survey Questionnaire (Page 2)

Surname _____ Name _____

Gender: Male ☐ Female ☐ Age:_____ Home language _____

Address: _____

Type of house: Rented ☐ Owned ☐ Backyard ☐ Government Subsidised ☐ Other? _____

1. HOUSEHOLD INFORMATION

1.1 How many people stay in your house? _____ Number Male _____ Number Female _____

Age 65+ Male _____ Female _____ Age 12- 17 Male _____ Female _____

Age 18 – 64 Male _____ Female _____ Age 0 – 11 Male _____ Female _____

1.2 Household education level: Number with Primary ☐ Number with Secondary ☐ Number with Tertiary ☐

1.3 How many children go to school? _____ Where? _____

1.4 How many people are employed? _____ Full-time ☐ Part-time ☐ Self-employed ☐

1.5 Type of employment _____ Is the job close to Masiphumelele? _____

1.6 Monthly Income: 0 – 499 ☐ 500 – 999 ☐ 1000 – 1499 ☐ 1500 – 2999 ☐ +3000 ☐

1.7 How much are the main expenses per month?

Food R _____ Electricity R _____ Transport R _____ Medicine R _____

Rent R _____ School fees R _____ Clothing R _____ Other R _____

1.8 What type of transport do you use when going to work?

Private ☐ Taxi ☐ Bus ☐ Train ☐ Walk ☐ How much do you pay per day? R _____

1.9 If unemployed do you receive a welfare grant? Yes ☐ No ☐ If yes, which? _____
(Such as: disability, child support, pension, refugee)

2. HOUSING

2.1 How long have you lived in Masiphumelele? _____ 2.2 Are you happy living here? YES ☐ NO ☐

2.3 What problems do you have in Masiphumelele? Flooding and fires ☐ Housing ☐ Lack of jobs ☐ Lack of services ☐

Drugs ☐ Crime ☐ Overcrowding ☐ Poverty ☐ Other? _____

2.4 Where were you living before you came here? _____

2.5 Why did you move to Masiphumelele? Job ☐ Family ☐ Better living conditions ☐ Other? _____

2.6 What is the condition of your house? Good ☐ OK ☐ Poor ☐

2.7 Construction Material: Brick ☐ Aluminium ☐ Wood ☐ Other? _____

2.8 Since moving here, have your living conditions... Improved? ☐ Worsened? ☐ Stayed same? ☐

Formal Area Survey Questionnaire (Page 1)

Page 1

3. WATER, SANITATION AND HEALTH

3.1 Where do you go to the toilet? Communal toilet ☐ House toilet ☐ Other? _____

3.2 How many people use this toilet? _____ 3.3 Is the toilet in good condition? Yes ☐ No ☐

3.4 Where do you get your water from?
Inside tap ☐ Outside tap ☐ Communal tap ☐ Other? _____

3.5 How many times is the refuse collected in your community? 1 x week ☐ 2 x week ☐

1 x month ☐ 2 x month ☐ Never ☐ Is it often enough ? Yes ☐ No ☐

3.6 What illnesses have you or your family had while living in Masiphumelele?

Cholera ☐ Typhoid ☐ Hepatitis ☐ T.B ☐ Other? _____

3.7 What health facilities do you have access to?

Hospital ☐ Clinic ☐ Traditional Healer ☐ General Practitioner (G.P) ☐ Emergency services ☐ Family planning ☐

3.8 Are theses facilities adequate? Yes ☐ No ☐ If no, why? _____

4. DISASTER RISK MANAGEMENT

4.1 Were you aware of the risk of flooding before you built this house here? Yes ☐ No ☐

4.2 If yes, why did you still build the house here? _____

4.3 Have you ever experienced fires or flooding at your home?

Fires Yes ☐ No ☐ How many times? ☐ When last? _____

Flooding Yes ☐ No ☐ How many times? ☐ When last? _____

4.4 Do you think you are at risk to flooding? Yes ☐ No ☐ Why? _____

4.5 What sort of flooding?
Seeping from underground ☐ leaking from roof or walls ☐ Complete flooding ☐ Other? _____

4.6 What do you (or could you) do to protect yourself from flooding? Please tick:

Raise house up	Use cement on floors	Divert water	Dig channels	Build / move away from wetland
Stay with a friend	Rebuild better house	Nothing	Other? _____	

4.7 Are you given any warnings about flood risks or before major storms? Yes ☐ No ☐

4.8 If you were able to move to a place, other than Masiphumelele, would you move? Yes ☐ No ☐

Where? _____

4.9 What do you suggest government do to reduce the risk of flooding in Masiphumelele? _____

_____

_____

Formal Area Survey Questionnaire (Page 2)

Date 11-05-10 Time 11:' Waypoint SO Easting 57393 E Northing 3777823 N

1. HOUSEHOLD INFORMATION

Surname SETI Name AMDILE Cell Number 0735691997

Gender: Male [✓] Female [ ] Age: 26 Home language XHOSA

Address: 29 1.1 How many people stay in your house? 2

2. HOUSING

2.1 How long have you lived in Masiphumelele? 4 years 2.2 Where were you living before you came here? E.CAPE

2.3 What is the condition of your house? Good [ ] OK [ ] Poor [✓]

2.4 Construction Material: Brick [ ] Aluminium [✓] Wood [✓] Other? _____

3. WATER, SANITATION AND HEALTH

3.1 Where do you go to the toilet? Communal toilet [✓] House toilet [ ] Other? _____

3.2 How many people use this toilet? many 3.3 Is the toilet in good condition? Yes [ ] No [✓]

3.4 Where do you get your water from?
Inside tap [ ] Outside tap [ ] Communal tap [✓] Other? _____

4. DISASTER RISK MANAGEMENT

4.1 Have you ever experienced fires or flooding at your home?

Fires Yes [ ] No [✓] How many times? - When last? _____

Flooding Yes [✓] No [ ] How many times? 10 When last? 09-MA-1-2010

4.2 Do you think you are at risk to flooding? Yes [✓] No [ ] Why? BAD CONDITION (HOUSE)

4.3 What sort of flooding?
Seeping from underground [✓] leaking from roof or walls [✓] Complete flooding [ ] Other? _____

