HOW GREEN IS GREEN? A SOCIO-SPATIAL ANALYSIS OF THE STATUS OF GREEN SPACES WITHIN THE ETHEKWINI MUNICIPALITY

SARUSHEN PILLAY
207508502

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SUPERVISOR: DR. S. NAIDOO
CO-SUPERVISORS: PROF. U. BOB AND DR M. GEBRESLASIE

As the candidate's supervisor's we have/ have not approved this thesis/ dissertation for submission.

Signed: _____ **Name:** Dr. S. Naidoo **Date:_____**
Signed: _____ **Name:** Prof. U. Bob **Date:_____**
Signed: _____ **Name:** Dr. M. Gebrelasie **Date:_____**

DECLARATION

I, Sarushen Pillay, hereby declare that the dissertation entitled: '**How green is green? A socio-spatial analysis of the status of green spaces within the eThekwini municipality**', is a result of my own research and investigation and that all sources utilised or quoted have been appropriately acknowledged and referenced. This dissertation is being submitted for the degree of Master of Science at the University of KwaZulu-Natal, and has not been submitted for a degree or examination at any other institution or university.

Sarushen Pillay **Date**

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ABSTRACT

Globally, urbanisation is occurring at an alarming rate and urban green spaces are increasingly recognised as essential components in the quest to achieve sustainable urban landscapes. This study, which involved a socio-spatial analysis of the status of green spaces within the eThekwini Municipality (located in KwaZulu-Natal, South Africa), offers a unique opportunity in terms of urban conservation research. The objectives of the study were to examine the socio-economic characteristics and the perspectives of residents on the use and value of green spaces within the eThekwini Municipality using areas surrounding the Bluff Conservancy (all situated within the SDA) as illustrative examples; to develop a spatial representation of the quality/ integrity of selected green spaces within the eThekwini Municipality in relation to land-use patterns; to examine the appropriateness of the typology presently used by the eThekwini Municipality to describe the status of green spaces and to compare the same with Adapted typologies in order to determine the level of deviation; and lastly, to generate recommendations on the conservation and management of these green spaces.

A variety of socio-spatial analysis methods were used to collect and analyse primary data. Data was obtained using Geographical Information System mapping and a questionnaire in order to ascertain resident perceptions towards their surrounding green spaces. Thereafter, secondary spatial data acquired from the eThekwini Municipality was processed and subjected to a range of analyses to evaluate the efficacy of the typology presently used by the Municipality to assess the quality/ integrity of green spaces. Six random green space types (settlement, tree crops, woodland, forest, grassland and thicket) were selected and first examined using the eThekwini typology and thereafter with the Adapted typology, developed as part of this study.

The results suggested that almost all respondents (75.50%) frequently utilised green spaces in their community, with most respondents favouring the use of recreational and social green spaces (for example, parks, sports field and the golf course). However, respondents also identified numerous challenges associated with accessing and using green spaces; crime, pollution and lack of maintenance in particular, were shown to hamper the optimal use and integrity of a number of green spaces. Additionally, it was found that respondents use of green spaces was not dependent on their gender and income but was significantly influenced by their education. Furthermore, though most respondents indicated that they frequently engage in environmentally-friendly practices, only a small proportion of respondents (9.75%) were aware

of the Durban Metropolitan Open Space System (which is a programme that formally allows for the creation and preservation of green spaces).

In terms of the spatial analyses, the results revealed that selected green spaces within the Municipality when classified using a more discriminatory typology (Adapted typology), can be shown to contain micro-habitats that are either more degraded or more intact than that reflected by the typology presently used by the eThekwini Municipality. It was found that the five thicket green space sites assessed using the eThekwini typology collectively deviated by approximately 60% from that assessed using the more discriminatory Adapted typology. Overall, it was evident that quality based land cover differed minimally to moderately when selected green space types were compared using the two typologies. This resulted in some green micro-habitats within larger green spaces being potentially misclassified in terms of their ecological integrity when using the eThekwini typology and, possibly not being prioritised for conservation and/ or restoration.

The combination of social and spatial results obtained and interpreted in this study was used to generate recommendations for the conservation and management of green spaces within the eThekwini Municipality. Evidence from the social survey clearly showed that respondents expressed a willingness and desire to have and use green spaces. Therefore, it is recommended that the eThekwini Municipality increase the number of green spaces, preferably within densely populated communities as well as improve existing greenery within the Municipality. In addition, these areas should be made more accessible and useable and have value added benefits to communities who are intrinsically supporting them. Furthermore, it was found that the current typology used for the classification of green spaces within the eThekwini Municipality is not discriminative enough to allow for effective management and conservation. This suggests the need for a more nuanced classification of green spaces within the Municipality which ensures that quality characteristics are adequately incorporated into the assessment of these environments.

TABLE OF CONTENTS

DECLARATION ii
ACKNOWLEDGMENTS iii
ABSTRACT iv
TABLE OF CONTENTS vi
LIST OF TABLES x
LIST OF FIGURES xiii
LIST OF ABBREVIATIONS xv
CHAPTER ONE: INTRODUCTION 1
1.1. Preamble 1
1.2. Problem identification 2
1.3. Motivation for the study 3
1.4. Aim and objectives 4
1.5. Brief summary of methodological approach 5
1.6. Structure of dissertation 6
1.7. Conclusion 6
CHAPTER TWO: LITERATURE REVIEW 7
2.1. Introduction 7
2.2. Importance of the environment and conservation 7
2.3. Environmental sustainability 10
2.4. Theoretical framework 12
2.4.1. Environmentalism 13
2.4.2. Ecological modernisation 14
2.4.3. Political ecology 16
2.5. Urban green spaces 19
2.5.1. Urban green space typologies 21
2.5.2. Anthropogenic impacts on urban green spaces 26
2.5.3. Approaches to urban greening 28
2.5.4. Benefits of urban green space 30
2.5.4.1. Ecological 31
2.5.4.2. Social 32

2.5.4.3. Economic 34
2.5.5. Challenges associated with urban green spaces 35
2.5.6. Human perceptions of urban green spaces 36
2.6. Conclusion 38
CHAPTER THREE: METHODOLOGY 39
3.1. Introduction 39
3.2. Background and geographical setting of eThekwini 39
3.2.1. Demographics 41
3.2.2. Climate 42
3.2.3. Biodiversity 43
3.2.4. Status of green spaces within the eThekwini Municipality 43
3.2.5. Durban Metropolitan Open Space System (D'MOSS) 47
3.3. South Durban Area (SDA) 48
3.4. Research design and approach 50
3.5. Data acquisition 50
3.5.1. Survey data 50
3.5.1.1. Sampling framework 51
3.5.1.2. Questionnaire 53
3.5.2. Spatial data 54
3.6. Data analysis and evaluation 55
3.6.1. Statistical analysis 55
3.6.2. Spatial analysis 55
3.7. Limitations and challenges 59
3.8. Conclusion 59
CHAPTER FOUR: RESULTS AND DISCUSSION 61
4.1. Introduction 61
4.2. Socio-economic and demographic characteristics of respondents 61
4.3. Respondent uses and perceptions of urban green spaces 67
4.4. Environmentally-friendly practices of respondents 100
4.5. Respondents awareness and perceptions of the D'MOSS programme 102

4.6. Spatial assessment of the quality of selected green spaces within the eThekwini Municipality 105
4.6.1. Settlements 106
4.6.2. Tree crops 112
4.6.3. Woodland 117
4.6.4. Forest 123
4.6.5. Grassland 128
4.6.6. Thicket 133
4.6.7. Summary for the collective spatial assessment of the quality of selected green spaces within the eThekwini Municipality 138
4.7. Conclusion 139
CHAPTER FIVE: CONCLUDING REMARKS AND RECOMMENDATIONS 140
5.1. Introduction 140
5.2. Summary of the results and key research findings in relation to the objectives 140
5.2.1. To examine social perspectives on the value and use of green spaces within the eThekwini Municipality using areas surrounding the Bluff Conservancy (all situated within the SDA) as illustrative examples 140
5.2.1.1. Socio-economic and demographic characteristics of respondents 140
5.2.1.2. Respondent uses and perceptions of urban green spaces 141
5.2.1.3. Environmentally-friendly practices of respondents 144
5.2.1.4. Respondents awareness and perceptions of the D'MOSS programme 144
5.2.2. To assess the appropriateness of the typology presently used by the eThekwini Municipality to describe the status of green spaces 145
5.2.2.1. Settlements 145
5.2.2.2. Tree crops 146
5.2.2.3. Woodland 146
5.2.2.4. Forest 147
5.2.2.5. Grassland 147
5.2.2.6. Thicket 148
5.3. Recommendations 148
5.3.1. Recommendations to increase user benefits of urban green spaces 148

5.3.2. Recommendations for urban green space conservation and management within the eThekwini Municipality 150
5.4. Concluding remarks 152
REFERENCES 154
APPENDIX A: URBAN GREEN SPACE QUESTIONNAIRE 177
APPENDIX B: COORDINATES (IN DECIMAL DEGREES) OF GREEN SPACE SITES EXAMINED IN THIS STUDY 185

LIST OF TABLES

Table 2.1: Definitions of urban green spaces....19
Table 2.2: Historical overview of the different uses for urban green spaces....21
Table 2.3: Typology used to classify urban green spaces....22
Table 2.4: A detailed typology used to classify green and public spaces in the United Kingdom....23
Table 2.5: Typology used to classify urban green space in China....24
Table 2.6: Simplified typology used to classify urban green spaces....25
Table 2.7: eThekwini typology used to classify urban green spaces....25
Table 3.1: Green space categorisation and ecosystem condition within the eThekwini Municipality....44
Table 3.2: Number of households sampled within each quadrant....51
Table 3.3: Description of spatial data....55
Table 3.4: Criteria used to assess quality of selected green space types as part of the Adapted typology....57
Table 4.1: Sex of respondents....61
Table 4.2: Number of persons currently residing in household....63
Table 4.3: Level of education of respondents....63
Table 4.4: Current occupation of respondents....65
Table 4.5: Total monthly household income in Rands....66
Table 4.6: Respondent opinions/ interpretations of green space....67
Table 4.7: Features respondents considered to be green spaces within their community and the greater eThekwini Municipality....69
Table 4.8: P-values of Chi-square tests between socio-demographic variables and perceptions of what constitutes green spaces within the community (C) and eThekwini (E).....71
Table 4.9: Green spaces respondents reside closest to....72
Table 4.10: Respondent use of green spaces....73
Table 4.11: P-values of Chi-square tests bteween socio-demographic variables and respondents use of green spaces....74
Table 4.12: Cross-tabulation between level of education and respondents use of green spaces....74
Table 4.13: Green spaces that respondents use....76
Table 4.14: Frequency of respondent use of green spaces....77

Table 4.15: Motives for respondents use of green spaces within their community.....78
Table 4.16: Green space resources that respondents would like to access 79
Table 4.17: Percentage of respondents that would like increased access to green spaces.....80
Table 4.18: P-values of Chi-square tests between socio-demographic variables and respondents desire to have increased access to green spaces 80
Table 4.19: Types of green spaces that respondents would like to have increased access to..81
Table 4.20: P-values of Chi-square tests between socio-demographic variables and types of green spaces that respondents would like to have increased access to 81
Table 4.21: Location of green spaces that respondents would like to have increased access to 82
Table 4.22: Respondent perceptions of green spaces within their community.....83
Table 4.23: P-values of Chi-square tests between socio-demographic variables and respondents perceptions of green spaces within their community.....87
Table 4.24: Types of pollution regarded as a threat to green spaces 89
Table 4.25: Changes to green spaces within the study area observed by respondents over the last five years 90
Table 4.26: P-values of Chi-square tests between socio-demographic variables and respondent views on how the selected green spaces within the study area should be used 95
Table 4.27: Cross-tabulation between total monthly household income in Rands and respondent views on how coastal forest within the study area should be used 96
Table 4.28: Environmentally-friendly practices respondents engage in.....100
Table 4.29: Proportion of respondents that dump waste in green spaces within the study area 101
Table 4.30: Respondent awareness of the D'MOSS programme 102
Table 4.31: D'MOSS objectives respondents are aware of 103
Table 4.32: Respondent recommendations on how the D'MOSS programme can be improved 104
Table 4.33: Comparison of the quality of green spaces within selected settlement sites using the eThekwini and Adapted typologies.....107
Table 4.34: Statistics incorporated into the Adapted typology calculated for all five settlement sites cumulatively.....108
Table 4.35: Deviation index for selected settlement sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies 110

Table 4.36: Comparison of the quality of green spaces within selected tree crop sites using the eThekwini and Adapted typologies.....113
Table 4.37: Statistics incorporated into the Adapted typology calculated for all five tree crop sites cumulatively.....114
Table 4.38: Deviation index for selected tree crop sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies 116
Table 4.39: Comparison of the quality of green spaces within selected woodland sites using the eThekwini and Adapted typologies.....118
Table 4.40: Statistics incorporated into the Adapted typology calculated for all five woodland sites cumulatively.....119
Table 4.41: Deviation index for selected woodland sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies 121
Table 4.42: Comparison of the quality of green spaces within selected forest sites using the eThekwini and Adapted typologies 124
Table 4.43: Statistics incorporated into the Adapted typology calculated for all five forest sites cumulatively.....125
Table 4.44: Deviation index for selected forest sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies 127
Table 4.45: Comparison of the quality of green spaces within selected grassland sites using the eThekwini and Adapted typologies.....129
Table 4.46: Statistics incorporated into the Adapted typology calculated for all five grassland sites cumulatively.....130
Table 4.47: Deviation index for selected grassland sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies 132
Table 4.48: Comparison of the quality of green spaces within selected thicket sites using the eThekwini and Adapted typologies 134
Table 4.49: Statistics incorporated into the Adapted typology calculated for all five thicket sites cumulatively.....135
Table 4.50: Deviation index for selected thicket sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies 137
Table 4.51: Summary of key results of the six green space types investigated.....138

LIST OF FIGURES

Figure 2.1: Overview of relevant environmental policies and legislation within South Africa 17
Figure 2.2: Terminology used to define urban green space 20
Figure 2.3: Benefits of urban green spaces 31
Figure 3.1: Location of eThekwini Municipality within South Africa 40
Figure 3.2: Status of green spaces within the eThekwini Municipality. 45
Figure 3.3: Location of South Durban Area (within a 2 km radius from the Bluff Conservancy) in KwaZulu-Natal (South Africa) 49
Figure 3.4: Selected communities/ households within South Durban Area digitised into six quadrants for sampling 52
Figure 3.5: Households/ points sampled in selected communities within South Durban Area 53
Figure 4.1: Age of respondents 62
Figure 4.2: Employment status of respondents 64
Figure 4.3: Factors preventing respondents' use of green space within their community 75
Figure 4.4: Main challenges associated with green spaces within the community 88
Figure 4.5: Respondent views on how the selected green spaces within the study area should be used 92
Figure 4.6: Additions to green spaces respondents would like to see within the study area ...97
Figure 4.7: Respondent level of satisfaction with the quality of green spaces within the study area and the eThekwini Municipality 99
Figure 4.8: Comparison of the quality of green spaces within selected settlement sites using the eThekwini (left) and Adapted (right) typologies. 106
Figure 4.9: Comparison of the quality of green spaces within selected tree crop sites using the eThekwini (left) and Adapted (right) typologies 112
Figure 4.10: Comparison of the quality of green spaces within selected woodland sites using the eThekwini (left) and Adapted (right) typologies. 117
Figure 4.11: Comparison of the quality of green spaces within selected forest sites using the eThekwini (left) and Adapted (right) typologies. 123
Figure 4.12: Comparison of the quality of green spaces within selected grassland sites using the eThekwini (left) and Adapted (right) typologies 128

Figure 4.13: Comparison of the quality of green spaces within selected thicket sites using the eThekwini (left) and Adapted (right) typologies 133

LIST OF ABBREVIATIONS

D'MOSS	Durban Metropolitan Open Space System
EPCPD	eThekwini Municipality's Environmental Planning and Climate Protection Department
GIS	Geographic Information Systems
IDP	Integrated Development Plan
IMEP	Integrated Metropolitan Environmental Policy
MDGs	Millennium Development Goals
MOSS	Metropolitan Open Space System
NEMA	National Environmental Management Act
R	Rands
RDP	Reconstruction and Development Programme
SANBI	South African National Biodiversity Institute
SDA	South Durban Area
SPSS	Statistical Packages for the Social Sciences
UN	United Nations
US$	US Dollars
WCED	World Commission on Environment and Development
WHO	World Health Organisation

CHAPTER ONE: INTRODUCTION

1.1. Preamble

There is significant debate in the literature about what green space is and whilst the definitions and conceptualisations of what constitutes urban green space vary, these spaces may be defined in the broadest sense as natural or human-modified urban outdoor environments consisting of considerable amounts of vegetation (Budruk *et al*., 2009). The need to refine and/ or agree on a definition is becoming increasingly important given the recent popularity of concepts such as green cities and urban greening (McConnachie *et al*., 2008; Nagendra, 2014; Tan *et al*., 2013). These concepts are, however, not generic in their application. 'Greening' of cities, for example, is conceptualised to different extents throughout the world, often influenced by local and regional factors such as political ecology and societal perceptions (Cilliers *et al*., 2013; Jahdi and Khanmohamadi, 2013; McConnachie *et al*., 2008). This may explain the recent research interest and intellectual debates around these concepts.

Green spaces play an important role in urban areas, contributing directly and indirectly towards the maintenance of a 'liveable' city, one that is environmentally, socially and economically sustainable (McConnachie *et al*., 2008, Tan *et al*., 2013; Wright Wendel *et al*., 2012). Over recent years, the subject of urban green space has gained attention from both academics and land-use planners. The availability and integrity of green spaces are widely acknowledged as positive contributors to environmental quality and societal behaviour within urban areas (M'Ikiugu *et al*., 2012). Additionally, the importance of urban green spaces in the context of climate change, to preserve biodiversity, improve air quality and relieve the impacts of increased temperatures and natural disasters, is well-documented (Akbari *et al.*, 2001; Bowler *et al.*, 2010; Donovan and Butry, 2009; Qureshi *et al*., 2013). Cities that lack urban green spaces in both quality and quantity are therefore often referred to as 'concrete jungles' that are vulnerable to the notion of low liveability (M'Ikiugu *et al*., 2012).

This global interest in the creation and/ or maintenance of green spaces has given rise to a new field of research, viz. urban conservation (Cilliers *et al*., 2004; Kareiva and Marvier, 2012; Kong *et al*., 2010; Kowarik, 2011; Shwartz *et al*., 2014). Urban conservation is the environmental practice of conserving/ maintaining/ protecting green areas and remaining patches of unexploited nature in an urban setting (Cilliers *et al*., 2004; Shwartz *et al*., 2014).

Urban conservation is a relatively new concept in the literature, and it is only over the past 20 years that developing countries like South Africa have implemented some forms of urban nature conservation (Cilliers *et al*., 2004, 2014; Mensah, 2014; Shwartz *et al*., 2014). According to Cilliers *et al*. (2004), in the case of South Africa, these strategies were implemented due to changing perceptions regarding the environment, accompanied by a rise in environmental awareness within the nature conservation movement. These views also motivated the implementation of the Metropolitan Open Space System (MOSS), a strategy based on biogeographical and ecological principles that was adopted by several South African cities (Cilliers *et al*., 2004, 2014). This programme aims to conserve the city's biodiversity and protect and maintain environmental goods and services for both current and future generations (eThekwini Municipality, 2011a). The Durban Metropolitan Open Space System (D'MOSS) is currently considered to be the flagship of urban conservation programmes within the country (Cilliers *et al*., 2014). The Durban Metropolitan Open Space System is implemented and monitored by the eThekwini Municipality which is also the broad study area for the present study: a socio-spatial analysis of the status of green spaces with the eThekwini Municipality.

1.2. Problem identification

Green spaces offer socio-economic, ecological and aesthetic benefits to communities surrounding them. However, within South Africa there is a lack of awareness on how to optimally interact with these spaces whilst maximising intended benefits, resulting in concomitant under-utilisation and degradation of green spaces (Cilliers *et al*., 2014). The logistical and financial implications of maintaining and conserving green spaces that offer minimal ecological and social value can actually hamper biodiversity conservation and more importantly, development in a rapidly developing city like eThekwini (Cilliers, 2010).

Research on the categorisation and management of green spaces within developing African cities such as eThekwini is lacking (Cilliers *et al*., 2014). Most studies conducted on urban green spaces are generally based on government reports and very rarely draw on the broader academic literature and contemporary ideas on urban conservation, particularly in the South African context (Cilliers *et al*., 2004; Mensah, 2014). Also, despite evidence of the value of using blended (that is inter-disciplinary) approaches to land-use planning and urban conservation, these approaches appear to be only partly adopted by municipalities such as eThekwini (Cilliers *et al*., 2014; Shwartz *et al*., 2014). It is also worth noting that within South

Africa it is national rather than local environmental conservation priorities that are often implemented to the greatest extent (Cilliers *et al*., 2013, 2014). This is worrying because urban green space contestations need to be addressed at a local scale, since it is at this scale that human-nature interactions take place (McConnachie *et al*., 2008; Shwartz *et al*., 2014). It is at this local scale that blended spatial and social techniques may be particularly useful in understanding human-nature interactions, assessing green space quality/ integrity in the context of urbanisation and enhancing urban conservation efforts (Balram and Dragićević, 2005). Again, a review of the literature suggests that these techniques are very seldom used to create and manage green spaces within rapidly developing cities such as eThekwini (Cilliers *et al*., 2014).

1.3. Motivation for the study

eThekwini Municipality is a rapidly developing city within which a number of green spaces, including natural vegetation that host indigenous vegetation, have undergone high levels of transformation and in some cases degradation (eThekwini Municipality, 2007; Jewitt, 2011). In 2011/ 2012, 53% of the Municipal area was classified as transformed (eThekwini Municipality, 2012). Furthermore, over a third of each terrestrial vegetation type found within the eThekwini Municipality has been transformed (eThekwini Municipality, 2007, 2012; Jewitt, 2011). In light of this, and the rising demands of urbanisation it has become increasingly important for the Municipality to start prioritising green spaces for conservation. To achieve this, it is critical that the typology used to classify green spaces status by the eThekwini Municipality be assessed in terms of its ability to accurately assess the quantity, quality (the physical condition of the landscape) and value of green spaces. A detailed assessment of the eThekwini typology (discussed in greater detail in Chapter Four) also revealed that it does not consider/ accommodate for the attitudes and perceptions of people that impact on these green spaces, particularly those living in close proximity to them. This is worrying since a number of studies have shown that it is critical to consider peoples' perceptions and attitudes when planning and managing green spaces (Balram and Dragićević, 2005; Swanwick *et al*., 2003).

This provided ample motivation for the present study which blends spatial and social geography methodologies to assess the typology presently used to classify green spaces by the eThekwini Municipality. The study used secondary spatial data to gauge the quality, use, value and vulnerability of selected green spaces within the eThekwini Municipality using the

typology presently used by the Municipality (referred to as the 'eThekwini typology' henceforth) and an Adapted typology developed for the purposes of this study. This spatial analysis served to identify the benefits derived from these zones as well as examine how they are impacted upon. Furthermore, social geography methods were used to assess resident perceptions of, and interactions with, green spaces in the highly industrialised and environmentally contested South Durban Area (SDA) (Sutherland *et al*., 2009), located within the Municipality.

More specifically, this study investigated how geographic techniques, specifically Geographic Information Systems (GIS), can be used to interrogate, validate and inform existing green space typologies. This use of spatial data and GIS for urban conservation is based on the fact that mapping is a popular monitoring tool in land-use and green space planning (Bell *et al*., 2007; Çabuk *et al*., 2010). Additionally, this study explored the relationships between people and nature in residential areas surrounding the Bluff Conservancy using structured questionnaires. Public perceptions inevitably determine the valuation of green spaces (Jim and Chen, 2006) and can inform the conservation strategy selected, yet very few studies have looked at urban conservation from this perspective. The objectives of this study and the methods adopted therefore ensured data of both scientific and societal relevance.

The present study will inform our understanding of how urban conservation should be approached in rapidly developing cities such as eThekwini and contribute to the growing literature on green spaces (Cilliers *et al*., 2013, 2014) and urban conservation (Cilliers *et al*., 2004; Mensah, 2014; Shwartz *et al*., 2014). Most importantly, the results obtained will inform recommendations on the validity/ appropriateness of the categorisation and management methods presently used for green spaces within the eThekwini Municipality.

1.4. Aim and objectives

The broad aim of this study is to critically examine the quality/ integrity and value of green spaces within eThekwini Municipality in relation to resident perceptions and land-use patterns and to make recommendations on the conservation and management of these spaces via an assessment of the typology presently used to describe their status.

Specific objectives are as follows:

I. To examine the socio-economic characteristics and the perspectives of residents on the use and value of green spaces within the eThekwini Municipality using areas surrounding the Bluff Conservancy (all situated within the SDA) as illustrative examples.
II. To develop a spatial representation of the quality/ integrity of selected green spaces within the eThekwini Municipality in relation to land-use patterns.
III. To assess the appropriateness of the typology presently used by the eThekwini Municipality to describe the status of green spaces and to compare the same with Adapted typologies in order to determine the level of deviation.
IV. To generate recommendations for urban green space conservation and management within the eThekwini Municipality.

The key research questions that were asked in this study are:

I. What socio-economic characteristics of the residents influence their perceptions on the value and use of green spaces within the SDA?
II. What are the factors affecting the quality/ integrity of the selected green spaces examined in this study?
III. How does the status of the selected green spaces differ when using the eThekwini and Adapted typologies?

1.5. Brief summary of methodological approach

A series of socio-spatial analysis methods were used to collect survey data, using proportionate random sampling techniques with the support of GIS. The target population were households within a 2 km radius of the Bluff Conservancy. The Bluff Conservancy was used as a "proxy" site for the eThekwini Municipality. The data collection methods used were GIS mapping and a questionnaire. Quantitative data extracted from the questionnaire was captured and analysed using the Statistical Packages for the Social Sciences (SPSS) v 19, in order to identify the relationships between the selected communities and their surrounding urban green spaces. Thereafter, secondary spatial data was used to gauge the quality, use, value and vulnerability of various green spaces within the eThekwini Municipality in relation to land-use patterns. The

interrogation of the secondary spatial data for selected green spaces using spatial geography methods allowed for an assessment of the appropriateness of the typology presently used by the eThekwini Municipality to describe the status of green spaces.

1.6. Structure of dissertation

This dissertation is divided into five chapters. The present chapter briefly outlines the importance of urban green space research, the aims and objectives of the present study and provides an overview of the methodological approach adopted. Chapter Two provides a comprehensive review of literature on urban green spaces and also outlines the theoretical framework selected. Chapter Three describes the background to the study area as well as the methodology and how data was used to undertake this research. The findings emanating from the study are described and discussed in Chapter Four. The final chapter, Chapter Five, provides a summary of the key findings as well as recommendations for further/ future research.

1.7. Conclusion

The value and functionality of urban green spaces has been extensively reviewed in literature (Abizadeh *et al*., 2013; Cilliers *et al*., 2013; Dinnie *et al*., 2013; Wright Wendel, 2012). Moreover, as the world continues to urbanise and the impacts of climate change become more apparent (Niemelä, *et al*., 2010), the environmental and socio-economic values of urban greenery are going to be recognised as significant contributors towards a sustainable urban landscape. This study was motivated by the importance of urban green spaces and their role in influencing people's perceptions of, and interactions with nature, particularly in rapidly developing cities such as eThekwini. The values of such studies is based on the fact that the impact and perceptions of residents on urban green spaces can significantly influence the quality of these spaces (Jim and Chen, 2006). In addition, understanding the spatial dynamics of urban green spaces is just as important to consider when developing land-use and conservation plans (Bell *et al*., 2007; Çabuk *et al*., 2010). If these environments are maintained and managed in an effective manner, they can significantly alleviate biodiversity erosion within natural habitats as well as contribute directly and indirectly towards a sustainable landscape (Cilliers *et al*., 2014; Shwartz *et al*., 2014). Chapter Two provides a detailed account of the multi-dimensional benefits and challenges associated with urban green spaces.

CHAPTER TWO: LITERATURE REVIEW

2.1. Introduction

Research on urban green spaces has benefited from numerous studies conducted within the fields of urban ecology, town planning, geography and sociology (Abizadeh and Zali, 2013; Anderson *et al*., 2014; Bengston *et al*., 2004; Dinnie *et al*., 2013; Sutton 2008). This knowledge has improved our general understanding of urban green space structure and functioning. Importantly, many of these studies (Balram and Dragićević, 2005; Cilliers *et al*., 2014; McConnachie *et al*., 2008; Wright Wendel *et al*., 2012) have shown that integrated and inter-disciplinary research is advantageous in understanding the complexity of urban green spaces. The literature reviewed in this chapter will be used to describe our present understanding of urban green spaces as well as the benefits and challenges associated with them.

The chapter begins by explaining the importance of the environment and conservation in both urban and non-urban settings and thereafter reviews results of some researchers pertaining to environmental sustainability in order to develop the theoretical framework used in the study. The theoretical framework was used to guide the design of this study and provides a discussion of the following themes: environmentalism, ecological modernisation and political ecology. The chapter then goes on to critically examine the dynamics of urban green space and provide a comprehensive overview of associated typologies, human impacts, planning, benefits, challenges and perceptions. The conclusion to the chapter summarise some of the key aspects reviewed.

2.2. Importance of the environment and conservation

In 1985 the human population was 4.8 billion people, which over the past 29 years has exponentially increased to more than 7 billion, reflecting an increase of more than 40% per human generation (Kareiva and Marvier, 2012). Furthermore, this advancing frontier of population growth has triggered an increase in the world's urban population with around 50% of people now living in cities (Kareiva and Marvier, 2012). Studies anticipate that over the next two decades 65% of the world's population will be found in urban communities (Cilliers *et al*., 2014; Kong *et al*., 2010). Furthermore, Kowarik (2011) asserts that this rapid urban expansion is expected to occur most in developing regions of world and since these are often located in

close proximity to biodiversity hotspots leads to an increasing number of conservation conflicts (Rull, 2011). Given the challenges associated with global sustainable development, the environment and conservation have become issues of high priority in today's society, with more emphasis being placed on ecological studies and potential strategies to reduce environmental impacts globally (Rull, 2011).

For instance, over the past 25 years countries throughout the world have made noticeable efforts to increase the amount of protected natural landscapes (Dearborrn and Kark, 2010; Kowarik, 2011; Naughton-Treves *et al*., 2005). Currently there are more than a 100,000 protected natural areas worldwide, encompassing 11.5% (17.1 million km^2) of the earth's terrestrial surface (Naughton-Treves *et al*., 2005). Over recent years the role of these areas have broadened substantially, as global mandates now demand that protected areas do far more than only conserve the environment (Naughton-Treves *et al*., 2005; Rull, 2011). These areas are charged with providing vital ecosystem services to society which include the provision of material goods (for example, food and timber), aesthetics, amenities, serving as ecological infrastructure by controlling floods and erosion, and sequestering carbon and water (Jim and Chen, 2006; Leeuwen *et al*., 2010; Rands *et al*., 2010).

Research has shown that conservation efforts are in fact linked to poverty alleviation, with a numbers of studies indicating the economic benefits associated with protected areas (Naughton-Treves *et al*., 2005; Wynberg, 2002). South Africa for example is ranked as one of the most biologically diverse regions in the world, hosting a vast array of endemic species and have successfully demonstrated the multi-versatile value of protected areas (Roberts *et al*., 2012; Wynberg, 2002). The great diversity of ecosystems within the region provide resources that support the livelihoods of many South Africans (especially rural dwellers) and contribute substantially to the country's economy (Roberts *et al*., 2012; Wynberg, 2002), serving as a buffer against poverty. For example, the medicinal plant trade in the KwaZulu-Natal province alone is estimated at R60 million per year (Naughton-Treves *et al*., 2005). A number of natural areas within the country also play a major role in ecotourism. The Kruger National Park for example, is one of South Africa's premier game reserves, providing numerous jobs to locals as well as attracting large amounts of tourists from around the world. In 2002 alone, the game reserve attracted over a million visitors (Shackleton *et al*., 2007).

Both in practice and research, environmental conservation has often been linked to a non-urban context (that is conservation outside of cities) (Elander *et al*., 2005). However, over the past four decades there has been a significant rise and interest in urban nature conservation efforts (Dearborn and Kark, 2010; Rull, 2011). As far back as the mid-1970s, most European countries began developing strategies and programmes aimed at enhancing nature conservation in urban areas (Dearborn and Kark, 2010; Rands *et al*., 2010). These programmes provided vital information which ultimately facilitated the introduction of numerous environmental laws across a range of countries (Cilliers *et al*., 2004; Dearborn and Kark, 2010; Rull, 2011). Early triumphs and breakthroughs included the 1992 and 1996 United Nations (UN) conferences on nature conservation held in Rio and Istanbul respectively, which enforced and prioritised the conservation of nature within cities throughout the world (Cilliers *et al*., 2004).

In South Africa the concept of urban nature conservation is still relatively new, and it is only over the past 20 years that the country has become more involved in implementing approaches to/ strategies for urban nature conservation (Cilliers *et al*., 2004, 2014). Literature has shown that these strategies were generated due to changing opinions and attitudes regarding the environment, accompanied by a rise in environmental awareness within the nature conservation movement (Cilliers *et al*., 2004, 2014). These efforts were targeted at a more diverse, functional form of urban nature conservation that not only focused on the conservation of a particular species, but also encompassed preservation of entire communities that aimed to maximise biodiversity in a sustainable manner (Cilliers *et al*., 2004; Roberts *et al*., 2012).

Currently, researchers concur that in an age of increasing urbanisation, conserving urban biodiversity is of the utmost importance (Dearborn and Kark, 2010; Kowarik, 2011). Aylett (2010) and Niemelä *et al*. (2010) further state that one of the main areas of interest where urban conservation plays a vital role is in mitigating anthropogenic-induced climate change. Numerous studies have highlighted the importance of urban environments in preserving biodiversity and mitigating climate change by improving air quality and alleviating the impacts of increased temperatures and natural disaster events (Akbari *et al*., 2001; Bowler *et al*., 2010; Donovan and Butry, 2009). The ecological, social and economic benefits derived from these urban environments will be discussed in greater detail later in this chapter.

It is important to note that even though conservation efforts throughout world have achieved relatively high levels of success, globally, biodiversity levels continue to decline (Cilliers *et al*., 2004, 2013; Rands *et al*., 2010). Shackleton and Blair (2013) emphasise that global sustainable development and preservation/ conservation of ecological areas is presently considered the most significant task amongst local governmental institutions such as municipalities. Therefore, drastic changes continue to be implemented in order to enhance the recognition of biodiversity as a public good, such that environmental conservation is integrated thoroughly into policies regarding resource production and consumption (Rands *et al*., 2010). The transition to global sustainability is not an easy task, but is the fundamental objective in securing present and future environmental conservation (Dearborn and Kark, 2010; Rands *et al*., 2010). Thus, given the importance of conservation, the issue of environmental sustainability has gained prominence and warrants further discussion here.

2.3. Environmental sustainability

It is only over the past few decades that the concepts and frameworks surrounding sustainability have become increasingly utilised in society (Pretty *et al*., 2007). The World Commission on Environment and Development (WCED, 1987: 43) define sustainable development as '*meeting the needs of the present without compromising the ability of future generations to meet their own needs*'. Over time there have been many definitions and interpretations of sustainability, progressively expanding the concept from primarily focusing on the environment, to include other dimensions such as economic, social and political factors (Pretty *et al*., 2007). However, in all cases the underlying notion still remains that human concern for the natural environment is fundamentally anthropocentric (Olewiler, 2006; Pretty *et al*., 2007; Rull, 2011). Thus, in order to ensure that social and economic issues in society are not only addressed from an anthropocentric perspective, but also include the environment as a key factor, the concept of environmental sustainability emerged (Goodland, 1995).

Morelli (2011: 23) defines environmental sustainability as '*meeting the resource and services needs of current and future generations without compromising the health of the ecosystems that provide them*'. More specifically, environmental sustainability is intended to incorporate factors such as biodiversity, carrying capacity and the quality of ecosystems in order to fulfil its ultimate objective of sustaining ecosystems indefinitely (Basiago, 1999; Goodland, 1995; Vlek and Steg, 2007). Studies have shown that in order for this particular approach to be

effective it necessitates that natural resources be sustained for the purpose of ecological, social and economic inputs, whilst also acting as a 'sink' for wastes (Basiago, 1999; Morelli, 2011). Furthermore, natural capital should be utilised in a manner that allows sufficient time for resources to be regenerated. Similarly, wastes should neither be emitted nor accumulated at a rate that exceeds the carrying capacity of the environment from which they are assimilated (Basiago, 1999).