4.4 What do you (or could you) do to protect yourself from flooding? Please tick:

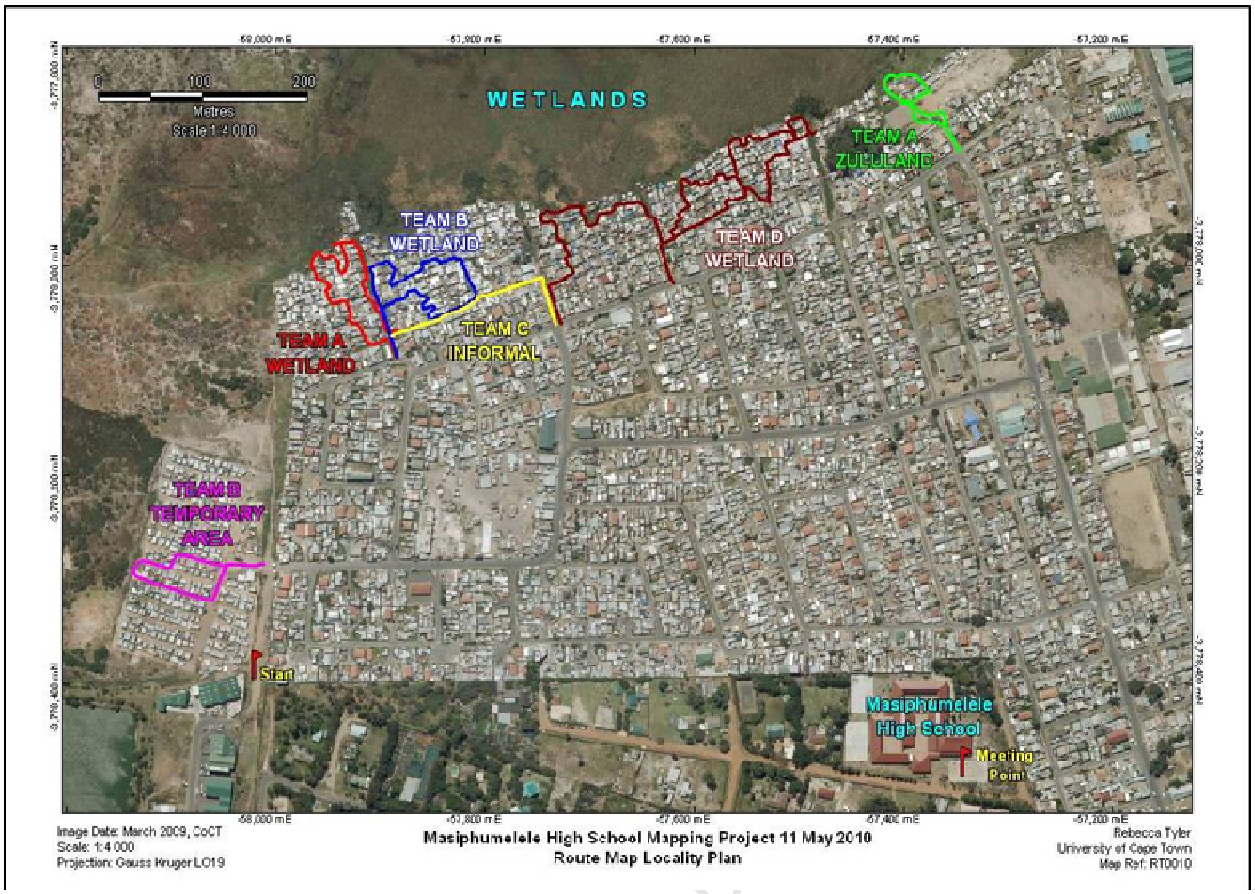
Raise house up	Use cement on floors ✓	Divert water ✓	Dig channels	Build / move away from wetland
Stay with a friend ✓	Rebuild better house ✓	Nothing	Other? _____	

4.5 Are you given any warnings about flood risks or before major storms? Yes [ ] No [✓]

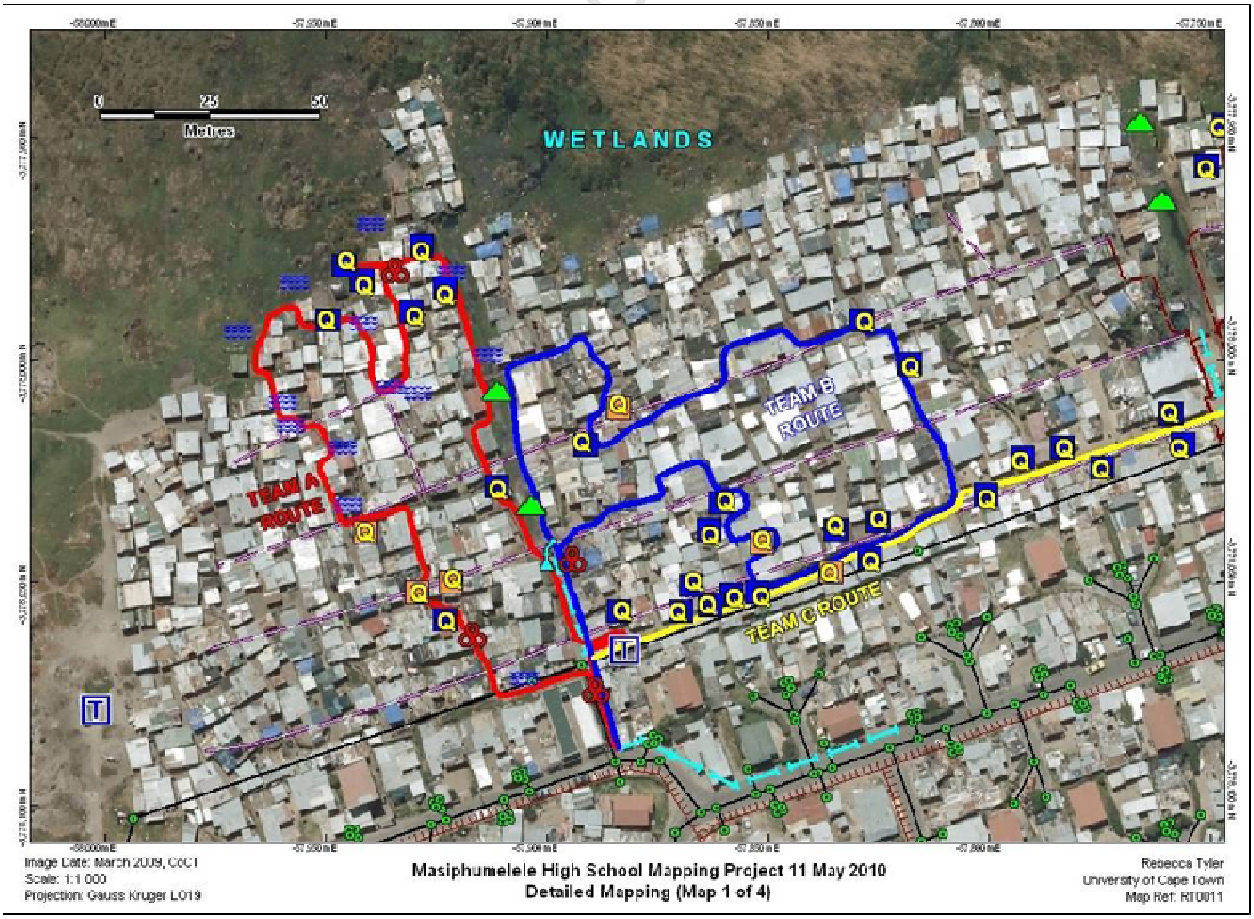
4.6 In the event of serious flooding, do you know which department to contact? _____