Environmental sustainability, in relation to key issues concerning the state of the environment along with use of natural capital, has become a priority issue for cities throughout the world (Vlek and Steg, 2007). As an enduring concept and initiative, environmental sustainability can be considered a fundamental long-term tool for the protection of urban environments, as it has the potential to improve both environmental quality and the quality of life (Haq, 2011). In order to achieve this level of urban sustainable development, governments in many regions of the world have devised conservation strategies that encompass landscape and ecological values, such that urban environments may be adequately maintained (Haq, 2011). Furthermore, ensuring environmental sustainability can also be considered an overarching strategy in the context of climate change mitigation (Vlek and Steg, 2007). The Millennium Development Goals (MDGs) support this notion by emphasising the importance for countries to achieve and maintain high levels of environmental sustainability, stressing its value as a strong buffer against climate change (Adelzadeh, 2003).

After its transition to democracy in 1994, South Africa like many other countries in the world, prioritised environmental sustainability as one of the country's key socio-economic and political agendas (Ncube *et al*., 2009). Initiatives within the country included policies and strategies that sought to promote and support the socio-economic well-being of people, while simultaneously preserving the natural capital of the country (Ncube *et al*., 2009). Early initiatives included the Reconstruction and Development Programme (RDP), which was implemented with the aim of reducing poverty levels within the country. The programme supported a human-centred approach (societal needs) to development, but also took into account the importance of sustainable utilisation of resources, in order to achieve a well-balanced socio-economic stature for the country (Adelzadeh, 2003). The Development Facilitation Act (Cilliers *et al*., 2004) utilised extreme methods to drastically speed up the implementation of reconstruction and development initiatives with regard to land-use. This included fundamental procedures and principles dictating sustainable land development

throughout South Africa (Cilliers *et al*., 2004). Similarly, the Integrated Development Plan (IDP; Cilliers *et al*., 2004) was generated with the purpose of acting as a strategic tool that could be efficiently utilised in planning and development. In South Africa IDPs have now become local governments' principal tool for facilitating the socio-economic needs of communities in a sustainable manner (Sowmanm and Brown, 2006).

South Africa, like many countries around the world, has come to recognise the fact that in order to ensure environmentally sustainable actions are able to be successfully implemented there are certain key strategies and aspirations that national and local governments should abide by. These include conserving the natural environment, regulating/ monitoring the use and availability of natural resources and promoting greater synergies between society and nature (Vlek and Steg, 2007). Furthermore, integrated research aimed at identifying the links between the environment, society and economy needs to be conducted in order to better guide environmental sustainability in practice. The actions described above requires a multi-disciplinary approach which, according Bakshi and Fiksel (2003) is an influential method in terms of initiating the proper changes needed to ensure long-term human well-being and environmental integrity globally. Therefore, it is critical to understand the key ideologies related to environmental sustainability, as its achievement will ensure a balance between development and the preservation of the environment. These ideologies comprise the theoretical framework of this study and are discussed in greater detail in the next section.

2.4. Theoretical framework

The construction of a multi-disciplinary framework is important as it facilitates an accumulation of knowledge from various fields of research (Kamp *et al*., 2003). In this study scientific, social and political views are integrated in order to evaluate the multi-dimensional aspects of urban environmental quality. The theoretical framework that will be used to guide the collection, analysis and interpretation of the data and literature referenced in this study is comprised of the following themes: environmentalism, ecological modernisation and political ecology.

2.4.1. Environmentalism

Stern (2000: 411) defines environmentalism as '*the propensity to take actions with pro-environmental intent*'. Schumacher (2009) expands on this definition indicating that environmentalism also encompasses the attitudes or perceptions of people towards the environment that results in green behaviour and benefits associated with clean air and water and lower species extinction rates. The short history of modern environmentalism, which started to gain momentum and interest around 30 years ago, has often been characterised by notions of tension and disorganisation, as nearly all aspects associated with the concept over the years have been controversial (Mulvihill, 2009). However, in more recent times the environmental movement has been in a state of considerable positive transition. Even though there is no universal concrete definition for environmentalism, academics widely regard the concept as an ideology that stems from an ecological paradigm that considers anthropogenic activities and the biosphere as undoubtedly inter-connected (Stern, 2000; Mulvihill, 2009). The ultimate goals of environmentalism are aimed at changing the practices and perceptions (regarding green materiality, inclusive of urban green spaces) of the present in order to ensure well-being and survival in the future (Mulvihill, 2009).

Recent trends in modern environmentalism demand that society should not consider cities and green spaces as separate entities, but rather as an interconnected network forming an urban matrix (Schumacher, 2009). Furthermore, environmentalism is inextricably linked to politics and also plays crucial role in social movements (Block, 1998; Schumacher, 2009). To elaborate, environmentalism does not only seek to politicise issues such as cleaner fuels and air quality for a greener future but also addresses aspects related to everyday living (for example, using bicycles, cleaning up the environment and proper disposal of waste) that are recognised globally as key priorities and initiatives that directly support environmental activism, green livelihoods and the preservation of urban green spaces (Block, 1998; Mulvihill, 2009; Vlek and Steg, 2007). Furthermore, from an economic perspective environmentalism has proved to have a positive influence in pro-environmental countries; for example, these countries often fare better with regard to investments and economic, industrial and service division growth (Schofer and Granados, 2006).

In addition, Davey (2009) asserts that environmentalism is the one of the global necessities required to achieve ecologically sustainable landscapes, particularly in poorer, less developed

regions of the world. From a South African perspective, environmentalism is without a doubt linked to the socio-political history of the nation, changing radically through the 1990s as a consequence of the country's transition to democracy (Vital, 2005). However, over recent years it has displayed tendencies indicative of a transition from a preservationist approach to a more holistic conservationist approach that incorporates social, economic, and political attributes (Cilliers *et al*., 2014; Khan, 2000). In the context of this study, it is important to note that the current approach of environmentalism within the South Africa aims to maintain as well as minimise the susceptibility of urban green spaces in the face of the adverse effects of climate change (Roberts *et al*., 2012). Furthermore, these conceptions of environmentalism within the country have emerged as initiatives that continue to bridge the gap between human-nature relationships in a more efficient and sustainable manner, which bodes well for the conservation of urban green spaces (Davey, 2009; Vital, 2005).

2.4.2. Ecological modernisation

The concept of ecological modernisation was developed during the late 1980s and early 1990s, as an environmental policy-making ideology that sought to rectify failures of past pollution control policies that occurred during the 1970s (Andersen and Massa, 2000; Murphy, 2000). Anderson and Massa (2000: 337) define the concept of ecological modernisation as '*the development of new and integrated technologies, to reduce the consumption of raw materials, as well as the emissions of various pollutants, while at the same time creating innovative and competitive products*'. Thus, in essence, ecological modernisation can be considered a concept that addresses a basic dichotomy between economic development and environmental sustainability (Murphy, 2000). This is achieved by maintaining a central assumption that the expansion of green technological innovations can be used to achieve environmental conservation, particularly in urban areas, together with economic growth (Barry and Paterson, 2004; Teräväinen, 2010). Over the past three decades, ecological modernisation has been at the forefront of environmental discourse, serving as a crucial tool in environmental management and as a driving force in the struggle to achieve sustainability in both developed and developing nations (Oelofse *et al*., 2006).

When utilised as a framework, ecological modernisation can be applied in two ways. Firstly, it may be implemented as a theoretical concept with the purpose of analysing changes to central institutions in today's society, which is regarded as a necessary procedure when addressing

ecological issues (Gibbs, 2000; Scerri, 2012). Secondly, it may be applied as a more practical political strategy in order to redirect environmental legislation and policy-making (Culkin, 2014; Gibbs, 2000). Thus, much like sustainable development, ecological modernisation also seeks to overcome environmental problems. In addition, this fundamentally technical approach relies on science and technology to address the following main areas of interest: efficiency in the use and consumption of natural resources, technological improvements and the development of new markets for ecosystem goods and services (Barry and Paterson, 2004; Oelofse *et al*., 2006; Scerri, 2012). With regard to the first area of interest, the ultimate goal of ecological modernisation is to generate a 'closed-loop' system that results in minimal waste disposal whereby the waste material itself can be used as inputs in various industrial processes (Barry and Paterson, 2004). In terms of the development of new markets, these actions are vital for the growth of improved commodities and services, allowing for continual accumulation (Barry and Paterson, 2004; Culkin, 2014; Scerri, 2012). When initiatives such as these are implemented in an effective manner, they can potentially promote and support economic growth and environmental sustainability. This is particularly important in developing regions of the world where improvements brought about through ecological modernisation have resulted in more effective ways to conserve and maintain urban nature (Scerri, 2012).

Furthermore, the developments brought about through ecological modernisation have also been increasingly used when analysing evolving policy discourses central to the relationships between industrial development and the environment (Huber, 2008; Murphy and Gouldson, 2000). In this respect, the implementation of ecological modernisation as a strategy of policy reform demonstrates its ability to manipulate policy intervention such that it leads to both economic and environmental benefits (Huber, 2008; Murphy and Gouldson, 2000; Teräväinen, 2010). This is particularly effective in rapidly developing cities where these policies can be used to support the improvement and implementation of innovative green technologies and practices, thereby reducing the vulnerability of green spaces to the impacts of urbanisation (Huber, 2008; Murphy and Gouldson, 2000; Teräväinen, 2010).

In South Africa, the use of sustainability ideologies has been primarily driven by a global conventional approach of ecological modernisation (Oelofse *et al*., 2006). This type of conventional environmental management emphasises that natural environments are most vulnerable to human- induced impacts and regards environmental concerns as technical and institutional aspects that should be the handled by appropriate scientific personal (Oelofse *et*

al., 2006). South Africa has tremendous potential to move towards a strong form of ecological modernisation as the country offers a 'gap', whereby new strategies and approaches can be applied to environmental legislation and decision-making (Oelofse *et al*., 2006). Studies have suggested that some of the country's most pressing issues, such as poverty and service provision can possibly be largely improved through extreme and radical approaches to ecological modernisation (Long and Patel, 2011; Oelofse *et al*., 2006). It is therefore crucial that innovative advancements (in natural resource management and green technologies) are nurtured and adequately supported for South Africa to achieve levels of ecological modernisation that benefit people and nature. In addition, these initiatives can potentially reduce the erosion of green spaces which is already a problematic issue in many South African cities (Roberts *et al*., 2012).

2.4.3. Political ecology

Political ecology is a relatively new field of research that has emerged as an approach with the intent of addressing critical issues relating to environmental sustainability, natural resource management and contestation over resources (Schubert, 2005). Political ecology is a highly comprehensive theoretical framework within the field of geography and can be described as a conceptual approach that not only attempts to recognise, but also understand the political views, conditions and implications of environmental change (Mung'ong'o, 2009; Zimmer, 2010). Political ecology is aimed at integrating the complexities of economic development as well as the politics of environmental change, in order to emphasise the importance of human-nature relationships which are fundamental to the conservation urban green spaces (Mung'ong'o, 2009; William and Hutton, 2007). The concept uses the premise that there is a mutual and reciprocal link between people and the environment (Mung'ong'o, 2009; William and Hutton, 2007). Therefore, in this context urban environments can be regarded as a reflection of the quality/ integrity of societal relations at various levels of functioning (Mung'ong'o, 2009).

Political ecology often involves addressing ecological concerns pertaining to the linkages between production, consumption, use and contestation of natural resources at various levels in society (Mung'ong'o, 2009; Schubert, 2005). Furthermore, studies have shown that in order to best address these issues, a good starting point for any government is to enforce the notion that a politicised environment is a critical component when tackling ecological issues and contemporary development, particularly within third world countries (Bailey and Bryant, 2005;

Mung'ong'o, 2009). It is also important to note that in political ecology, the environment itself is recognised as a forceful contributor toward its own politicisation (Mung'ong'o, 2009). Over recent years many questions related to socio-environmental issues have become almost entirely affiliated with political questions (Loftus, 2005). The political aspect of political ecology is intended to first identify and then implement various strategies. This is intended to achieve greater levels of equitable distribution of social power together with higher levels of ecological systems, such that an improved governmental stance towards socio-environmental construction can be attained (Loftus, 2005)

With regard to the present study, it is important to highlight some of the relevant environmental legislation and policies that influence the ways in which open green spaces are planned within South Africa. Figure 2.1 provides an overview of relevant environmental policies and legislation at the national, provincial and local level.

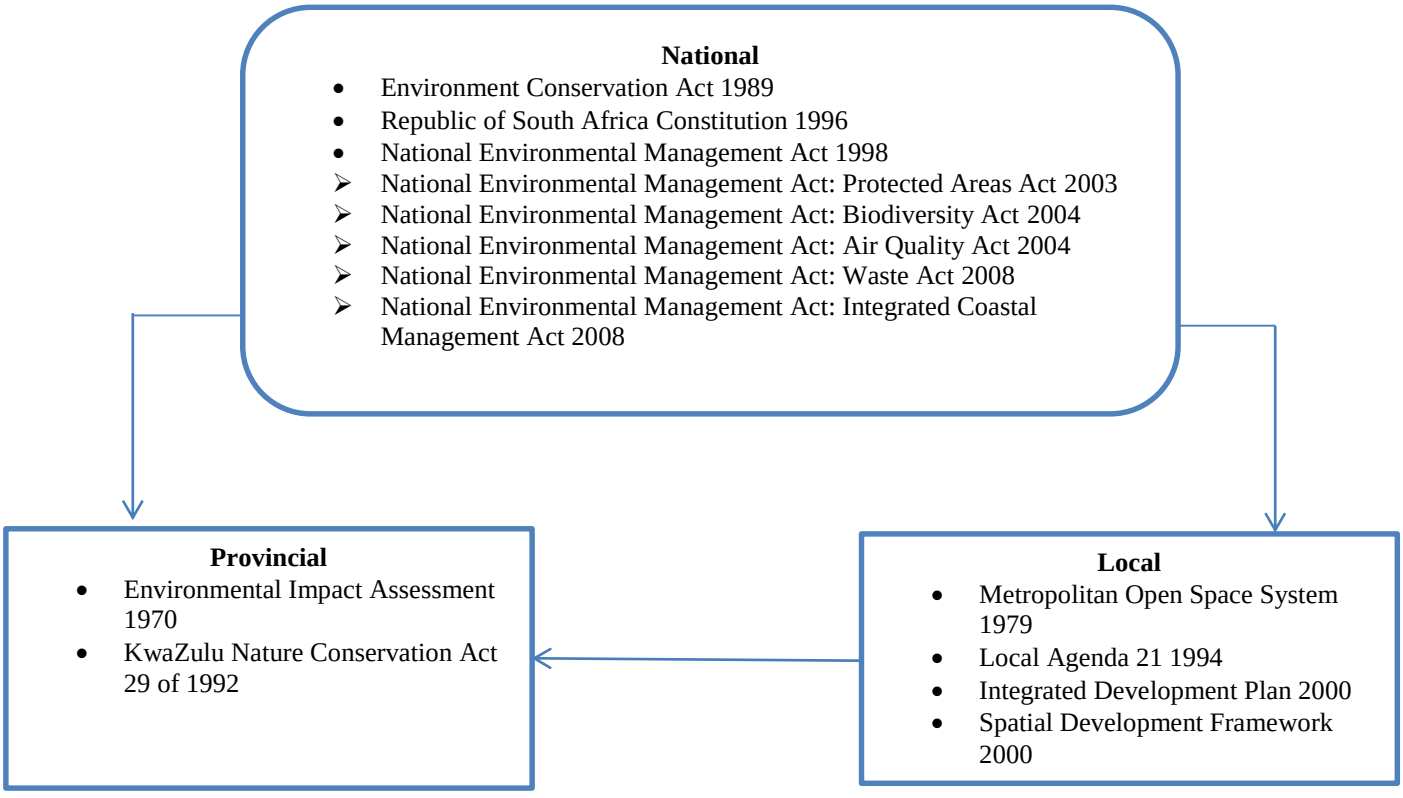

Figure 2.1: Overview of relevant environmental policies and legislation within South Africa (Source: Sutton, 2008: 64)

From an environmental perspective, the South African Constitution has cemented issues of environmental rights and protection using strong legislation. The constitution highlights the imperative need for municipalities to promote social and economic growth along with safe and healthy environments. The National Environmental Management Act (NEMA) implemented in 1998, was designed to support and ensure that environmental management be incorporated within urban settings, such that environmental governance could be carried out in a cooperative fashion at various scales of government (Sutton, 2008). Furthermore, NEMA also emphasises that vulnerable and valuable ecological areas be given more attention in terms of planning and management, especially in the case of high human use and development pressures (Van der Linde, 2006). The Environment Conservation Act of 1989 was enforced with the dual purpose of protecting and controlling utilisation of the environment (Van der Linde, 2006). Therefore, by identifying and recognising the significance of healthy living environments combined with community needs, the Environment Conservation Act serves as a mechanism whereby open green spaces can be integrated into urban planning (Sutton, 2008). It is also important to note that the national legislation is linked to the provincial and local policies as it provides the foundation required for provincial and local policies to operate effectively.

The 1992 Earth Summit in Rio de Janeiro saw the development of the Agenda 21 report, which was created with the intention of identifying and targeting appropriate environmental action at all scales of government (Sutton, 2008). The report incorporated principles and strategies aimed at achieving a relative stability between development and environmental sustainability. In South Africa, one of the most important and most actively implemented programmes inspired by the Agenda 21 report, is the Local Agenda 21 programme, which has a key focus on local government action (Selman, 1998; Sutton, 2008). In South Africa, the cities of eThekwini, Cape Town and Johannesburg took the initial step in implementing the Local Agenda 21 programmes as an integral tool with the purpose of post-apartheid reconstruction and development. At a metropolitan level, these initiatives were highly beneficial as they provided the foundation for the implementation of the MOSS, a strategy adopted by numerous South African cities that led to the creation of more cohesive open space network systems (Roberts *et al*., 2012). Furthermore, eThekwini has gone a step further to utilise open green spaces in a proactive ecosystem-based approach that promotes economic growth, whilst ensuring the restoration and preservation of these green areas (Roberts *et al*., 2012). In view of the above, it is evident that environmental legislation, if implemented in an effective manner, can potentially improve the maintenance and conservation of green spaces, particularly in

developing countries which are often located in close proximity to or nested within biodiversity hotspots (Kowarik, 2011).

2.5. Urban green spaces

With the theoretical framework in place this section examines the many dimensions associated with urban green spaces. It is important to begin by defining the term, as it is the key focus of this study. This is, however, challenging since there is significant debate in the literature about what urban green spaces constitute and as a result numerous definitions of urban green spaces have been suggested. Table 2.1 lists some of the various definitions appearing in the literature.

Table 2.1: Definitions of urban green spaces

Author	**Definition**
Budruk *et al*. (2009: 825)	'*Natural or human-modified urban outdoor environments containing significant amounts of vegetation*'
Schipperijn *et al*. (2010: 26)	'*All publicly owned and publicly accessible open space with a high degree of cover by vegetation, for example, parks, woodlands, nature areas and other green space*'
Fratini and Marone (2011: 9)	'*A space entirely covered or covered only above with vegetation, located in the centre of a city or in the periphery*'
Haq (2011: 601)	'*Public and private open spaces in urban areas, primarily covered by vegetation, which are directly (for example, active or passive recreation) or indirectly (for example, positive influence on the urban environment) available for the users*'
M'Ikiugu *et al*. (2012: 450)	'*Outdoor places with significant amounts of vegetation*'
Wright Wendel *et al*. (2012: 273)	'*Human-modified outdoor spaces as well as vegetated natural spaces*'
Cilliers *et al*. (2013: 685)	'*The entire urban green infrastructure that includes a network of all natural, semi-natural and artificial ecological systems within, around and between urban areas, at all spatial scales*'

In order to generate an appropriate definition of urban green space it is essential to first gain a clear understanding of the relevant terminology, exemplified in Figure 2.2. The term 'urban' infers that the space is situated in an urban environment. Urban space in this context denotes the open space that is located outside and among buildings in urban areas. Swanwick *et al*. (2003: 98) define urban open space as '*a mixture of public (or civic) and green space, where public spaces are mainly 'hard' spaces such as squares, street frontages and paved areas*'. These spaces consist of what James *et al*. (2009) and Swanwick *et al*. (2003) refer to as 'grey

space' and 'green space'. Swanwick *et al*. (2003: 97) go on to define 'green space' as '*land that consists predominantly of unsealed, permeable, 'soft' surfaces such as soil, grass, shrubs and trees*'.

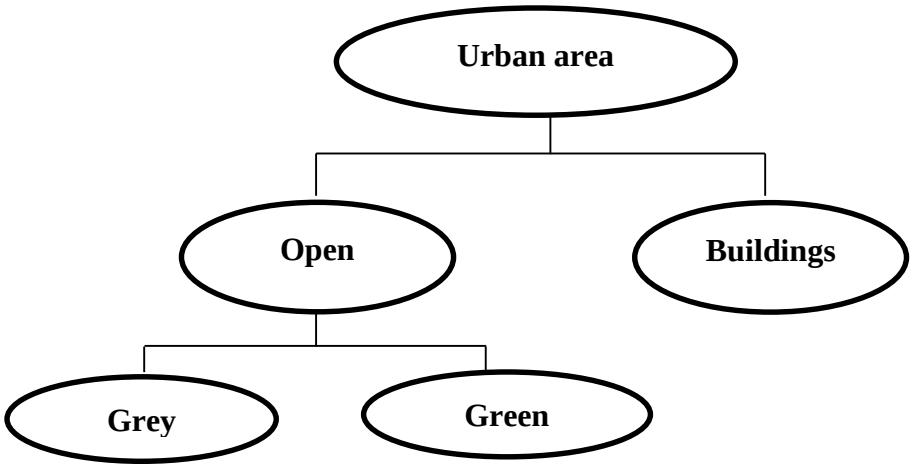

Figure 2.2: Terminology used to define urban green space (Source: adapted from Swanwick *et al*., 2003: 97)

Definition of urban green space for this study:
Based on the above this study defines urban green spaces as public and private, natural or human-modified (transformed) urban outdoor environments mainly comprised of vegetation, which are directly or indirectly available for users (Budruk *et al*., 2009; Haq, 2011).

It is also important to note that throughout history urban green spaces have played critical roles in providing societies with different functions ranging from production and agriculture to health and ecology (see Table 2.2) (Leeuwen *et al*., 2010). Initially these green areas were promoted by the development of urban gardens. However, today urban green spaces are regarded as an indispensible commodity of urban quality of life, contributing directly and indirectly towards a 'liveable' city (one that is environmentally, socially and economically sustainable) (Leeuwen *et al*., 2010; McConnachie *et al*., 2008; Niemelä *et al*., 2010).

Table 2.2: Historical overview of the different uses for urban green spaces (Source: Leeuwen *et al*., 2010: 21)

Time period	Uses for urban green space
600 BC	Private power and social status
1300 AD	Innovative agriculture
1700 AD	Gardens for knowledge
1900 AD	Food production
2000 AD	Recreation
2010 AD	Health and ecology

This study draws attention to the vital role of green spaces in cities by emphasising the numerous functions they provide. The various functions of urban green spaces articulate their multi-dimensional structure (Leeuwen *et al*., 2010), as there are many different types of habitats and ecosystems that are included under the umbrella of urban green spaces. Therefore, it is also important to understand the typologies and classification systems associated with these spaces and this is the focus of the next section.

2.5.1. Urban green space typologies

Typologies and classifications can serve many different purposes. In the context of urban green spaces, a basic typology is comprised of a classification of categories within which sit different types of green spaces (Dunnet *et al*., 2002). Dunnet *et al*. (2002) suggest that when developing such a typology one should ensure that it reflects an inventory of the full extent of various types of urban green space that constitute the green fabric of an urban area. Urban land-use is a promising and new playground for urban green space design and over recent years classification systems have become increasingly important tools when evaluating and managing these green space systems (Leeuwen *et al*., 2010). There are numerous factors that can be used to classify urban green spaces such as size, type, usage, location, intended function and level of biodiversity. The literature reviewed in this section highlights examples of existing typologies that guided the methodology used to analyse the spatial data associated with urban green spaces in this study.

There are many challenges associated with assessing the diversity of green space types that actually exist in urban areas owing largely to inconsistency in definitions and the risk misinterpreting where urban green spaces types overlap. The typology proposed by Swanwick

et al. (2003), outlined in Table 2.3, was developed with the purpose of minimising these challenges. The typology reflects the full range of urban green space types that may occur in an urban area, inclusive of both public and private green spaces. Furthermore, it is based on a hierarchical classification that permits different categories of urban green spaces to either be aggregated or disaggregated, depending on the level of detail required (Swanwick *et al*., 2003).

Table 2.3: Typology used to classify urban green spaces (Source: Swanwick *et al*., 2003: 99)

Main types of green spaces			
All urban green spaces	Amenity green spaces	Recreational	Parks and gardens
			Recreational areas (for example, playgrounds and picnic areas)
			Sports areas
		Incidental	Housing green spaces
			Other incidental spaces
		Private	Domestic and private gardens
	Functional green spaces	Productive	Urban farmland
			Allotments (vegetable gardens)
		Burial grounds	Cemeteries
			Church grounds
		Institutional	School grounds
			Other institutional grounds
	Semi-natural green spaces	Wetland	Open/ running water
			Marsh, peatland
		Woodland	Deciduous woodland
			Coniferous woodland
			Mixed woodland
		Other habitats	Moor/ health
			Grassland
			Disturbed (transformed) landscape
	Linear green spaces		River and canal banks
			Green corridors (hiking trails and paths)
			Other linear features (for example, cliffs)

Bell *et al*. (2007) later expanded on the classification system developed by Swanwick *et al*. (2003) by generating a hybrid green space typology. This included the addition of a series of public green space sub-types that were indented to simplify the mapping process of urban green spaces in the United Kingdom (Bell *et al*., 2007). The typology adopted comprised of nine primary categories which is depicted in Table 2.4 below.

Table 2.4: A detailed typology used to classify green and public spaces in the United Kingdom (Source: Bell *et al*., 2007: 107)

Primary search level	Secondary search level
Parks and gardens	All parks and gardens: urban parks and gardens, private gardens, country parks
Natural and semi-natural spaces	All natural and semi-natural spaces: water and wetlands, woodland, remnant, vacant land and green belts and wedges post-industrial land
Green corridors	All green corridors: tree belts and woodland, linear green spaces, canal and riverbanks, disused railways
Outdoor sports facilities	All outdoor sports facilities: school playing fields, other playing fields and pitches, other sports
Amenity green spaces	All amenity green spaces: housing green space, informal recreation areas, other amenity green space
Provision for children and young people	All provision for children and young people: children's play facilities for special activities such as skateboarding, facilities for young people
Allotments, community gardens and urban farms	All allotments, community gardens and urban farms: allotments, community gardens, city farms, urban agriculture
Cemeteries, disused churchyards and other burial grounds	All cemeteries, disused churchyards and other burial grounds
Public space	All public space: streets, residential roads, civic squares, seafronts and promenades, market places, shopping precincts, settings for public heritage buildings, other hard surfaced places

A similar typology, illustrated in Table 2.5, was used to classify urban green spaces in China (Manlun, 2003). This classification system was developed with the practical purpose to meet the needs of urban construction within the country. In addition, this typology looks at urban green space from a regional perspective. The concern is directed more towards suburban green spaces that embody ecological functions within the city (Manlun, 2003). Furthermore, Manlun (2003) suggests that this type of classification system associates itself with landscape horticultural classifications traditionally used within the China.

Table 2.5: Typology used to classify urban green space in China (Source: Manlun, 2003: 11)

First class	Second class
Park	Municipal comprehensive park, district comprehensive park, residential comprehensive park, botanical garden, zoo, children park
Street side green space	Small pleasance, avenue, garden belt, square green space
Residential green space	Green space in residential district, green space in residential quarter, green space in street area
Department affiliated green space	Affiliated green in the factory, school, hospital, hotel, warehouse, municipal public facility
Roadside green space	Roadside tree, affiliated green space of road
Defensive green space	Defensive forestry of health, industry, railway, wind-defensive forestry, cuneal green space, water and soil conservation forestry
Productive green space	Nursery, flower garden, grass garden
Landscape green space	Landscape forestry, forestry parcel and other independent forestry parcel
Suburban ecological green space	Landscape area, forestry garden, natural conservation forestry, waterhead conservation forestry, farmland forestry network, orchard and other forestry land

A simplified typology of urban green space was proposed by Byrne and Sipe (2010). The framework for this typology was developed with the intention of recognising the various dimensions of urban green space that are significant components in terms of planning for their consolidation (Byrne and Sipe, 2010). These dimensions included green space type, size, typical densities, visit length, facilities and naturalness (Byrne and Sipe, 2010). Similarly, a typology presented by Levent *et al*. (2004), outlined in Table 2.6, suggests a simplified systematic assessment that reflects the multi-dimensional nature of urban green spaces. Moreover, this typology was also developed in parallel with an operational taxonomy regarding the evaluation of urban green spaces such that it can be used to further aid in urban planning efforts (Leeuwen *et al*., 2010).

Table 2.6: Simplified typology used to classify urban green spaces (Source: Levent *et al.*, 2004: 6)

Dimension of urban green space	Values
Ecological	Intrinsic natural value, genetic diversity value and life-support value
Economic	Market value
Social values	Recreational value, aesthetic value, cultural symbolisation value, historical value, character-building value, therapeutic value, social interaction value and substitution value
Planning	Instrumental/ structural value, synergetic and competitive value
Multi-dimensional	Scientific value and policy value

The eThekwini typology presently used to classify urban green spaces is based on a mapping system that recognises and assigns different habitat/ ecosystem/ land-use/ land cover types to green spaces within the eThekwini Municipality using available aerial photography (eThekwini Municipality, 2007). Green spaces are mapped using 1:5000 aerial photography and thereafter captured (via GIS software) as polygons along with their relevant attribute information (eThekwini Municipality, 2007). Table 2.7 indicates the attribute information that is assigned to these GIS polygons which represent urban green spaces.

Table 2.7: eThekwini typology used to classify urban green spaces (Source: eThekwini Municipality, 2007: 13)

Attribute information	Description
Generic habitat	This describes the broad habitat type
Detailed habitat	Where possible a more detailed habitat type was recorded
Ecosystem condition	Indicates the ecosystem condition of the polygon
D'MOSS	Whether the polygon falls under D'MOSS protection or not
Nature reserve	Those polygons which fall within 'nature reserves'
Oversteep	Indicates that portion of or the whole of a polygon may be affected by steep slopes
Floodlines	Indicates that the polygon is affected by 1 in 100 year flood events
Unstable land	Indicates that the polygon contains land identified as potentially unstable
Landslide	Indicates that the polygon contains land on which landslides are known to have occurred
Area	Area of the polygon
Perimeter	Perimeter of the polygon

2.5.2. Anthropogenic impacts on urban green spaces

Urban areas occupy a meagre 3% of the earth's surface, but are inhabited by more than 50% the world's population (Cilliers *et al*., 2014). Studies have predicted that by 2025 more than 65% of the world's population will be living in cities, with the most rapid growth expected to occur in developing countries such as Africa, Asia and Latin America (Cilliers *et al*., 2014; Kong *et al*., 2010). Urbanisation is therefore, arguably recognised as the most profound and permanent threat to natural environments at the landscape level (Cilliers *et al*., 2014; Kowarik, 2011; Wu, 2013). Furthermore, as a result of this unprecedented global urban growth, the dynamics of urban green spaces are almost entirely determined by human activities (Cui, 2011).

There is an increasing body of literature which indicates that accelerated urban growth has brought about numerous undesirable environmental concerns that have impacted negatively on land cover (Faria *et al*., 2009; Haq; 2011; Kong *et al*., 2010). As the human population grows, enormous pressures have also been exerted on energy and water resources as well as waste management systems. Environmental pollution intensification within and outside cities can affect the quality (ecological and aesthetic value) of urban green spaces and ecosystems leading to the loss of biodiversity (Laghai and Bahmanour, 2012; Puppim de Oliveira *et al*., 2011). For example, in Europe during the 1990s, an influx of acid deposition resulted in more than 1,000 plant species being threatened. Furthermore, in Munich, Germany, over the past century nearly 200 plant species have become locally extinct due to urban pollution pressures (Kong *et al*., 2010).

The physical development and expansion of cities has resulted in habitat disturbance and the inaccessibility of urban natural environments (Laghai and Bahmanour, 2012). This irregular unsustainable growth of cities has also caused the mass conversion of green space to urban developments such as industrial and residential areas, resulting in the significant degradation, fragmentation and disturbance of urban green spaces (Ahern *et al*., 2014; Laghai and Bahmanour, 2012; Nagendra *et al*., 2014). For example, in Europe it was found that between 7.3%-41% of landscape supposedly reserved for green spaces has been transformed/ degraded as a result of human-induced land-use change (Mensah, 2014). Similarly, in the United States, research has indicated a staggering 1.4 million ha loss of green spaces due to various land development (Mensah, 2014). Human-mediated habitat disturbance has also resulted in an increase of alien species often leading to a decrease in native flora and fauna (Kowarik, 2011).

As a rapidly developing country, South Africa faces mounting environmental challenges regarding the expansion of its cities and managing an expanding urban population whilst maintaining the quality and quantity of urban green spaces within them. Some South African cities face the erosion of green spaces entirely, with only around 10% of the land left occupied by green spaces (Mensah, 2014). A case in point is the eThekwini Municipality, where a recent study by the Municipality showed that the city's rich biodiverse ecosystems are under severe threat (Roberts *et al*., 2012). Furthermore, the rapid migration of people from rural areas into the cities has exacerbated the demand for the land within eThekwini and the country as a whole (Cilliers *et al*., 2014; eThekwini Municipality, 2007). This has often resulted in a situation of land invasions (informal settlements) along the urban periphery, which in many cases are located in urban open spaces that are ecologically sensitive, thus leading to the fragmentation of urban green environments (Cilliers *et al*., 2004; Mthembu, 2009).

Human-induced climate change is regarded as the most expansive and arguably the most threatening environmental challenge facing humanity (McCright, 2010). The progression of urbanisation has resulted in more vegetated/ green surfaces being replaced by paved surfaces, whereby energy exchanges and urban temperatures are modified to generate what is known as the urban heat island effect (Gill *et al*., 2007). Increasing air temperatures are expected to be problematic in urban areas, particularly in developing and tropical countries, where rapid urbanisation is most prominent, thus exacerbating the impacts of the urban heat island effect (Feyisa *et al*., 2014). The negative effects of this urban warming can affect human health and well-being as a result of thermal discomfort and stress (Feyisa *et al*., 2014). In addition, this often increases the energy use (for example, air conditioning and maintenance cost within buildings) within cities, which may result in higher carbon emissions exacerbating micro-climate change. Furthermore, high temperatures in urban areas may also enhance air pollution, thus negatively impacting on the quality of urban green spaces as well as human health (Feyisa *et al*., 2014; Gill *et al*., 2007).

In an era of urbanisation and global climate change, it is evident that there are numerous human driven activities that are significantly fragmenting urban green landscapes. This places paramount importance on the innovation of urban green space systems that are integrated into urban planning. The various approaches to urban green space planning undertaken in order to mitigate the effects of urbanisation are discussed in the next section.

2.5.3. Approaches to urban greening

Urban green space development has become recognised globally as a critical tool in the quest for sustainable cities, contributing significantly to the improved quality of urban livelihoods and urban natural environments (Abizadeh and Zali, 2013; Nilsson *et al*., 2007). Nilsson *et al*. (2007: 94) define urban greening as '*embracing the planning and management of all urban vegetation to create or add values to the local community in an urban area*'. Urban greening has aimed to enhance and maintain the 'greenery' of cities by virtue of designing, creating and managing these multi-dimensional natural environments (Jim, 2004; Nilsson *et al*., 2007).