4.7 What is the telephone number? _____

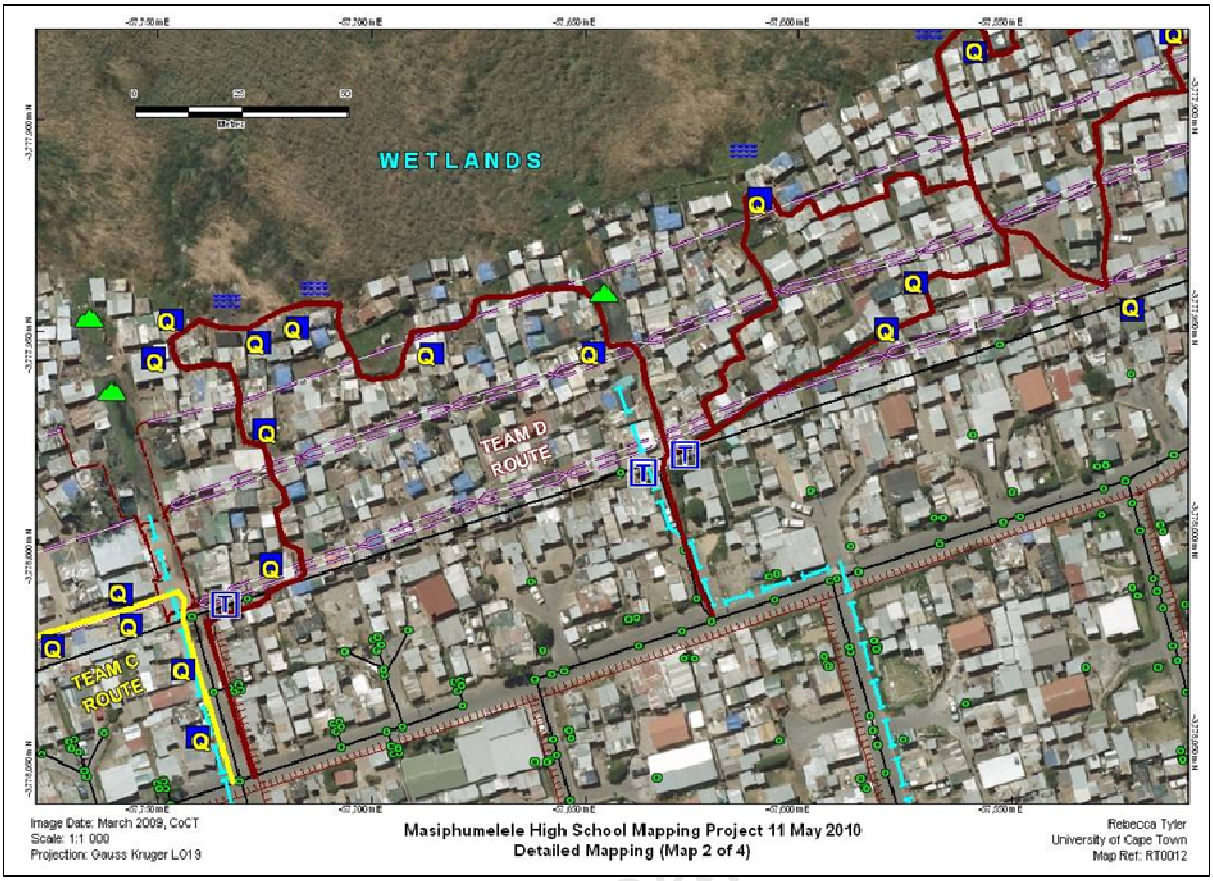
Example of Completed Survey Questionnaire (Phase 2)



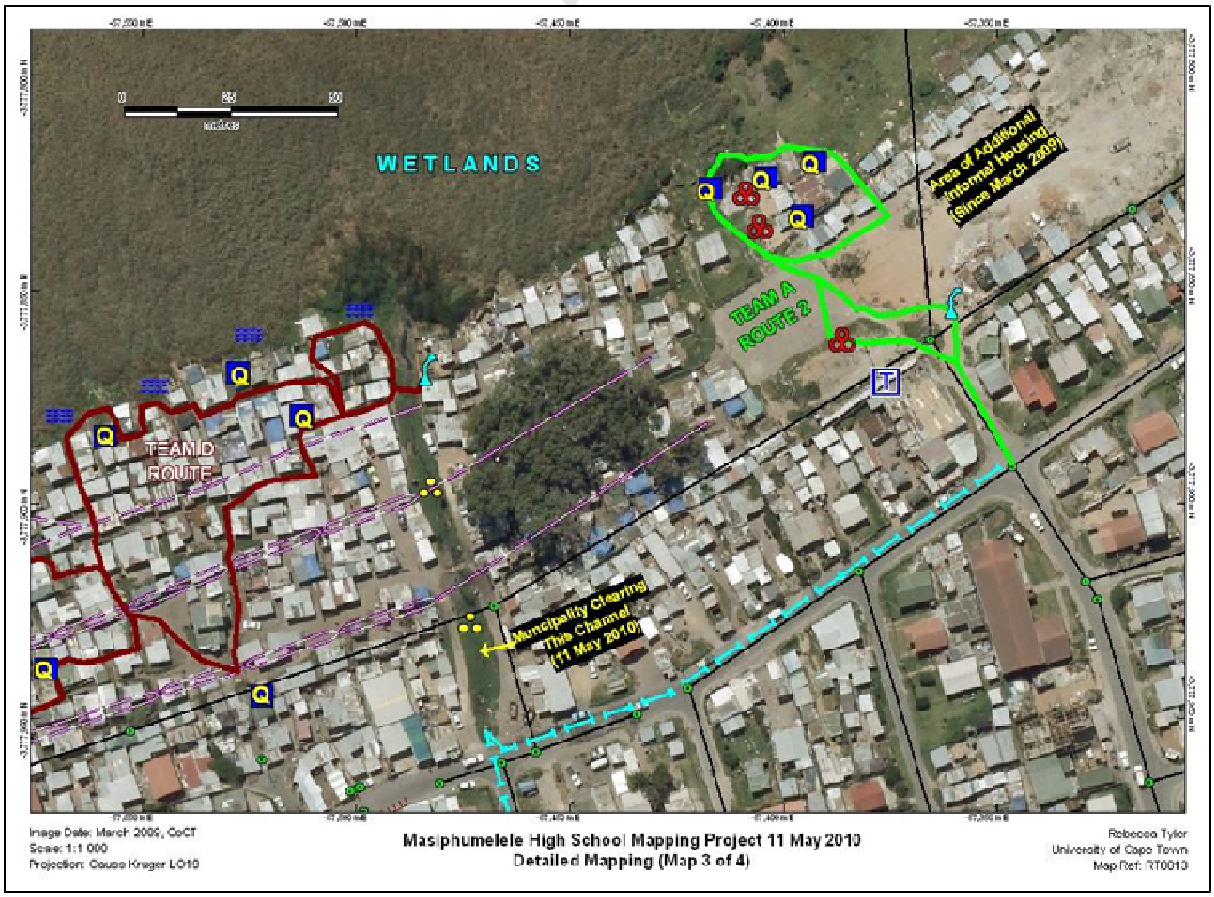
Route map Phase 2 Mapping Exercise



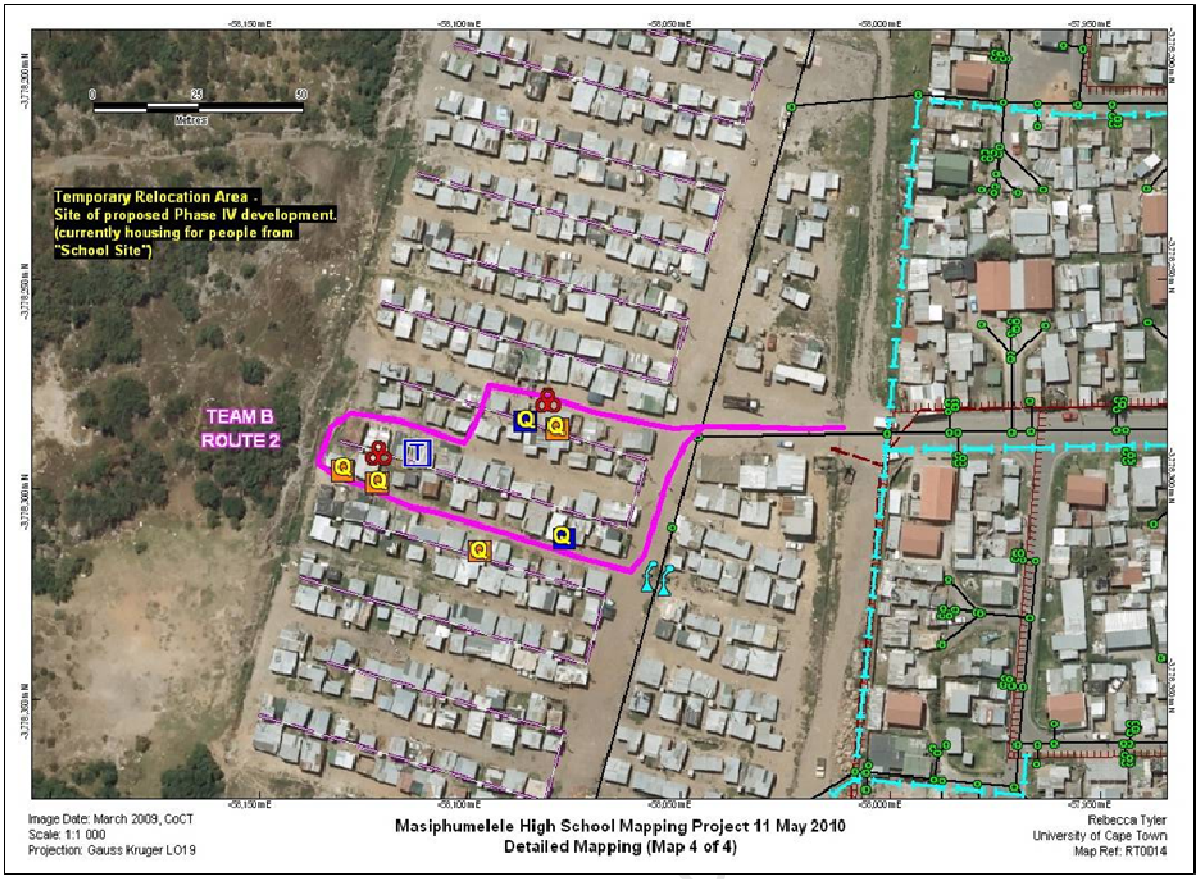
Team A, route 1; Team B, route 2 and Team C route - Phase 2 Mapping Exercise



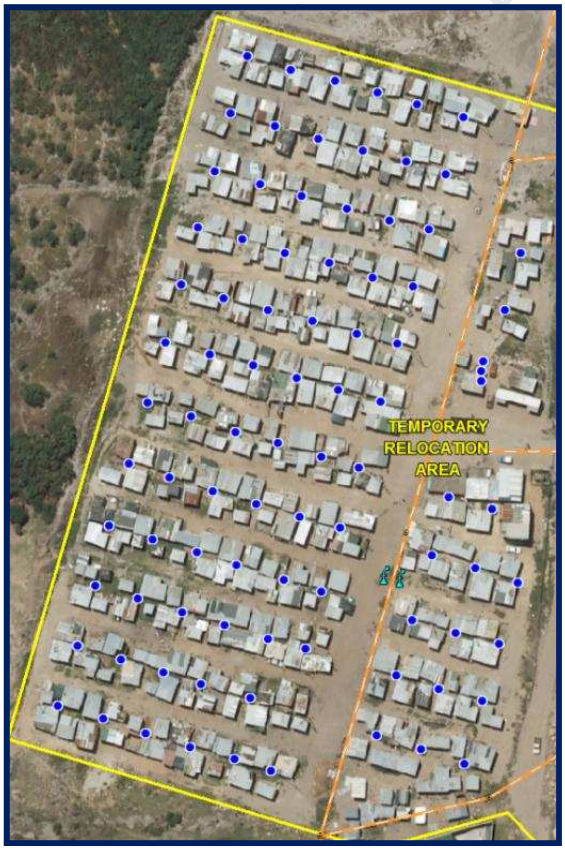
Team C and B Routes - Phase 2 Mapping Exercise



Team D Route and Team A Route 2 - Phase 2 Mapping Exercise



Team B, Route 2 - Phase 2 Mapping Exercise



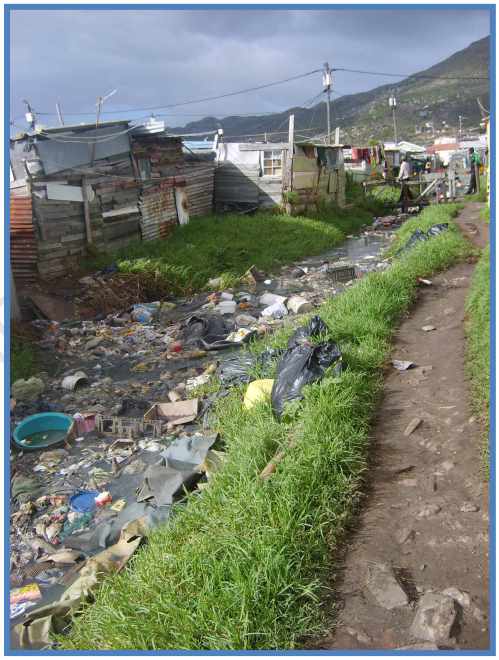
Location of Toilets and Taps and Drainage Infrastructure - TRA