A review of the literature suggests that urban green spaces are no longer viewed as isolated pockets of space that harbour aesthetic value, but rather as a critical component of urban networks, providing vital ecosystem goods and services to cities, such as regulating micro-climate, conserving biodiversity and improving human health, among others (Chiesura, 2004; Gill *et al*., 2007; Haq, 2011; Li *et al*., 2005; Niemelä *et al*., 2010; Roberts *et al*., 2012). However, it is important to note that the idea of 'greening' of cities is conceptualised to different extents throughout the world, often influenced by factors such as political ecology and societal perceptions (Jim, 2004). In terms of international norms for urban green spaces, experts in the field of urban environmental sustainability in Germany, Japan and other developed countries recommended a standard of 40 m^2 urban green space per capita to meet the necessary ecological balance for ensuring human well-being (Singh *et al*., 2010). In the developing world, Latin American cities have on average 225 m^2 of green space per person, followed by African cities with 74 m^2 of green space per person and lastly, Asian cities with 39 m^2 of green space per person (Unit and Siemens, 2009). Also, in recognising the importance of urban greening, the World Health Organisation (WHO) stipulated that in order to achieve a good level of urban health, a minimum of 9.5 m^2 of green space is required per city dweller (Senanayake *et al*., 2013). This suggests that developing countries are far exceeding the level of required green space per capita. However, it is important to note that simply looking at the quantity of urban green spaces is not an accurate indicator of the quality of those spaces and their value to people that interact with them (Tratalos *et al*., 2007). Senanayake *et al*. (2013) support this perspective indicating that most developing countries, in comparison to developed countries, have not paid adequate attention to urban green spaces, in terms of ensuring and evaluating environmental quality. This further strengthens the motivation for the present study

which examined the quality and environmental and social value of urban green spaces within a rapidly developing city.

Over recent years countries throughout the world have devoted considerable efforts towards developing initiatives to improve the quality of cities and towns through the creation and/ or conservation of urban green spaces (Nilsson *et al*., 2007; Zhou and Wang, 2011). The city of London for example, implemented the London Plan, an approach that includes policies and programmes aimed at protecting and improving existing urban green spaces as well as producing new green and biodiverse environments over a 30-50 year time frame (GLA, 2011). Similarly in New York, the PlaNYC effort initiated in 2007 focused on upgrading and generating new parks (for both the public and tourists), producing more aesthetic streetscapes and greenways in order to enhance ecological connectivity within the city (NYC, 2011). Other major urban greening efforts include the Seoul 2020 Vision, an initiative designed to make the city a human-orientated green city, having a high distribution of public green areas similar to other advanced cities, thus encouraging human-nature relationships to thrive (Tan *et al*., 2013). In Seattle, green space planning has focused on designing and implementing green infrastructure, such as rain and rooftop gardens, to achieve sustainable urban practices (Ignatieva and Stewart, 2011). In China many cities have adopted a 'national ecological city' approach (Tan *et al*., 2013). This approach integrated criteria such as park space and other green environments into urban development models such that they are given adequate priority (Tan *et al*., 2013). Other examples of urban greening from Chinese cities can be found in Beijing and Nanjing: both cities adopted an integrated ecological network plan, which targeted three spatial scales (regional, city and neighbourhood) for green space planning to achieve long-term sustainability (Jim and Chen, 2003; Li *et al*., 2005). Furthermore, this three level green space system aims at enhancing the future distribution of green space environments, ecological benefits and recreational functions within Beijing and Nanjing (Jim and Chen, 2003; Li *et al*., 2005).

From a South African perspective, urban greening is still a relatively young initiative, as it is only over the past 25 years that South Africa has implemented effective green space network strategies (Cilliers *et al*., 2004). Noticeable initiatives include the implementation of MOSS. With the city of Durban spearheading the programme, D'MOSS was designed to protect and enhance the city's open green spaces and the various ecosystem goods and services they provide (eThekwini Municipality, 2007; Roberts *et al*., 2012). Furthermore, in terms of

‘greening’ the city, the ecosystem services derived from these spaces have actually been proposed to replace the need for certain expensive infrastructure (Roberts *et al*., 2012). In Cape Town the Integrated Metropolitan Environmental Policy (IMEP) was developed with the purpose of increasing urban greening at a local scale. The IMEP serves as a mechanism that employs strategies aimed to enhance the management and development of green areas, whilst also promoting environmental awareness and education, thus ensuring sustainable practices within the city (Cities Alliance, 2007). In addition, a recent study in Cape Town revealed a growing interest in civic-led interventions that are aimed at planting indigenous vegetation and green space protection, in an attempt to enhance greenery within the city (Anderson *et al*., 2014).

It is evident from the above that incorporating green space areas in cities and towns is beneficial for numerous reasons. Therefore it is important to consider the integrity of green spaces within urban settings and clearly understand the benefits derived from them. This is focus of the next section.

2.5.4. Benefits of urban green space

Green spaces have unique implications within urban areas. It is well appreciated that green spaces enhance environmental quality and liveability, providing a range of ecological, social and economic benefits at the national and local level (Levent and Nijkamp, 2009; M’Ikiugu *et al*., 2012). One of the outcomes of the present study is to create a better understanding of the various benefits, illustrated in Figure 2.3, using selected urban green spaces within the rapidly developing city of eThekwini. The generalised benefits of urban green spaces are discussed below.

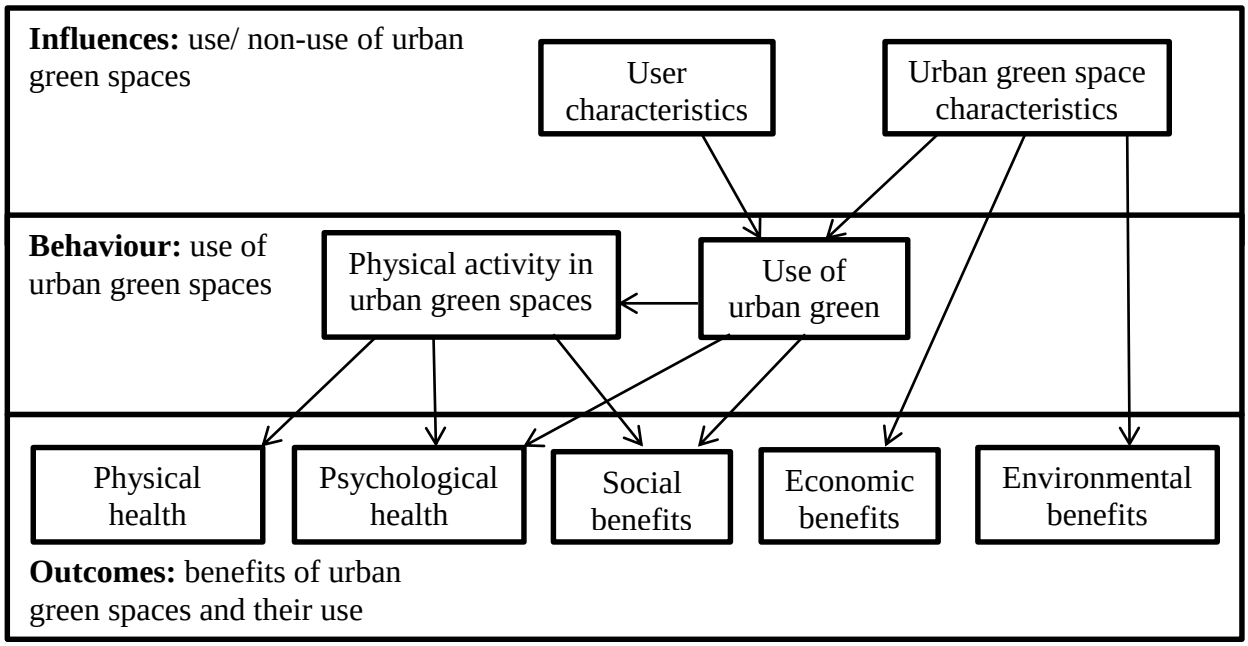

Figure 2.3: Benefits of urban green spaces (Source: Schipperijn, 2010: 14)

2.5.4.1. Ecological

Urban green spaces provide a range of ecological benefits from micro-climate regulation, removal of air pollutants, offsetting carbon emissions to habitat provision and conservation of flora and fauna (Bowler *et al*., 2010; Jim and Chen, 2006; Rafiee *et al*., 2009). The main ecological value of green spaces within the city, according to Niemelä *et al*. (2010), is that they function as carbon sinks. Urban green spaces have tremendous potential to influence urban energy consumption by regulating air temperature, thereby reducing urban energy use and carbon emissions, thus regulating the urban heat island effect (Akbari *et al*., 2001; Donovan and Butry, 2009). Research has also shown that in certain green environments more than 80% of air pollutants can be filtered (Bolund and Sven, 1999; Zhou and Rana, 2012). Furthermore, because green spaces also mitigate heat stress in urban areas by improving micro-climates and reducing thermal discomfort levels they create more comfortable outdoor settings for urban dwellers (Lafortezza *et al*., 2009). Moreover, well-distributed and maintained urban green spaces in congested cities can also serve as buffer against the effects of noise pollution (Gidlöf-Gunnarsson and Öhrström, 2007).

In addition, research has indicated that the continual provision of urban green spaces is regarded as a vital adaptation tool, particularly in developing countries, in the face of climate

change (Roberts *et al*., 2012). The ecological services derived from these spaces provide many tangible resources for people (for example, medicinal plants, fruit, vegetables and fuelwood) and are expected to be the safety net for poor and susceptible communities against the extreme weather conditions and natural disasters likely to accompany climate change (Roberts *et al*., 2012; Shackleton and Blair, 2013). Furthermore, research has shown in developing regions of the world, within Africa in particular, urban green spaces have been increasingly used for agricultural production (Shackleton *et al*., 2010). Urban agriculture provides numerous benefits to communities (particularly within rural and urban poor areas) by significantly contributing towards food security as well as generating local employment and income when utilised as a source of trade (Shackleton *et al*., 2010).

Urban green spaces also play a vital role in protecting micro-habitats and natural resources, and conserving biodiversity. According to Ward *et al*. (2010), these spaces can be described as sanctuaries of biodiversity (for example, they provide a habitat for certain bird species and allow for reproduction of certain plant species through pollination). Furthermore, in South Africa, green spaces provide refuge to a large number of threatened plant species which have been eliminated from other natural areas due to development (Grobler *et al*., 2006). Thus, aside from the intrinsic ecological benefits urban green spaces hold for humans, they also provide essential services for the continual existence of nature within urban areas.

2.5.4.2. Social

There is a large body of literature proclaiming the social benefits of urban green spaces (Chiesura, 2004; Dinnie *et al*., 2013; Haq, 2011; Jim and Chen, 2006; Lee and Maheswaran , 2011; Leewen *et al*., 2010; Sanesi *et al*., 2006; Ward *et al*., 2010; Zhou and Rana, 2012). Research has shown that urban green spaces provide a variety psychological and social benefits that contribute to human well-being by providing recreational activities, health improvements and livelihood provision (Chiesura, 2004; Dinnie *et al*., 2013; Sanesi *et al*., 2006). The recreational benefits of urban green space are portrayed by their abilities to serve as attractive and relaxing spaces, where people can socialise and engage in outdoor activities (Chiesura, 2004; Dinnie *et al*., 2013; Haq, 2011). In Mexico City, the well-established Chapultepec Park attracts more than three million people on a weekly basis who engage in a wide range of activities within the park (Ward *et al*., 2010). Similarly, in South Africa, botanical gardens have

also received much attention in this respect. Research has indicated during the period of 2006-2007, botanical gardens in the country attracted over 1.2 million visitors (Ward *et al*., 2010).

In terms of human health and psychological well-being, studies established that the presence of green spaces in urban areas can improve physical health and neighbourhood social interactions (Jim and Chen, 2006; Kuo, 2003; Lee and Maheswaran, 2011; Zhou and Rana, 2012). These green spaces provide people with daily contact with nature, thus inducing a sense of serenity and 'escape' from stressful urban lifestyles (Haq, 2011; Lee and Maheswaran, 2011). In addition, the multi-dimensional characteristics of urban green spaces urge people to engage in more outdoor activities (Haq, 2011; Lee and Maheswaran, 2011; Zhou and Rana, 2012). Research has found that the retrieved benefits from physical activity in a preferable environment can greatly reduce the risk of people suffering from diseases such as diabetes, cardiovascular problems and even certain types of cancer (De Vries *et al*., 2003; Maas *et al*., 2006). Furthermore, research conducted in certain schools showed that in the presence of green spaces, children coping with attention deficit-hyperactivity disorder actually experienced fewer symptoms (Kuo, 2003). Other research demonstrated that hospital patients with a view of green environments such as parks experienced a faster recovery rate (10% more) and required less pain relief medication than patients with a view of the building walls only (Haq, 2011).

Literature has also shown that urban green spaces provide an environment that can enhance social ties (Haq, 2011; Zhou and Rana, 2012). Zhou and Rana (2012) indicated that social interactions are more frequent in preferred green spaces than other places. The pursuit of recreation, leisure and excitement can often be satisfied in urban green spaces (Chiesura, 2004; Zhou and Rana, 2012). Furthermore, well-maintained urban green spaces can also serve as attractive amenities, which, according to Jim and Chen (2006), render aesthetic enjoyments to residents. In addition, studies have found that in some cases green spaces provide cities and communities with a sense of identity (Jim and Chen, 2006; Schipperijin *et al*., 2010). Green spaces such as neighbourhood gardens and allotments, golf courses and parks often encourage community members to engage in outdoor activities which can create a sense of community (Jim and Chen, 2006). Moreover, the Green Ribbon project in Houston, Texas was found to strengthen the regional identity of the city (Lockwood, 1999).

Urban green spaces can also be utilised for educational purposes. An increasing trend is the use of urban green spaces as outdoor classrooms. Research has shown that in some cases the

exposure to green spaces can actually enhance the performance of students by stimulating their ingenuity and imagination (Zhou and Rana, 2012). Examples in South Africa include the Franklin Nature Reserve in Bloemflontein, which has been used as an outdoor classroom for children (Mthembu, 2009). In Cape Town the Edith Stephens Wetland Park has been increasingly used for promoting environmental education as well as a venue for conferences and meetings (Mthembu, 2009). Additionally, four national botanical gardens in South Africa have been used to promote environmental education and were found to be so effective that they have now been linked to the national school curriculum (Ward *et al*., 2010).

2.5.4.3. Economic

Over recent years a number of studies have noted the economic dimensions of urban green spaces (Cilliers *et al*., 2013; Haq, 2011; Leeuwen *et al*., 2010). The ecological functions of green spaces that may lead to economic gains are mainly derived from their ability to reduce urban energy use (Derzken, 2012; Lafortezza *et al*., 2009). A study in Chicago showed that a 10% increase in urban vegetation cover within the city, resulted in a 5-10% reduction in energy costs for heating and cooling (Haq, 2011), which, according to Levent *et al*. (2009), also lowers the risk and costs of repairing and insurance claims. Furthermore, natural resources such as wood found within green spaces have the capacity for energy production and also contribute to its market value (Derzken, 2012). The management and maintenance of urban green spaces also creates employment for locals (Derkzen, 2012). In South Africa, green spaces are often utilised by poorer communities to cultivate medicinal plants that are traded (Sutton, 2008). This may explain why the city of eThekwini has adopted the concept of resource economics and employed an ecosystem-based approach aimed at converting the value of biodiverse regions (including green spaces) into monetary values, such that they are not only more appealing to relevant stakeholders, but also directed towards meeting the basic needs of the urban poor (Cilliers *et al*., 2013; Roberts *et al*., 2012).

Another economic benefit associated with urban green spaces, is that of property value. Research has shown that well-maintained urban green spaces can significantly improve the image of an area and potentially increase landscape and property value from anywhere between 5 to 15% (Cilliers, 2010; Haq, 2011). Urban green spaces also have the ability to generate economic gains through tourism. For example, the aesthetic quality of green spaces within Singapore and Kuala Lumpur (Malaysia) was shown to be a major factor driving increased

foreign investment and economic development and contributed to their recognition as prime tourist destinations (Haq, 2011). Similarly, in Durban, South Africa, tourists (local and foreign) are often drawn to the 'greenness' of the city, characterised by abundant biodiversity and well-maintained open green spaces that are accessible for recreation and leisure (eThekwini Municipality, 2007).

2.5.5. Challenges associated with urban green spaces

While there is little doubt about the benefits of urban green spaces, negative impacts of these environments can arise if they are neglected, poorly maintained, congested or unsafe; all of these hamper the quality and quantity of green space, thereby leading to a decline in their use or complete avoidance (Wright Wendel *et al*., 2012). In fact, it is important to note that urban green spaces are not only associated with a variety of ecosystem goods and services, but also with a variety of challenges. Lyytimäki and Sipilä (2009: 311) refer to these challenges as '*the negative effects of ecosystem degradation caused directly or indirectly by human activities, or they can be associated with the functioning of undisturbed ecosystems*'.

There are several different types of ecological challenges associated with green spaces important in urban areas. The first group of challenges relates to health concerns and safety. In terms of health issues, certain vegetation growing in urban areas can cause allergic reactions and consumption can in some cased lead to intoxication (Moro *et al*., 2009). Moreover, pollen in the atmosphere has been known to cause severe health concerns for people who suffer with allergies and respiratory problems such as asthma (Lyytimäki *et al*., 2008). Another serious health concern is the spread of diseases through certain animal species (for example, avian influenza, Lyme disease and rabies) inhabiting green spaces which can lead to health epidemics (Lyytimäki *et al*., 2008; Lyytimäki and Sipilä, 2009). With regard to safety, green spaces that are unmanaged are usually considered unpleasant and are often perceived as unsafe areas, especially at night (Jim and Chen, 2006; Jorgensen and Anthopoulou, 2007; Koskela and Pain, 2000). Studies conducted in Finish and Chinese cities both revealed that residents expressed concerns of insecurity towards green spaces (Hunter 2001; Jim and Chen, 2006). Additionally, a study by Perry *et al*. (2008) showed that public green spaces in urban areas of South Africa are often associated with security concerns and are deemed to be unsafe spaces by and for women, particularly.

The economic challenges associated with urban green spaces include damage to physical infrastructure which can occur as a result of the decomposition of wood from microbial activity, bird droppings exacerbating corrosion, tree roots impacting on pavements or animals creating unwanted nests; all of these results have negative cost implications (Lyytimäki and Sipilä, 2009). In addition, indirect costs can arise from the preservation and maintenance of certain green spaces which may hinder a more profitable use for the funds (for example, construction and development) (Lyytimäki *et al*., 2008). For example, green areas with the presence of a protected species can restrict other more 'profitable' uses of the land. Other indirect economic costs implications of green spaces include a decrease in property value, caused as a result of proximity to an unmanaged, aesthetically displeasing and/ or unsafe green area (Lyytimäki *et al*., 2008; Lyytimäki and Sipilä, 2009).