Location of Toilets and Taps and Drainage Infrastructure – Wetlands and Formal Areas

Litter Clogging Drainage Channels - Wetlands

Mitigation Measure: Plastic Linoleum Covering the Floor of a Dwelling - Wetlands

Litter and building materials dumped into the wetland adjacent to the settlement - Wetlands



One of the clogged Drainage Channels – Wetlands

Close Proximity of Dwellings - Wetlands

Water Ponding between Dwellings - Wetlands

TEAM A: Rebecca Tyler

Mishikwa Wongekile
Fani Lwandokazi
Ngqalo Siyambona

TEAM B: Vicki Ferguson

Bulelani Gekiso
Sivuyile Mkhwezo
Vuyiseka Nganase

TEAM C: Kevin Musungu

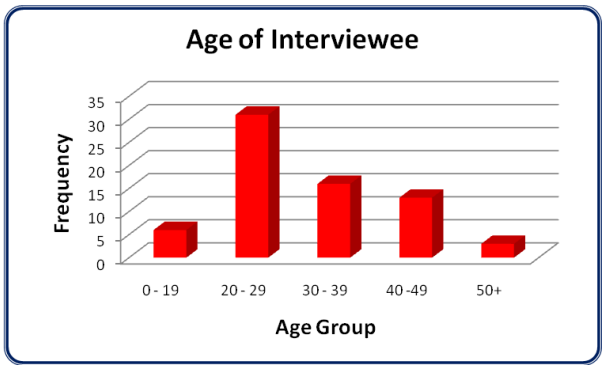
Mkhona Sibongiseni
Mhambi Gcobokazi
Qokelwa Masibulele

TEAM D: Roger Tyler

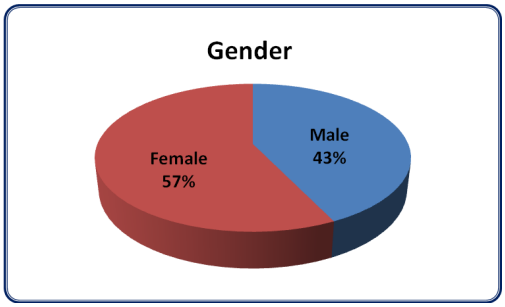
Buthelezi Ntokozo
Aviwe Nkabi
Asanda Gondwana

Phase 2 Teams A - D

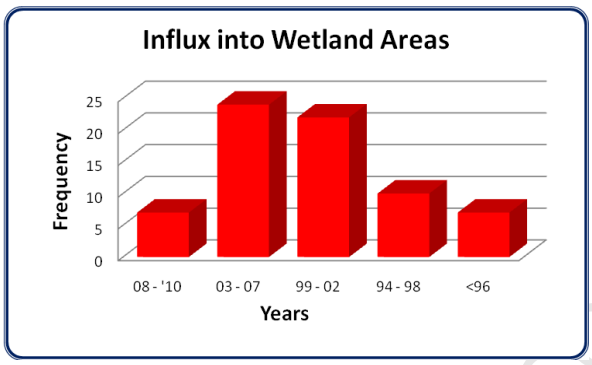
APPENDIX III: ADDITIONAL PHASE 2 SURVEY STATISTICS

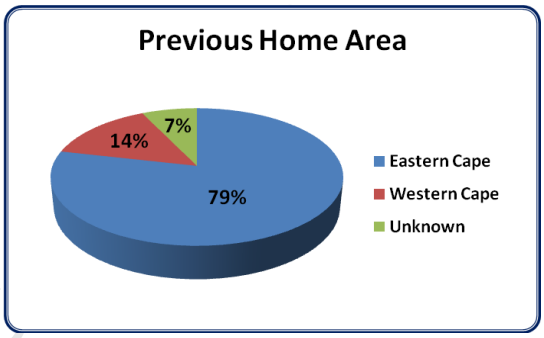


Most of the people interviewed were in the age category 20 – 40.

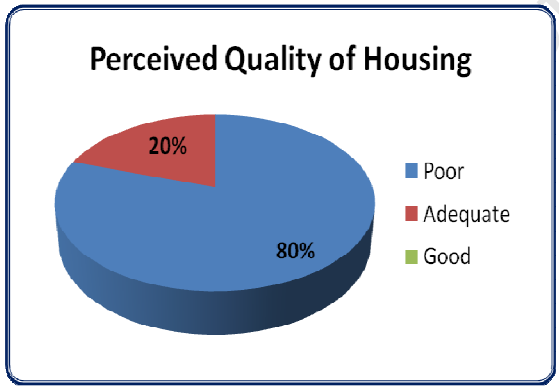


Females accounted for 57% of those interviewed.

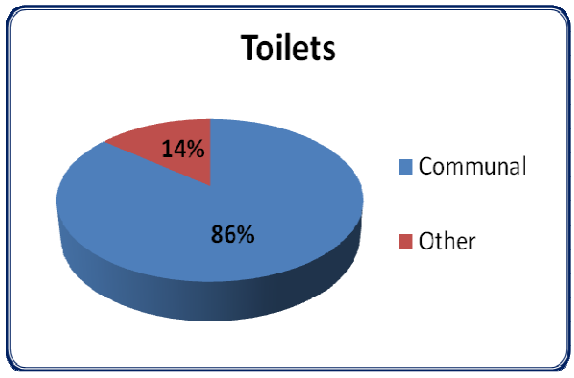




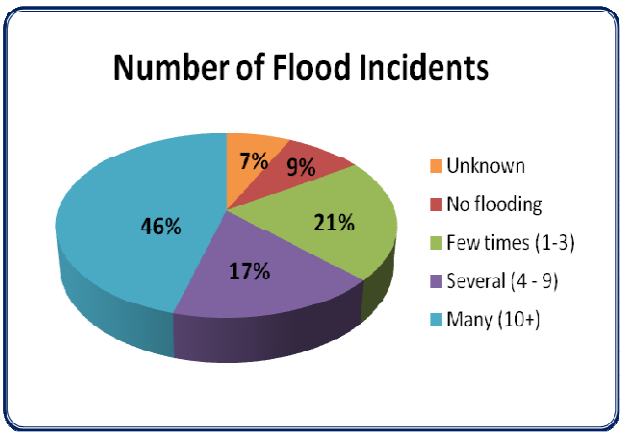
Most Residents originate from the Eastern Cape



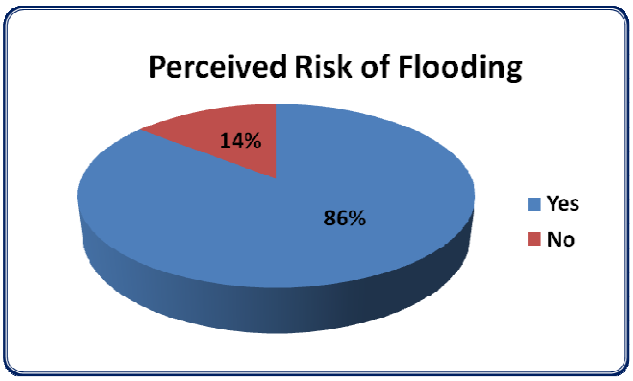
The graph shows the homeowners perception of the quality of their home. Most people believe their homes are of inferior quality.



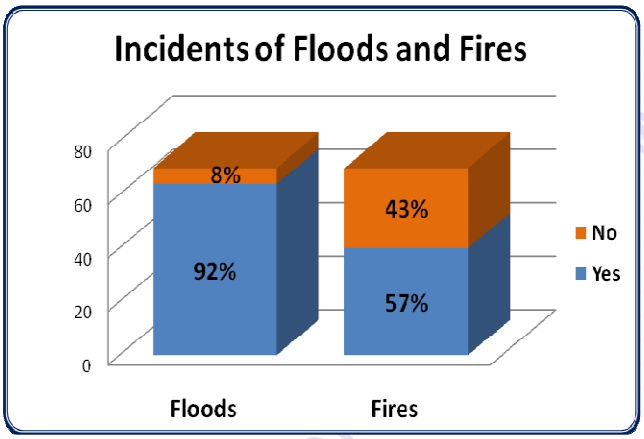
Communal toilets are the norm here. Many people use the bucket system, the contents of which are thrown directly into the channels.



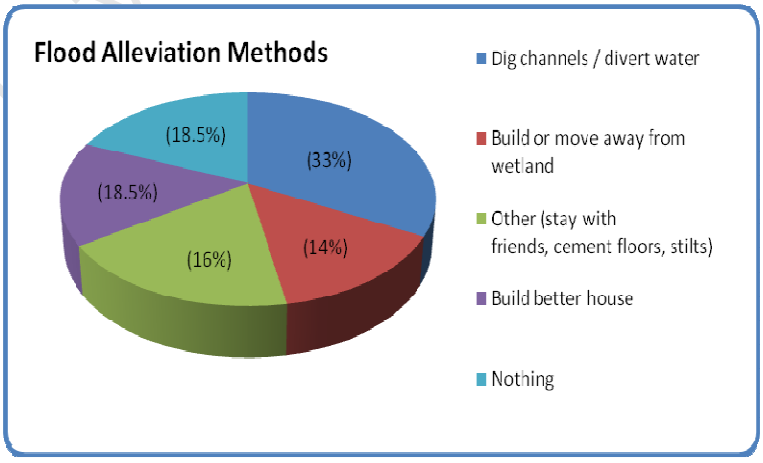
Flooding is mostly seasonal, though in areas adjacent to the wetland, the ground can be damp all year round.



Most residents say they are aware of the risk of flooding,
There are no signs to be found anywhere in this settlement warning newcomers of this danger.



Floods and fires are a common occurrence in this community.
The closeness of a property to a wetland and the small distance between houses is probably the major reason. for this.



Flood alleviation methods witnessed in the field included amongst others, the following:

Digging channels, concrete on floors, plastic sheeting and rebuilding homes.

APPENDIX IV: HOUSING DEVELOPMENT PLANS

This appendix summarises the housing situation in Cape Town in general and specifically addresses the development plans for Masiphumelele and surrounding areas.

a. The Problem of Housing in Cape Town

There are various scenarios as to how the City will deal with the backlog of around 48 000 houses required per annum. The Cape Town Housing Directorate's 5-year integrated housing plan 2009/10 – 2013/14 report proposes four housing scenarios (City of Cape Town, 2009c). These scenarios are briefly outlined below.

Scenario A: An estimated total of 157 700 houses delivered assuming R1 billion funding from the National Provincial Department of Housing. Factoring in a growth rate of 17 000 houses *per annum*, which seems the most reasonable estimate, this scenario would lead to a backlog of 655 000 at the end of 2027.

Scenario B: 1/3rd of the annual budget to be used for serviced sites with houses while the remaining 2/3^{rds} will be used for serviced sites only. 2 580 sites with houses and 16 700 serviced sites totalling 19 280 housing units *per annum* and 366 320 houses by the end of 2027. This scenario would lead to a backlog of 339 680 by the end of 2027.

Scenario C: 100% of the annual budget will be used to provide 20 500 serviced sites *per annum*, totalling 389 000 sites by 2027. The backlog would be 317 000 by the end of 2027.

Scenario D: This scenario assumes full commitment from public and private sectors in dealing with the total backlog. It will require R100 billion to sufficiently provide the infrastructure and housing necessary within the 18 year period

Figure IV.1 shows this backlog of housing and the four scenarios presented above. If these figures are accurate, the city of Cape Town faces a precarious future, particularly if issues of land, housing and employment, not to mention disaster management, are not addressed in a co-operative and systematic manner. Obtaining suitable land, even if merely for temporary relocation purposes, is a major concern. Once suitable land is obtained, procedures, such as environmental impact assessments and project approval by means of public participation, are obligatory and increase the waiting period of housing delivery. In addition to this, these types of formalities can often take up to three years to complete. During this lengthy process, more informal occupants are likely to have taken up residence in these areas if there is no proper control. Strict legislative processes include the compliancy of a number of environmental, planning, heritage and transport laws. Local government does not currently have the capacity to change this legislation.

Of concern to the City is not just the increase of people taking residence in existing informal areas, but also into areas already identified as suitable for development. One particular problem is that of the refusal of residents to move out of areas designated for upgrade, which can lead to further delays in the building process. Some residents on the housing list have been living in Cape Town for over 20 years and should therefore be given priority for receiving formal housing. New arrivals however, tend to settle in the least suitable areas, especially those areas prone to flooding. Often this fact has lead ironically to the City having to allocate them with priority serviced land ahead of longstanding residents. The perception amongst existing residents is that newcomers are given decent housing before or quicker than themselves. This appears to be a real belief amongst many who are residing in informal settlements and has often resulted in conflict. In some cases, this can lead to more new arrivals moving into these lower lying areas, as it gives the impression of perhaps being able to 'get ahead of others' who are on the list of recipients for decent housing.