Another major direct cost associated with urban green spaces is caused by the removal or attempts to control alien invasive species which can inflict serious environmental harm (Lyytimäki *et al*., 2008; Lyytimäki and Sipilä, 2009). This issue has reached significant levels of concern to the extent that invasive plant species are now considered to be second most prevalent threat to biodiversity, after habitat destruction (Alston and Richardson, 2006; McConnachie *et al*., 2008). In South Africa, a study conducted in 2002 showed that around 6.8% (10 million ha) of the landscape was invaded to some degree (Le Maitre *et al*., 2002). The removal of these invasive species was estimated to cost US$ 0.86 billion over a 20 year period (Le Maitre *et al*., 2002). Furthermore, other research found that during the period of 2009-2012 an estimated R430 million was spent on combatting the invasive plant, triffid weed, in the KwaZulu-Natal province alone (Mthembu, 2009).

2.5.6. Human perceptions of urban green spaces

Numerous studies emanating from the field of environmental psychology have shown that people of different gender, age, education and socio-economic status differ greatly in how they use and perceive the natural environment (Balram and Dragićević, 2005; Burke *et al*, 2009; Jadhi and Khanmohamadi, 2013; Jim and Chen, 2006; Priego *et al*., 2008; Schipperijn *et al*., 2010). In terms of gender, Lee and Maheswaran (2011) argue that men and women perceive urban green spaces in different ways. For example, women are less likely to engage in recreational activities in urban green spaces as compared to men and women tend to feel less safe in these spaces (Lee and Maheswaran, 2011). Women also tend to view environmental

concerns and risks more so than men and are also more likely to possess stronger pro-environmental attitudes linked to their gender roles in society (Burke *et al*., 2009; Hunter *et al*., 2004).

Age is also a constituent associated with the use and perception of green spaces, where younger individuals may harbour different views and opinions compared to older individuals and *vice versa* (Sanesi and Chiarello, 2006; Schipperijn *et al*., 2010). Moreover, Jadhi and Khanmohamadi (2013) suggested that younger individuals have more energy and spirit, thus influencing their views and type of activities (often recreational) when interacting with urban green spaces. However, Balram and Dragićević (2005) indicated that middle-aged and older individuals tend to show more appreciation towards urban green spaces and are less wreckless, behaviour-wise within these environments. Literature has found that different levels of education can influence how individuals perceive their surrounding natural environments (Jim and Chen, 2006; Sanesi and Chiarello, 2006). Recent studies have found individuals with higher education levels tend to have positive aspirations about the natural environment and are more willing to socialise with others compared to those with lower education levels (Home *et al*., 2012; Shan, 2014).

In terms of income, research has shown that an individual's attitude towards and use of urban green spaces can be influenced by their income status (Crow *et al*., 2006; Priego *et al*., 2008; Vogt and Marans, 2004). Priego *et al*. (2008) showed that individuals of a higher socio-economic status tend to perceive and value urban green spaces to a greater extent than those of lower means. Moreover, Qureshi *et al*. (2013) indicated that people with more means (higher income) tend to prefer less crowded green spaces such as private golf clubs, resorts or places which are comparatively far more expensive for people of lower or middle income groups to access. Shackleton and Blair (2013) also added that green spaces in middle to high income areas are generally perceived as leisurely places used more for recreational and psychological purposes, whereas in poorer communities these spaces are often perceived as vital livelihood components, providing numerous resources to community members in order to sustain their living.

Public perceptions inevitably determine the valuation of the green spaces (Jim and Chen, 2006) and can inform the conservation strategy selected when planning residential areas in a city with a heterogeneous socio-economic profile, such as eThekwini (eThekwini Municipality, 2007;

Shackleton *et al*., 2010). This is important to consider as collective evidence from the field of environmental psychology and landscape planning demonstrates that people's perceptions and behaviour are influential factors in terms of land-use patterns and transformations (Balram and Dragićević, 2005; Jim and Chen, 2006). From the perspective of urban green space planners and managers, it is important to recognise that each individual has different preferences and needs. Therefore, before any physical changes are made to a specific green space it is vital to understand the individual factors that influence human interactions and perceptions of these green spaces (Schipperijn *et al*., 2010), which is examined in Chapter Four of this dissertation.

2.6. Conclusion

The task of this chapter was to undertake a comprehensive review of literature pertaining to the focus of this study and to generate a theoretical framework for the study. Literature was sourced from a range of disciplines ensuring that multiple opinions, views and trends were discussed. This chapter established the importance of conservation, environmental sustainability and the multiple dimensions of urban green spaces. In addition, the theoretical framework for the study was presented by reviewing the concepts underlying environmentalism, ecological modernisation and political ecology. The environmental importance of urban green spaces and their role in influencing people's perceptions of, and interactions with, nature in both developed and developing countries was also highlighted. Importantly, the literature review conducted also revealed that socio-spatial studies on urban green spaces in developing cities are regrettably scarce, particularly in a South African context. This provided ample motivation for the present study.

CHAPTER THREE: METHODOLOGY

3.1. Introduction

This chapter begins with an overview of the background and geographical context of the broader study area that is eThekwini. A brief synopsis of the demographics, climate and biodiversity characteristics of eThekwini are provided, as well as a concise description of the illustrative example used to collect the survey data, the South Durban Area, is also presented. This is followed by a discussion of the research design, description of the survey and spatial data collection, processing and analysis methods employed to achieve the aims and objectives of the study. Lastly, an account of how the limitations and challenges encountered during the course of this research were addressed is provided. It is important to note that the primary literature used in this chapter was extracted from municipal reports as much of the data or patterns observed have been reported in municipal reports rather than peer-reviewed sources.

3.2. Background and geographical setting of eThekwini

eThekwini (29.8697° S, 31.0236° E) is the epitome of a South African city, as it is one of the fastest growing cities in the country, situated at the centre of one of the most ecologically diverse regions in the world, viz. the Maputaland-Pondoland-Albany Biodiversity Hotspot (Roberts, 2008). The city encompasses a respectable municipal area that spans 2,300 km^2 (Figure 3.1) (eThekwini Municipality, 2007; Roberts, 2008) but only covers about 1.4% of the total provincial area (that is KwaZulu-Natal). However, with a total a population of 3.5 million people contributing to 60% of economic activity within the province, eThekwini has established itself as one of the country's leading urban and economic centres (eThekwini Municipality, 2007; Roberts, 2008). In 2000, the Municipal demarcation process saw the extent of the Municipal boundary increase by a staggering 68%, which subsequently led to a 9% increase in the Municipality's population (eThekwini Municipality, 2007). Mostly rural and open areas were incorporated into the Municipality that significantly increased the green and open spatial footprint. This expansion in range also brought about the need for the redistribution of resources from a wealthy centre to poorer periphery areas (Marx and Charlton, 2003). Post re-demarcation the Durban Municipality was renamed eThekwini Municipality (Zulu name for Durban) in order to reflect its proud indigenous history (Marx and Charlton, 2003). The eThekwini Municipality is the local government instrument responsible for governance,

provision of services, socio-economic development and maintenance of a clean and safe environment within the city.

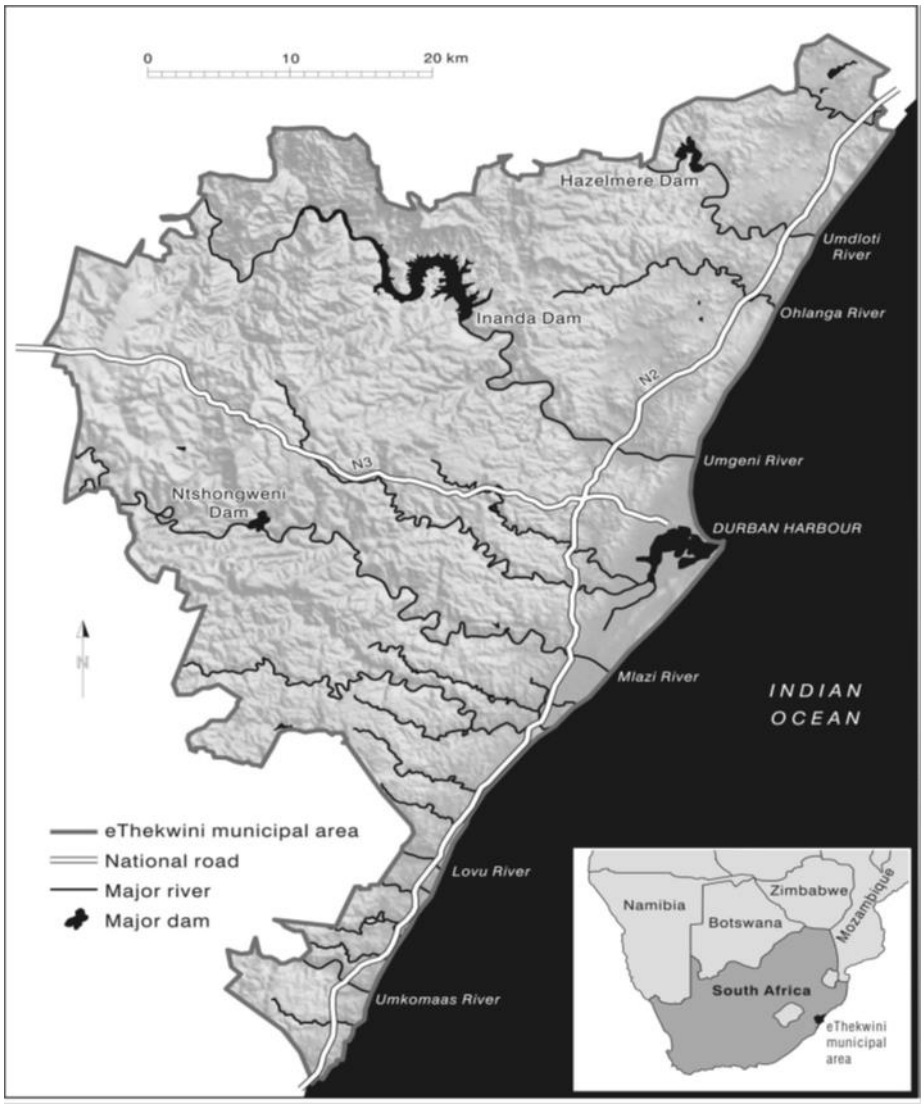

Figure 3.1: Location of eThekwini Municipality within South Africa (Source: Roberts, 2008: 522)

Geographically, eThekwini is situated below the Drakensberg Mountains towards the narrow lowland coastal terrain. The western Municipal area is characterised by steep escarpments due to past weathering of sandstone deposits, with the eastern regions generally comprising of flat terrain and coastal plains (eThekwini Municipality, 2013). The land cover boasts an impressive 98 km of coastline, along with 18 river catchments, 16 estuaries, and over 4,000 km of river (eThekwini Municipality, 2007). The main river that flows through city into the ocean is the

Umgeni River. Due to prior economic and political factors, many of the developed regions within the eThekwini Municipality are situated on an east-west axis that follows the 98 km Municipal coastline. This development incorporates two major national freeways, viz. N2 and N3, that link important structural features resulting in a "T" shape spatial urban setting (eThekwini Municipality, 2007). The N2 freeway runs adjacent to the east coast and serves as a major link for eThekwini to the northern regions of KwaZulu-Natal as well as southerly regions such as the Cape. The N3 freeway provides the main transport route to South Africa's economic heartland, Gauteng (eThekwini Municipality, 2007; Marx and Charlton, 2003). The majority of areas situated closer to these roads are generally well developed in terms of infrastructure and social amenities, while more remote areas towards the periphery of the Municipal border tend to be less well-equipped and resourced (eThekwini Municipality, 2007).

Approximately a third of the eThekwini Municipality is comprised of peri-urban and informal settlements that are generally characterised as traditional households situated on hilly and rugged terrain (eThekwini Municipality, 2007). Many of these areas are often subject to extreme poverty and high levels of unemployment, with the majority of people relying on natural resources, government grants and any available social assets in order to sustain their livelihoods (Shackleton *et al*., 2010). According to Shackleton *et al*. (2010), these conditions are often exacerbated by the lack of service delivery, lack of awareness amongst locals on how to optimally interact with natural resources, degradation of the environment, a stretched Municipal budget that struggles to support the countless demands on its resources, and insufficient substantive information with regard to planning.

3.2.1. Demographics

Nearly 3.5 million people reside within the eThekwini Municipality (Roberts, 2010), making it the second largest municipal population in the country after Johannesburg. eThekwini is a culturally diverse city and consists of people from a range of ethnic backgrounds, a mix which has generated a vibrant cosmopolitan city (eThekwini Municipality, 2007; Shackleton *et al*., 2010). The majority of the population are African (68%), followed by Indians (20%), Whites (6.6%) and a minority Coloured community (3%) (Shackleton *et al*., 2010). The age profile for the city indicates that the majority of the population comprises of individuals within the working age category of 18-52 years (eThekwini Municipality, 2013). Gender statistics revealed that the eThekwini population comprises of 1,679,040 males and 1,763,321 females

(eThekwini Municipality, 2013). In terms of population concentration, the largest population distribution can be found within central (34%) and northern (31%) regions of the Municipality. The central region is the urban core of the Municipality and is therefore home to majority of the individuals within the city. Approximately 18% of the population reside in the southern region, with the outer west area of the Municipality accommodating 16.5% of the population (eThekwini Municipality, 2013). However, what is important to note is that the eThekwini Municipality is characterised by a fragmented economic landscape: the urban core and selected suburbs in the vicinity are comprised of very wealthy households, whilst regions on the periphery of the city largely constitute informal settlements and low-cost housing. Furthermore, 27% of African individuals reside in informal settlements which represents a huge economic gap when one considers that only 0.4% of Whites reside in informal settlements (Aylett, 2011). Half the African and Coloured population within the city are unemployed, with a quarter of the employed individuals within the city earning less R800 per month (Aylett, 2011; eThekwini Municipality, 2013).

3.2.2. Climate

eThekwini is characterised by a humid subtropical climate experiencing an average of 320 days of sunshine per year, with relatively warm summer periods and mild winters. The mean annual temperature ranges from 18-26°C (Shackleton *et al*., 2010). Summer temperatures generally reach the lower thirties, however, summer berg winds have been recorded to drive temperatures into the 35-38°C range (Ceroi, 1999; Higdon, 2007; Shackleton *et al*., 2010). Winter temperatures rarely drop below 10°C (Shackleton *et al*., 2010). Temperatures during winter months are generally mild with sporadic cool events due to polar surges rising from the south. Berg winds are generally the cause for higher temperatures during winter (Higdon, 2007). Humidity levels range from 50-70% and can often reach extreme highs during summer periods causing high discomfort levels within the eThekwini Municipality (Higdon, 2007). eThekwini has a mean annual rainfall of 1,000 mm, falling mainly during the summer period (Shackleton *et al*., 2010). Peri-urban areas in the western region of the eThekwini Municipality generally have lower annual rainfall as drier areas are situated inland (Shackleton *et al*., 2010).

3.2.3. Biodiversity

As mentioned previously, eThekwini is located at the heart of the Maputaland-Pondoland-Albany Biodiversity Hotspot (Roberts *et al*., 2012). 'Hotspots' are some of the world's most extraordinary places, but are also the most vulnerable, possessing the highest, and most often threatened, levels of plant and animal diversity on the earth (Myers *et al*., 2000). Additionally, from a biogeographic standpoint, the eThekwini Municipality is situated between two distinct zones, viz. the subtraction and transition zone. Combined, these zones create conditions that bring specific elements to the eThekwini Municipality which include tropical and warm temperate habitats indigenous to the area (eThekwini Municipality, 2007). Together these conditions along with the diversity of landforms and distinct climate have resulted in a variety of terrestrial and aquatic ecosystems that are rich biodiversity and in many cases unique (eThekwini Municipality, 2012). Of the country's eight terrestrial biomes, three are located within the eThekwini Municipality, viz. savannah, forest and grassland (eThekwini Municipality, 2012). eThekwini is home to more than 2,000 plant species, 82 terrestrial mammal species and 69 reptile species (eThekwini Municipality, 2007, 2012). In terms of flora, eThekwini is considered to be the second richest floristic region within southern Africa (eThekwini Municipality, 2007). However, many of the vegetation types found within the Municipality are severely threatened due to increasing urban pressures (eThekwini Municipality, 2007).

3.2.4. Status of green spaces within the eThekwini Municipality

The eThekwini Municipality is host to a variety of green spaces, spanning an impressive area of 2,286.36 km^2. The numerous green spaces within the city provide a range of environmental goods and services, offering socio-economic, ecological and aesthetic benefits to communities surrounding them. Table 3.1 and Figure 3.2, below, were generated using spatial data provided by eThekwini Municipality and are designed to depict the status of these green spaces.

Table 3.1: Green space categorisation and ecosystem condition within the eThekwini Municipality (Source for raw data: eThekwini Municipality, 2012)

		Ecosystem condition (m^2)				
Habitat	**Green spaces**	**Degraded**	**Good**	**Intermediate**	**Transformed**	**Total (m^2)**
Artificial	Extractive	8,081,633.6	-	313,007	1,283,826.7	9,678,467.3
	Field crops	-	-	-	215,950,675.1	215,950,675.1
	Recreational	21,849,060.1	-	543,126.3	-	22,392,186.5
	Settlement	191,996,540.5	5,700.2	66,247.1	959,050,170.1	1,151,118,658
	Tree crops	65,951.6	-	-	10,249,502.1	10,315,453.7
	Utility	6,099,048.8	-	259,346.1	11,602,924.1	17,961,318.9
	Woodland	44,572,856.4	118,435,633.6	47,773,558.9	-	210,782,049
	Total (m^2)	272,665,091	118,441,333.9	48,955,285.5	1,198,137,098	1,638,198,808
Natural/Semi-natural	Artificial waterbody	-	-	20,349,430.1	-	20,349,430.1
	Estuary	-	-	24,323,155	-	24,323,155.0
	Forest	10,034,120.8	100,187,091.1	28,252,956.8	-	138,474,168.7
	Freshwater wetland	-	419,768.5	70,902,289.7	-	71,322,058.2
	Grassland	19,263,391.5	92,012,027.8	21,788,517.6	-	133,063,936.9
	Rocky	-	4,422,732.2	-	-	4,422,732.2
	Thicket	66,731,656.9	153,235,576.2	36,239,944.3	-	256,207,177.4
	Total (m^2)	96,029,169.2	350,277,195.8	201,856,293.5	-	648,162,658.5
	Grand Total (m^2)	368,694,260.3	468,718,529.7	250,811,578.9	1,198,137,098	2,286,361,467

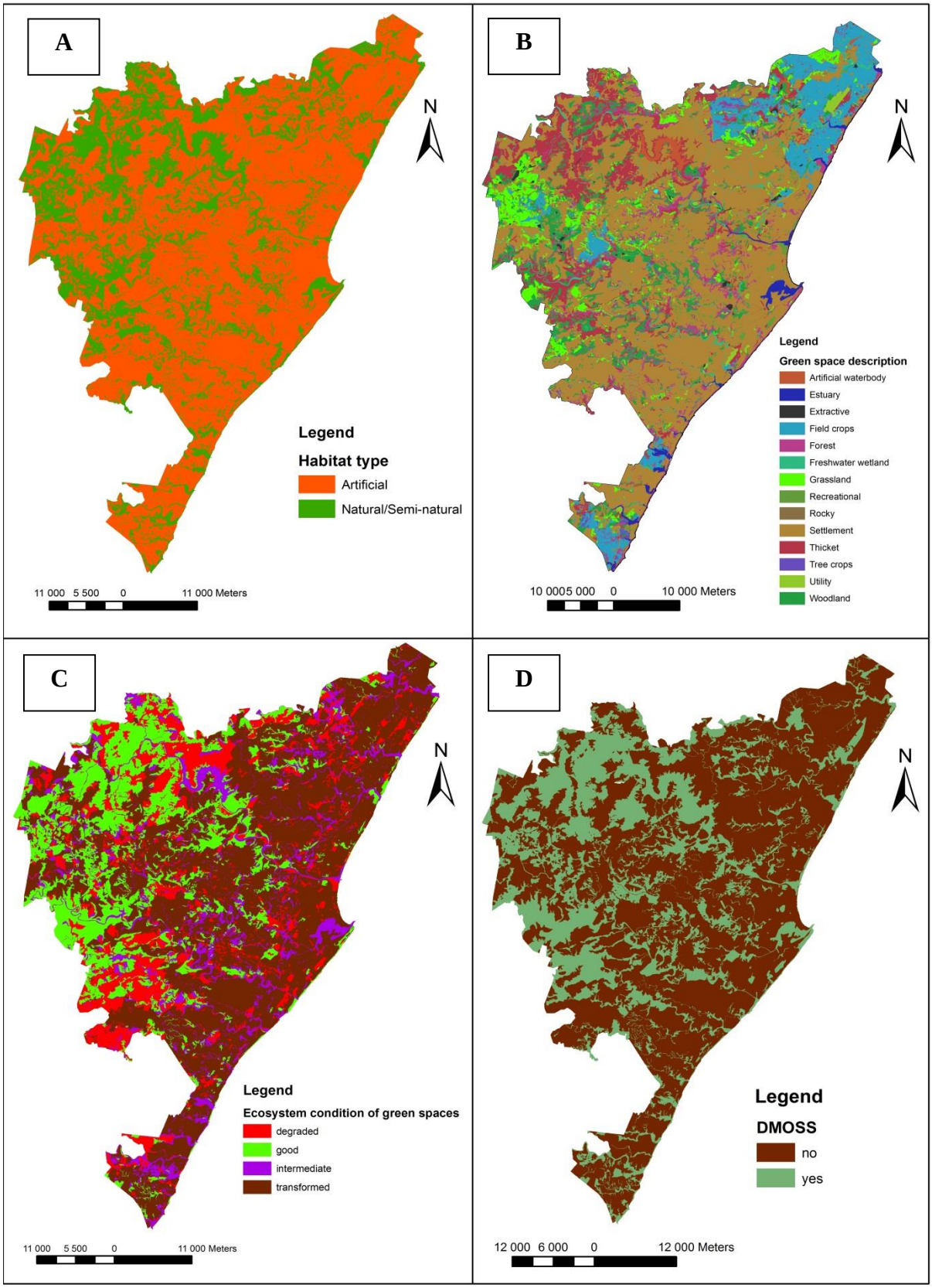

Figure 3.2: Status of green spaces within the eThekwini Municipality. A: habitat type, B: categories of green space, C: ecosystem condition of green spaces and D: D'MOSS/ Non-D'MOSS zones (Source for raw data: eThekwini Municipality, 2012)

With reference to Table 3.1 and Figure 3.2 the eThekwini Municipality categorises green spaces into two broad habitat types, viz. natural/ semi-natural and artificial. A detailed analysis of the raw data provided by the Municipality revealed a number of important patterns and as these informed the research questions addressed in the chapters that follow they are described below.

Based on the data shown in Table 3.1 and Figure 3.2 artificial habitats occupy the majority of green space within the eThekwini Municipality covering 71.7% of the land, while natural/ semi-natural habitats only occupy 28.3%. This indicates that less than a third of the Municipal area is comprised of natural/ semi-natural habitats. This is most likely a consequence of the exponential urban expansion within the city, resulting in far less land for flora and fauna within natural habitats to thrive (eThekwini Municipality, 2007). In terms of green space categories, settlements occupy around half (50.3%) the Municipal area, while woodlands (9.2%) and field crops (9.5%) also constitute a relatively large proportion of green space in comparison to other environments. Combined extractive, recreational and utility spaces occupy only 2.2% of the Municipal area. Furthermore, the categories of green space described above are also constituents of artificial habitats within the Municipality. The remaining categories of green spaces fall under natural/ semi-natural space within the Municipality and are mainly comprised of thicket (11.2%), forest (6.1%) and grassland (5.8%) environments. Artificial waterbody, estuary and rocky environments total a meagre 2.1% of the eThekwini Municipality.

The majority of the Municipal area is subject to high degrees of transformation (52.4%) due to increasing urbanisation rates (eThekwini Municipality, 2012) as previously mentioned. More than half of the green spaces within the eThekwini Municipality have been designated as transformed, while 16.1% have been classified as degraded and only a fifth (20.5%) of these areas remain good/ intact. The minority of green spaces (11%) within the Municipality are in an intermediate condition. Furthermore, artificial habitats are subject to far higher degrees of degradation and transformation compared to natural/ semi-natural areas. Settlement and woodland spaces are subject to the highest levels of degradation, with settlements also subject to high degrees of transformation. Natural/ semi-natural areas constitute the largest proportion of good/ intact ecosystems within the eThekwini Municipality, with no transformation occurring in these spaces. However, with the exception of artificial waterbodies, estuaries, freshwater wetlands and rocky spaces, the remaining natural/ semi-natural green space categories are all exposed to considerable degradation. With the above information in place,

the quality of green spaces within the Municipality is examined in greater detail in Chapter Four.

3.2.5. Durban Metropolitan Open Space System (D'MOSS)

The eThekwini Municipality began to identify open spaces that should be conserved as far back as 1979. eThekwini's first open space plan was implemented in 1979 and over the years has been continually improved and transformed in accordance with new environmental approaches and land-use planning schemes (eThekwini Municipality, 2007). In 1989 a detailed joint project between the eThekwini Municipality and University of KwaZulu-Natal (former University of Natal) was undertaken to perform an ecological evaluation of open spaces within the Municipality. This project resulted in the development of D'MOSS (eThekwini Municipality, 2007). In terms of environmental planning, D'MOSS was geared to shift away from a predominantly conservationist and ecological approach towards a more integrated approach whereby ecological, social and economic factors could be integrated to produce a sustainable open space system (eThekwini Municipality, 2007). In terms of sustainable planning, D'MOSS consists of a wide range of both terrestrial and aquatic environments that satisfy both conservation needs as well as the provision of ecosystem services to residents (eThekwini Municipality, 2007; Roberts *et al*., 2012). This is particularly important in a rapidly urbanising city such as eThekwini, as the sustainable provision of environmental goods and services is vital in meeting community needs, especially those of the urban and rural poor.

D'MOSS is basically the ecological footprint of the Municipality that is used to identify environmentally important regions. Currently more than 75,000 ha of land (33%) within the eThekwini Municipality fall under the umbrella of D'MOSS zones (Figure 3.2; eThekwini Municipality, 2012). This was accomplished by means of conservation zoning and environmental servitudes and land acquisition (eThekwini Municipality, 2012). However, only 12% of all D'MOSS areas are protected and managed for conservation, while 2% are zoned as D'MOSS, but not managed and 86% have no management at all (eThekwini Municipality, 2012). This is important to consider, given that in 2003 the environmental goods and services provided by D'MOSS were valued at R3.1 billion (eThekwini Municipality, 2007). D'MOSS has now been introduced as a controlled development layer into all town planning schemes within the eThekwini Municipality. This implies that any area classified as a D'MOSS zone should not be degraded and that any development/s occurring on or in close proximity to

D'MOSS zones has to be thoroughly assessed before any action takes place (Roberts *et al*., 2012).

3.3. South Durban Area (SDA)

The SDA (Figure 3.3), located on the east coast of KwaZulu-Natal, is considered one of the largest industrial hubs in the country, covering an area of approximately 63 km^2 extending from the Bluff area, to Umbogintwini in the south (Adebayo and Musvoto, 2013; Guastella and Knudsen, 2007; Sutherland *et al*., 2009). This region is home to the two largest oil refineries in the country (ENGEN and Sapref) as well as the busiest port on the eastern seaboard which serves as the main entry for cargo containers into the country; all of which are in very close proximity to densely populated residential areas as well as green environments.

This housing scheme can be attributed to poor planning practices during the apartheid era, which saw the SDA being transformed into a hub for industrial and economic productivity (Guastella and Knudsen, 2007). The economic growth and job creation during this period ultimately led to industries being developed and situated in areas south of the Durban Bay. Additionally, it was considered advantageous to have working class individuals situated in close proximity to their workplace, therefore housing schemes during the apartheid regime saw many African and Indian residents located in surrounding (lower income) areas such as Lamontvillle, Wentworth and Merebank, supplying the labour force for industry within the SDA (Adebayo and Musvoto, 2013). Remnant floodplains of the Umlazi, Isipingo and Umbogintwini regions within the SDA were utilised for development of many industries due to the relatively flat land along these plains (Guastella and Knudsen, 2007). This spatial order development progressed in a haphazard manner with major faults that included residential areas situated next to these industries as well as little consideration for the environmental pollution (Adebayo and Musvoto, 2013; Guastella and Knudsen, 2007).

Currently, the SDA is the second largest industrial zone within South Africa (Sutherland *et al*., 2009). It houses some 600 industries, with large concentrations of petrochemical and chemical industries that contribute heavily to the air pollution and hazardous waste that typify the area (Sutherland *et al*., 2009). Moreover, the SDA is also home to around 285,000 people, many of whom are located immediately adjacent to these industries (Adebayo and Musvoto, 2013; Guastella and Knudsen, 2007; Sutherland *et al*., 2009). Consequently social, economic and

environmental issues in this area are highly controversial, with residents frequently expressing concerns about environmental risks, health impacts and disturbance of social amenity (Sutherland *et al*., 2009). Communities in close proximity to these industries include Bluff, Wentworth, Clairwood, Merebank, Lamontville and Isipingo (Adebayo and Musvoto, 2013). In addition, this area comprises of numerous green spaces, including a nature reserve and conservancy, golf course (well-maintained with many trees on the range) and a large stretch of coastal forest.

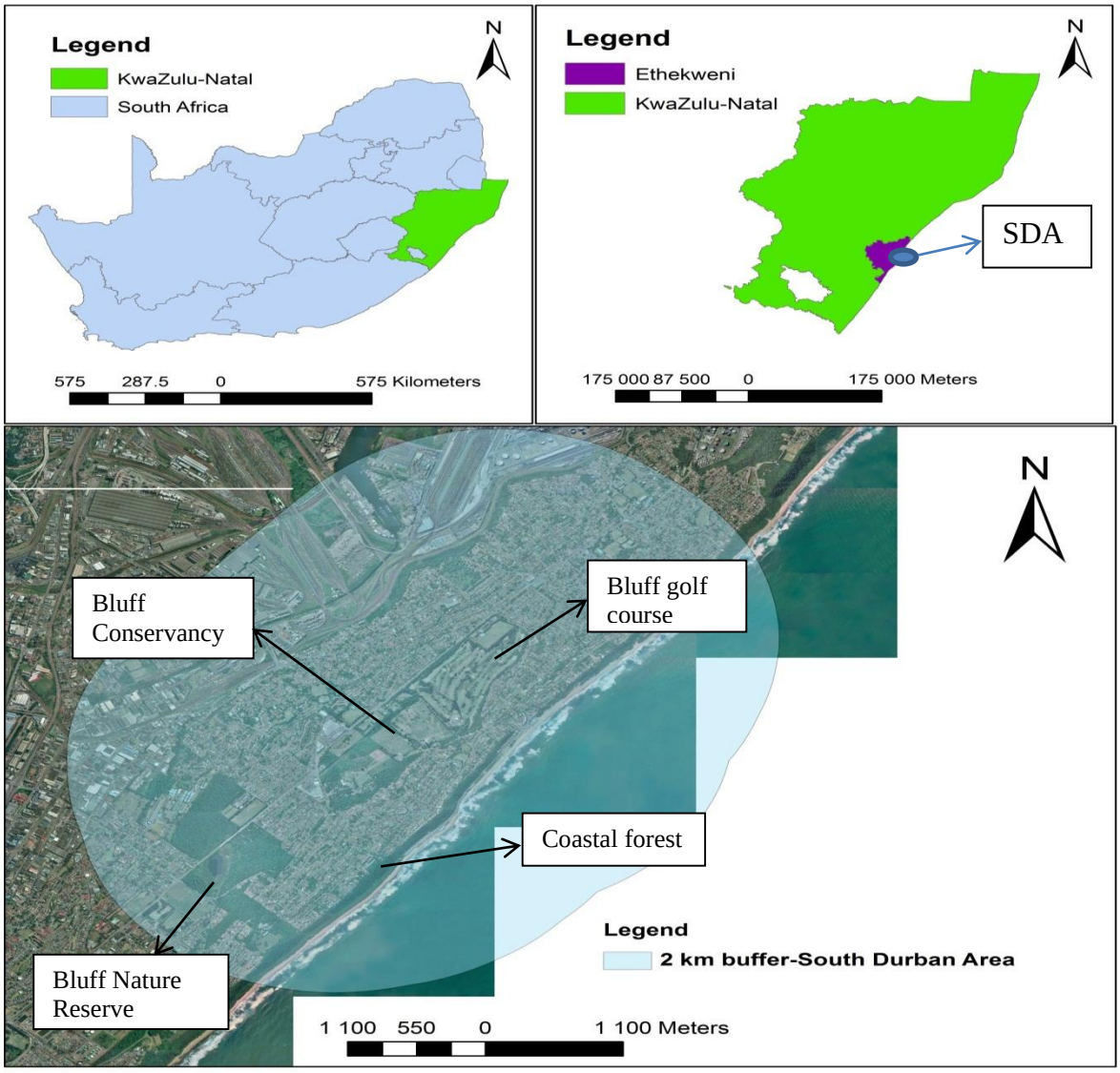

Figure 3.3: Location of South Durban Area (within a 2 km radius from the Bluff Conservancy) in KwaZulu-Natal (South Africa)

3.4. Research design and approach

Structured as exploratory research, this study utilises a case study approach which is aimed at detailed description and understanding of green space quality and value and residents perceptions thereof. Stake (2000: 11) defines a case study as "*the study of the particularity and complexity of a single case, coming to understand its activity within important circumstance*". Moreover, according to Bryman (2008) and Stake (2000), case study research is meant to capture the complexity of a specific case whilst also providing a high context of validity. VanWynsberghe and Khan (2007) suggest that case study research is trans-disciplinary and can be applied in both social science and scientific research. Hence, in this study eThekwini was selected as a case study as it is indicative of a rapidly developing city with green spaces subject to high urban pressures (the spatial analyses of green spaces examined in this study were randomly selected from the entire eThekwini Municipality). Moreover, integrated within this case study research, was a mixed-methods approach that combined multiple data sources. Research has indicated that using a mixed-methods approach is advantageous in contemporary geographical research (Balram and Dragićević, 2005; Yin, 2009). This type of approach allows for a more holistic view of the data, strengthening the validity of research, in that the limitations of one method can possibly be met by the strength of another and it also allows for objective data interrogation and interpretation (Balram and Dragićević, 2005; Yin, 2009). Therefore, within the case study (eThekwini) examined in this research, selected residential areas surrounding the Bluff Conservancy (all situated within the SDA) were used as illustrative examples in order to unpack social perspectives on the use and value of green spaces within the eThekwini Municipality.

3.5. Data acquisition

3.5.1. Survey data

A series of socio-spatial analysis methods were used to collect survey data, using proportionate random sampling techniques with the support of GIS. The data collection methods used was GIS mapping and a questionnaire.

3.5.1.1. Sampling framework

The target population for the study were households within a 2 km radius of the Bluff Conservancy in the selected case study area (Figure 3.4). More specifically, these households were located in the Bluff, Wentworth and Merebank communities; all of which are situated within the SDA. As mentioned earlier, this area was purposively selected as it is one of the most environmentally sensitive locations in the country (Sutherland *et al*., 2009), playing host to a number of residential and environmental issues. Data collection was conducted using a stratified multi-stage sampling approach in order to attain a statistically significant (95% confidence interval) number of households for the survey. Given the fact that there were a total of 6,599 households within the spatial extent of the 2 km buffer, it was necessary to conduct 400 household questionnaires for the results to be statistically significant (using a 95% confidence interval). The sampling framework consisted of spatially dividing the 2 km buffer into six equal quadrants using ArcMap v 9.3 (Figure 3.4) and thereafter calculating the total number of households to be sampled within each quadrant (Table 3.2) using the following formula:

$$Households\ sampled\ within\ quadrant\ = \left(\frac{Number\ of\ households\ within\ quadrant}{Total\ number\ of\ households}\right) \times 400$$

Table 3.2: Number of households sampled within each quadrant

Quadrant	**Total number of households within quadrant**	**Households sampled within quadrant (*n*)**
1	999	60
2	967	59
3	1477	90
4	862	52
5	952	58
6	1342	81
Total	6599	400

Figure 3.4: Selected communities/ households within South Durban Area digitised into six quadrants for sampling

The next stage of sampling involved the selection of 400 households from the six quadrants via proportionate point random sampling. Using the Hawth's Tools extension in ArcMap v 9.3, random points were generated according to the sample size required for each quadrant (Figure 3.5). Interviews were conducted with any adult household member at each of these points. If it were to occur that any household/ point was unable to be sampled, the nearest available neighbour was approached to substitute the selected household/ point. Aerial photography obtained via the eThekwini Municipality's Environmental Planning and Climate Protection Department (EPCPD) facilitated this GIS based sampling approach.