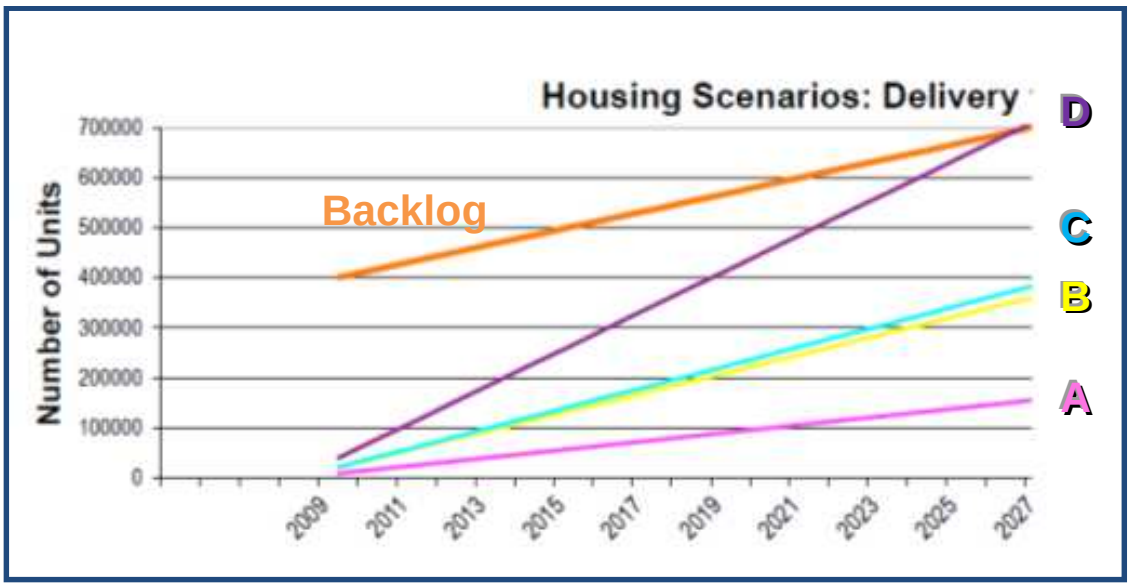


Figure IV.1 Cape Town Housing Directorate 5 year integrated housing plan (2009/10 – 2013/14)

Clearly scenario D would be the ideal, though in reality probably highly unlikely.

The City of Cape Town however, has set up an anti-land invasion unit (ALIU) in an attempt to stop people illegally occupying land demarcated for people on this housing register (www.capetown.gov.za). The approach of zero tolerance, to invading City-owned property is currently being adopted by the City of Cape Town. The delivery of housing, in its current methodology is unlikely to solve the needs of the continued influx of people into the urban environment. The informal settlement environment allows people to obtain access to this environment relatively cheaply. The political response to these settlements is to attempt to solve the problems through proposing new housing solutions.

The delivery of housing in its current methodology is unlikely to solve the needs of the continued influx of people into the urban environment. The informal settlement environment allows people to obtain access to this environment relatively cheaply. The political response to these settlements is to attempt to solve the problems through the proposal of new housing solutions.

b. Masiphumelele Phase IV

Phase IV was originally proposed by the City of Cape Town in 2006 (Chand, 2006). This has been designated as a subsidy housing development where approximately 200 – 400 residential housing units together with associated infrastructure are planned. The site, classified as 'green fields' [a portion of undeveloped land designated for future development] is approximately 12ha in size, and is situation on a portion of Erf 4198 of Kommetjie. It is immediately adjacent to the existing Masiphumelele residential area and the Wildevoelvlei Sewage Treatment Works.

Due to the shortage of facilities in the vicinity, included in this proposal were the addition of sports fields, urban agriculture and public open space. New environmental regulations have however resulted in Phase IV's existing environmental approval lapsing. Subsequently the whole approval process for this project will have to be restarted. Similar incidents have also occurred in a number of other Settlements around Cape Town, notably; Temperance Town, Pelican Park and Somerset West (City of Cape Town annual report 2007/8). According to the Cape Town directorate of housing report entitled: Five year integrated housing plan 2009/10 – 2013/14, the project is still listed in the 'planned' section. To date, nothing has come of this proposal, but once approval is given, it is likely that the project will still take place.

The three following housing alternatives were considered as viable options for the Phase IV project:

- Develop the whole site (11.4 ha). 378 dwellings single-story dwelling and three recreation facilities would be the result.
- Partially develop the site with single-storey housing but leave a buffer along the western side to the National Park. 174 single-storey dwelling units and two sports fields would be developed.
- Partially develop the site with double-storey housing but leave a buffer along the western side to the National Park. 252 double-story dwelling units and two sports fields would be developed with this scenario.
- Develop as a recreational park area with no housing and maintain a park buffer. Four sports fields will result from this development.

The Papkuilsvlei is under pressure due to increased development in the Noordhoek valley, therefore an additional channel to re-route some of the water from the reed beds to the Wildevoelvlei, has been recommended. Currently there is only a narrow drainage furrow.

Some of the problems associated with this development are discussed below:

- Flood levels
  Much of the western portion of the site is unsuitable for housing development because it lies below the 1:100 year flood level. Problems with building below this level include poor drainage, standing water and high water tables.
- Land use planning
  The site goes against many of the land use development policies such as the urban edge limit, conservation of the wetlands and the City's 'open space' strategy.
- No alternative land considered
  Other alternatives such as the land opposite Masiphumelele to the south of Kommetjie Road and adjacent smallholders were never seriously considered.
- Close proximity of Waste Water Treatment
  The site might be negatively influenced by ground water pollution, potential flooding, sludge seepage, smells and noise; this could negatively impact on human health and wellbeing. Future expansion of the Treatment Works is also possible.

Phase IV is the obvious expansion area for Masiphumelele because of its size and close proximity to the existing settlement. It should be noted however that the area is low-lying (3 – 7 metres amsl) and will be prone to flooding; the area is also adjacent to the National Park Boundary. There must be concerns that the buffer zone might not be maintained and a 'blind eye' turned to an influx of illegal settlers, as was the case in the original Wetlands settlement.

A plausible alternative to Phase IV is to relocate residents to other areas within the Southern Peninsula. These options are discussed in the following section.

b. Proposed New Urban Housing Plans for the Southern Peninsula

One of the principal setbacks in the Southern suburbs is undoubtedly the unavailability and / or high price of suitable land. Suitable land is largely owned by either the private sector for which Provincial Government lacks sufficient funding to purchase. The City of Cape Town does however have plans to develop certain areas in the Southern Peninsula. According to the CitySpace Southern District Plan of August 2009, there are seven proposed urban infill sites that have been identified as suitable for housing in the far south (City of Cape Town, 2009c) (See Figure below).

Five of the seven proposed new housing areas are summarised in Table IV.1 (also shown in Figure IV.2), also including pros and cons for each development area.

Two other infill areas, namely, the Kaolin Mine and the Silvermine Road sites, both in the Noordhoek suburb are to be allocated for low density housing development, and therefore not strictly relevant to this study. Imhoff's Gift and Solele along the Kommetjie road have been set aside as mixed use urban infill with medium and low density options immediately behind them. The largest area is located in Dido Valley where a range of different density housing has been proposed.

Since Masiphumelele is already at full capacity, the only plausible areas of further influx, or movement of existing residents, appears to be in Solele immediately to the south and possibly also at Imhoff's gift, a kilometre to the west (and Phase IV if approval is obtained). Mixed use intensification, which includes high density housing, is also planned in certain areas, notably the area close to the entrance of Masiphumelele as well as in Ocean View. The merits of the Phase IV development have been discussed in the previous section. The Solele development onto the smallholdings immediately south of Masiphumelele and south of the Kommetjie Road are also an obvious expansion area, assuming the ground can be obtained by the City at an affordable price.
Advantages of the Solele property is the fact that the ground is high lying and is very close to the existing settlement of Masiphumelele. Imhoff's Gift although located quite close to Masiphumelele and on higher ground than the Wetlands, still lies within the coastal risk area. Dido Valley is a large site on the other side of the Peninsula and would effectively become a new settlement due to its distance from Masiphumelele; much of the site is quite steep and would therefore require more expensive foundations. Jupiter Avenue is an obvious expansion area for Ocean View and is clearly not suitable from a physical or cultural perspective as an expansion to Masiphumelele.

Proposed New Housing Areas near Masiphumelele

Name	Location	Size (ha)	Pros	Cons
Masiphumelele Phase IV	Immediately west of Masiphumelele	11	• Obvious expansion site. • Close to Masiphumelele • Area has already been cleared and surveyed.	• Located within coastal risk area • Parts are prone to flooding • (5 – 7m elevation) • 3. Small area
Solele (Kommetjie Road)	Immediately south of Masiphumelele on defunct Game Farm	23	• Obvious expansion site. • Close to Masiphumelele • Higher ground less likely to flood.	• Small area • Expensive land? • Protest from neighbouring • Suburbs?
Imhoff's Gift	To the west of Masiphumelele, opposite Ocean View	26	• Close to Masiphumele • Higher ground	• Within the coastal risk area. • Expensive land?
Jupiter Avenue (Ocean View)	To the south of Ocean View	8	• Close to Masiphumelele • Higher ground	• Not obvious expansion area as • Located next to Ocean View - cultural problems. • Small area.
Dido Valley	Near Da Gama Park, Simon's Town area	73	• Higher ground • Large area Closer to work • Opportunities in Simon's Town	• Terrain is steep – more difficult and expensive to build • Relatively far from Masiphumelele

Table IV.1 Proposed New Housing Areas near Masiphumelele

A number of areas have been proposed as possible development sites for additional housing; only the first three areas would make logical expansion areas for Masiphumelele.

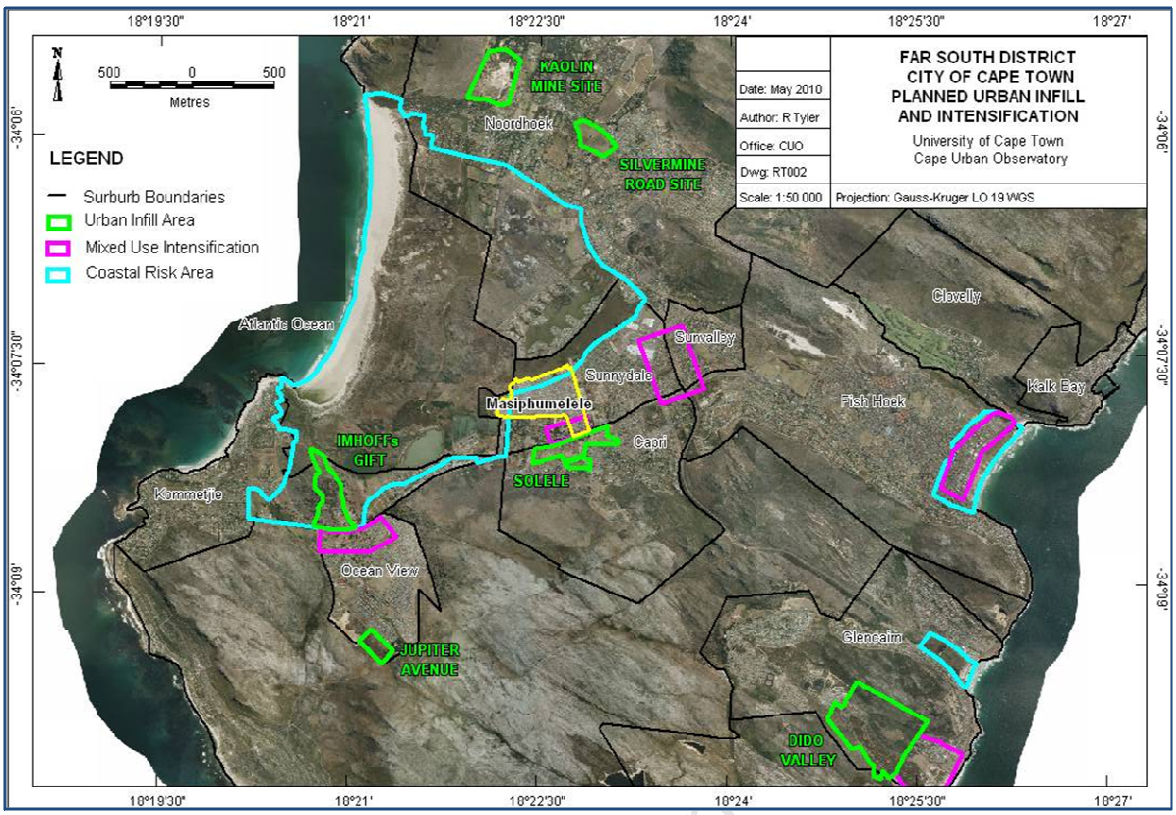


Figure IV.2 Proposed New Housing Development Areas – South Peninsula

Solele to the immediate south of Masiphumelele is the obvious expansion area.

APPENDIX V

Amakhaya Ngoku Community-Based Housing Initiative

In 2006, Amakhaya Ngoku was formed by local residents as a self-help project, after a fire destroyed 400 shacks. The project, is currently building residential units on the so-called Masiphumelele 'School Site'. The housing initiative plans to build flats for 352 families whose homes were destroyed by fire in 2006. Various setbacks have occurred during the building process; notably, informal dwellers refusing to vacate the land allocated for the project. The informal dwellers that had lived in the School Site were relocated to a temporary relocation area (TRA) to the immediate west of Masiphumelele. Basic services such as electrical connections, communal stand taps and toilets have been installed into this area. The area has been fenced off to deter more informal occupants settling. The housing is neatly arranged with ample spacing between each row. This area is the site of the proposed Phase IV development. The Figures below show the first completed blocks of flats of the Amakhaya Ngoku initiative in Masiphumelele.

This initiative has however not been incident free, and rioting broke out in 2009. It was believed that only a small group of backyarders were causing the problems, thereby slowing the building process. Some backyarders refused to move out of the area within Masiphumelele designated for flats, to be built by a public and private sector partnership called Amakhaya Ngoku. This refusal fuelled demonstrations and protests in the streets and became political in nature. The rioting was believed by some not to have been directly related to the building of the flats by this group (Personal Communication: van Dijk, 2010).

Amakhaya Ngoku Completed Flats

Two views of blocks of flats in Masiphumelele completed in 2009 by Housing Initiative Amakhaya Ngoku.