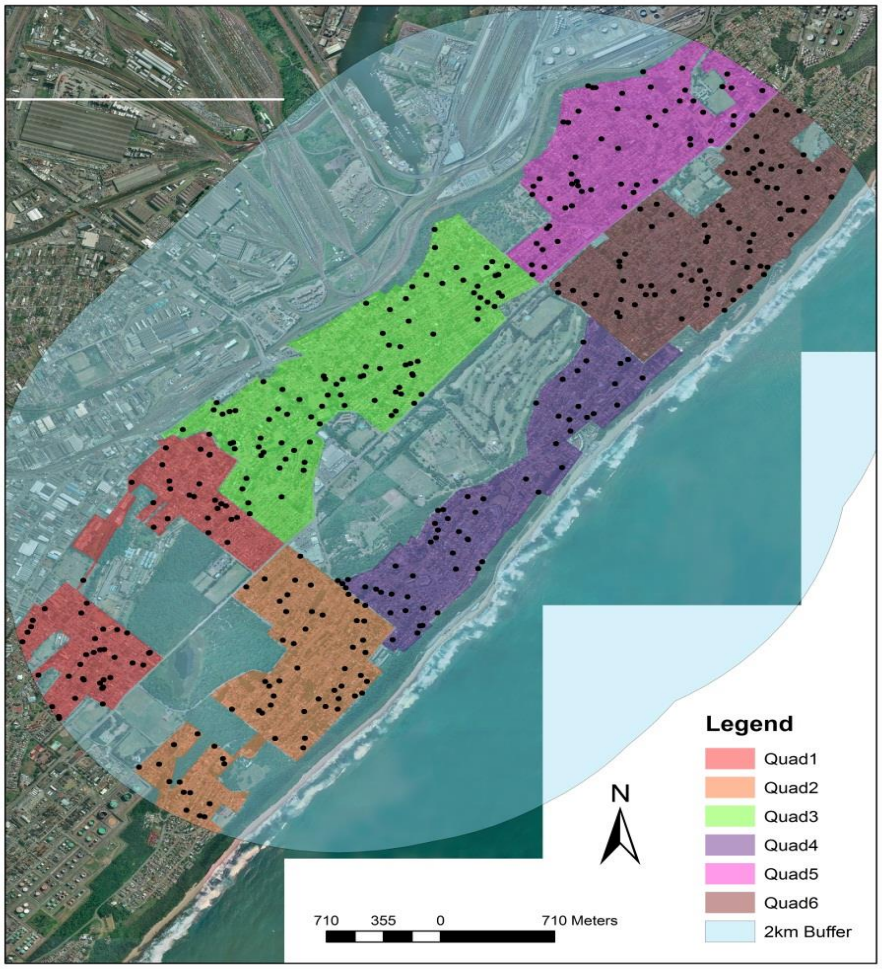

Figure 3.5: Households/ points sampled in selected communities within South Durban Area

The sampling technique described above ensures a randomised selection of household/ points, which is a vital component in geographical research (Derkzen, 2012). Furthermore, the spatially-orientated technique utilised was both efficient and cost-effective, as oversampling was avoided and household rosters did not have to be created. The fieldwork process was also simplified as the households were already spatially and visually identified thus aiding in easy location.

3.5.1.2. Questionnaire

Questionnaire surveys have been prominently used as the method of choice when conducting perception studies (Balram and Dragićević, 2005). In terms of urban green spaces, measuring

resident perceptions at a local scale is highly valuable and can greatly support conservation and management efforts and community development projects (Balram and Dragićević, 2005; Gerd and Wänke, 2002). This can potentially lead to a better understanding of urban green spaces, thereby aiding in ways to increase user benefits and optimal use of these spaces. Environmental studies indicate that resident perceptions toward nature are influenced by multiple variables, with key determinants including demographics, value and knowledge (Balram and Dragićević, 2005; Lakhan and Lavalle, 2002).

In view of the above, this study utilised a questionnaire (Appendix A) in order to obtain quantitative data regarding resident use and perceptions on value of urban green spaces within the SDA. Effective questionnaire tactics such as likert and semantic-differential scales (Sanesi and Chiaerello, 2006) were used to ascertain the necessary data. The questionnaire was divided into four sections:

I. Section A: Demographic profile of respondents
II. Section B: Respondents' use and perceptions of urban green space
III. Section C: Environmentally-friendly practices of respondents
IV. Section D: Respondents awareness and perceptions of D'MOSS

The questionnaire consisted of open and close-ended questions allowing respondents to express their perceptions and opinions freely. Questions were focused on issues concerning resident interactions and the value of green spaces within their surroundings. Moreover, respondents were also elicited to provide their interpretation of a context based definition of urban green spaces. Additionally, the questionnaire also aimed to determine how well respondent perceptions of green spaces within their community resonate with the existing (eThekwini Municipality) and Adapted (developed as part of this study) typology's classification of these particular green spaces.

3.5.2. Spatial data

Spatial data as well as aerial photography for the study was obtained from the EPCPD. Table 3.3 below lists and describes the spatial data used in this study.

Table 3.3: Description of spatial data

Data	Description
Shape file of land classification for the eThekwini Municipality (2011)	Attributes such as generic and detailed habitat description, D'MOSS status, ecosystem condition, alien invasive plant infestation and area of open spaces within the eThekwini Municipality
Shape file of land-use for the eThekwini Municipality (2005)	Attributes and descriptions for all land-use within the eThekwini Municipality
Aerial photography of the eThekwini Municipality (2012)	Aerial photography depicting the entire eThekwini Municipality

3.6. Data analysis and evaluation

3.6.1. Statistical analysis

Data collected from the questionnaire was captured and analysed using the SPSS v 19. Data was categorically analysed according to the format of the questionnaire via descriptive and inferential statistics (cross-tabulations and Chi-square tests). Thereafter, results were quantitatively displayed using graphs, tables and charts reflecting key trends, issues and correlations in relation to the relevant literature being discussed. Furthermore, in line with the other objectives of the study, findings from the social survey were used to inform the spatial results.

3.6.2. Spatial analysis

In order to assess the status of green spaces within the entire eThekwini Municipality, geographic techniques, specifically GIS were utilised to develop a spatial representation of the quality, use and vulnerability of these spaces in relation to land-use patterns. The data generated using the rapid geographic technique developed was incorporated into an Adapted typology developed for six green space types occurring in the eThekwini Municipality: settlement, tree crops, woodland, forest, grassland and thicket. The Adapted typology draws on aspects included in the existing Municipal typology as well attributes derived from other typologies appearing in the literature.

The initial step was to identify and extract all green spaces within the eThekwini Municipality. Green spaces were selected using existing typologies found in the relevant literature (Bell *et al*., 2007; Swanwick *et al*., 2003). It is important to note that as the analysis of all green spaces within the eThekwini Municipality was beyond the scope of the present study, six random green space types were selected for the purposes of the assessment; thus the findings presented in Chapter Four are trends reflective of these six green space types. The green space types selected included: settlement, tree crops, woodland, forest, grassland and thicket. ArcMap v 9.3 was used to overlay all sites corresponding with these green space types on aerial photography of the eThekwini Municipality. Thereafter, the Hawth's Tools extension was used to select five random sites belonging to each of the six green space types (yielding 30 sites in total). These 30 sites were then subjected to the analysis described below.

The 30 green space sites were first examined using the eThekwini typology and thereafter with the Adapted typology. The two typologies were compared in terms of their utility in classifying/ polarising the selected green spaces into sub-environments on the basis of ecosystem condition (degraded, good, intermediate or transformed). This comparison between the two typologies also allowed for an assessment of the value of the set of criteria employed in the Adapted typology to visually assess the quality of selected green spaces. The criteria described below (Table 3.4) informed the statistics used to assess the quality of the different green space types in the Adapted typology.

Table 3.4: Criteria used to assess quality of selected green space types as part of the Adapted typology

Criteria	Description
Classification	The adapted classification of ecosystem condition (degraded, good, intermediate or transformed) of the green space site
Habitat and vegetation type, and threat status	• The habitat of the green space site. ➢ The habitat type was determined using the Swanwick *et al*. (2003) typology which categorises green spaces according to the categories: amenity, functional or semi-natural • The vegetation found within the green space site ➢ The vegetation type was identified according to the South African National Biodiversity Institute's (SANBI, 2011a) KwaZulu–Natal vegetation type classification • Ecosystem threat status of the green space site ➢ The ecosystem threat status was based on the following categories: critically endangered, endangered, vulnerable or least threatened (SANBI, 2011b)
Infringement	The level on infringement on the green space site using the likert scale: none, minimal, moderate or considerable

Statistics incorporated in the Adapted typology were calculated for each of the five sites, within the six green space types selected using the criteria listed in Table 3.4. Equations to calculate the indicators used to assess green space site quality in this study are listed below:

1. Quality based land cover condition (area and percentage)

Using the GIS tools described earlier the area and associated percentage of land cover determined to be degraded, good, intermediate or transformed was calculated as follows for each site:

$$Quality\ based\ land\ cover\ condition = \left(\frac{Area\ degraded/good/intermediate/transformed}{Total\ area\ of\ site}\right) \times 100$$

2. Habitat, vegetation and threat status, and infringement (percentage)

For each site the proportions of land associated with the different habitat, vegetation, threat status and infringement categories were calculated as a percentage of the total area assessed for the green space type (i.e. sum of the areas of the five sites sampled) as follows:

$$Habitat, vegetation, threat\ status\ and\ infringement = \left(\frac{Area\ in\ agreement\ with\ habitat, vegetation, threat\ status\ and\ infringement}{Total\ area\ of\ green\ space\ type}\right) \times 100$$

3. Deviation index for green space type

For each site a deviation index was scored based on the amount of land that was classified differently to (deviated from) the broad eThekwini typology. The approach adopted for these calculations is based on a statistical technique commonly used to evaluate the level of agreement between two variables, which in this study are eThekwini typology green space condition and Adapted typology green space condition.

More specifically, the deviation index was calculated by first assigning a score to each of the five sites within a particular green space type. These scores were:

0- No deviation from eThekwini typology; land is classified the same by both typologies.

1- Minimal deviation, approximately a third of the land deviated from eThekwini typology (< 33%).

2- Moderate deviation, between a third and two thirds of the land deviated from eThekwini typology (> 33% but < 66%).

3- High deviation, more than two thirds of the land deviated from eThekwini typology (66% >).

The equation below was then used to calculate the percentage deviation for each green space type:

$$Percentage\ deviation\ of\ green\ space\ type = \left(\frac{Sum\ of\ site\ deviation\ scores}{Maximum\ possible\ deviation\ (3) \times No.\ of\ sites\ (5)}\right) \times 100$$

*Based on the criteria used the maximum deviation score for any possible site is equivalent to 3 and in this particular study, 5 sites were sampled within each green space type.

The overall goal of the spatial analyses carried out was to assess whether the Adapted typology developed could be used to generate a more refined quantitative assessment of green space quality.

3.7. Limitations and challenges

This study encountered limitations in both the social and spatial aspects of the research. From a social perspective certain bias opinions may have arisen in the household interviews conducted. Field observations showed that some respondents neglected to mention or even acknowledge clear problematic issues/ challenges associated with their surrounding green spaces and even took offense to certain questions when probed about the quality of these green areas. According to Vogt *et al*. (2012), this is a common occurrence that may arise when conducting household surveys. In addition, even though questionnaires are a cost-effective method of collecting data, it was a labour intensive task. Moreover, in order to obtain a more conclusive understanding of resident use and perceptions of green spaces within the eThekwini Municipality, many more communities, from an array of different locations would have to be included in the study. This would certainly reduce the influence of factors such as biasness and scientific generalisation which arise when using a case study approach. Spatially, the amount of information on the ecosystem condition of green spaces that may be obtained from a visual perspective is limited. Only certain criteria were able to be assessed from a visual standpoint. Moreover, the Adapted typology employed is limited to terrestrial habitats (aquatic environments could not be assessed). In some cases the ecosystem condition of particular green spaces was also difficult to assess based on poor image resolution. This was also the case when certain ground features were obscured by other features (for example, settlements occurring within wooded or forest areas). These challenges indicate the need for a higher level of analysis that should include both ground-truthing and GIS techniques.

3.8. Conclusion

In this chapter the geographical, demographic and biodiversity profile of eThekwini are used to highlight the importance of using the city as a case study area. The contextual background of the SDA provides a foundation for understanding the dynamics of this area, which also aids in interrogating the results examined in Chapter Four. Furthermore, this chapter also summarised the data and research methodology utilised in the study. A detailed discussion into

the framework and protocol for acquisition, capturing and analysing the data was provided. The limitations and challenges of the research methodology employed were also outlined. The data acquired through the application of these processes are discussed in Chapter Four.

CHAPTER FOUR: RESULTS AND DISCUSSION

4.1. Introduction

This chapter presents and interprets the results of analyses carried out on the primary and secondary data utilised in this study in order to address the research objectives outlined in Chapter One. The chapter interrogates the critical findings of the study by making links between relevant literature and the patterns observed in the data. The first section is based on an analysis of the relationships between people and nature in residential areas surrounding the Bluff Conservancy. Thereafter, results of analyses carried out on secondary spatial data pertaining to the quality, use and vulnerability of various green spaces within the eThekwini Municipality are presented and discussed.

4.2. Socio-economic and demographic characteristics of respondents

One of the main components of any analysis in perception studies is the socio-economic and demographic characteristics of respondents, as it provides the context to understand how these variables potentially influence the perception and attitudes of respondents within the specific case study (Jaggernath, 2013). Schipperijn *et al*. (2010) reiterate the importance of examining these variables when evaluating human-nature relations, including the use and perception of urban green spaces. Furthermore, research conducted in the field of environmental psychology and urban planning studies found that people's perceptions and interactions with urban green spaces are significantly influenced by their socio-economic stability (Balram and Dragićević, 2005; Jim and Chen, 2006). An analysis of the surveyed respondents' socio-economic and demographic characteristics including their gender, age, level of education, employment and income status is presented next.

Table 4.1: Sex of respondents (n=400)

Gender	Percentage
Male	50.75
Female	49.25

Data shown in Table 4.1 suggests that within the respondent group surveyed, there were marginally more males (50.75%) than females (49.25%). This was a useful observation as this ratio is typical of male to female ratios within eThekwini (Statistics South Africa, 2012a) and also suggests that gender bias was unlikely to have been a constraining factor in relation to respondents' use and perceptions of urban green spaces. Other studies conducted in the SDA such as Sutherland *et al*'s. (2009) also involved respondent groups with similar male to female ratios.

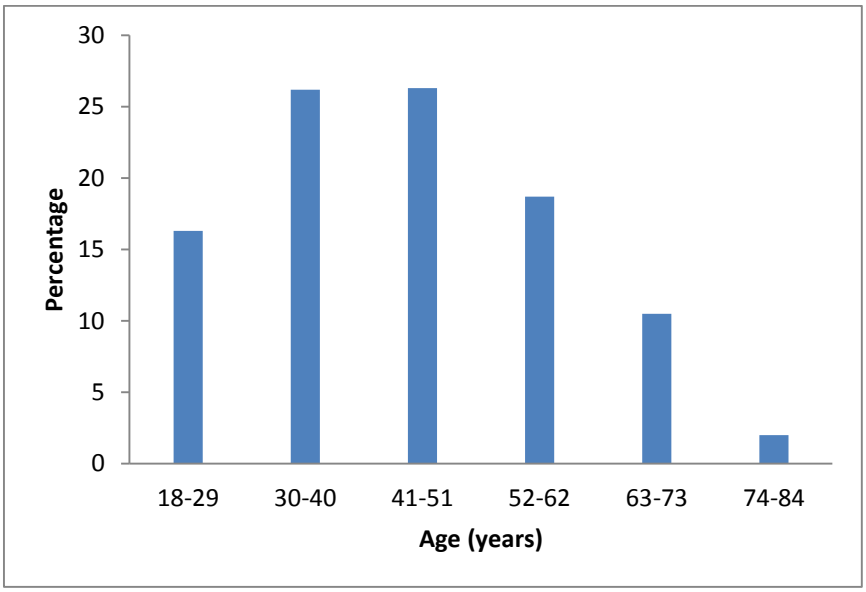

Figure 4.1: Age of respondents (n=400)

Data shown in Figure 4.1 indicates that 16.25% of respondents within the sample population were between the ages 18-29 years, 26.25% were between 30-40 years old, 26.25% were between 41-51 years old, 18.75% were between 52-62 years old, and 10.50% were between 63-73 years old. A very small percentage of the study population (2%) were between the ages 74-84 years. The age profile also shows that the majority of the respondents (87.50%) interviewed were found to the between the ages of 18-62 years. Only 12.50% of the population were between the ages of 63-73 years and 74-84 years. The average age of respondents was ±44.4 years and ages ranged from 18 to 84 years.

From the data described above a significant portion of the study population (87.50%; incorporating those between the ages of 18-62 years) fall within the range of economically active people in the country. Statistics South Africa (2012b) indicate that 70% of individuals

residing in the eThekwini Municipality are between the ages of 15-64 years old. This indicates that the study population was reflective of the age profile typical of the eThekwini Municipality. Similarly, in a study conducted by Sutherland *et al*. (2009) within the SDA, almost two thirds of the respondents they sampled fell within the age bracket of 20-65 years old, with most respondents being relatively young to middle-aged (60% of the respondents were under 51 years old). This is important to consider as studies have found that age has implications on resident uses and perceptions of urban green spaces (Sanesi and Chiarello, 2006; Schipperijn *et al*., 2010), where younger individuals may harbour different opinions and preferences compared to older people and *vice versa* (Jahdi and Khanmohamadi, 2013).

Table 4.2: Number of persons currently residing in household (n=400)

Number of people	Percentage
1-3	53.50
4-7	45.50
8-12	1

Over half the study population surveyed consisted of households with 1-3 occupants (53.50%). The remaining respondents' households were predominantly comprised of 4-7 persons (45.50%) and only very few households (1%) comprised of 8-12 people (1%). The average number of people residing within respondent households was ±3 and occupant numbers ranged from 1-12.

Table 4.3: Level of education of respondents (n=400)

Level of education	Percentage
Primary school	0.75
Secondary school	45.75
Certificate/ diploma	35.25
Undergraduate degree	13
Postgraduate degree	5.25

The data shown in Table 4.3 indicates that 45.75% of the respondents received a secondary level of education, 35.25% completed a certificate/ diploma, 13% completed an undergraduate degree and 5.25% attained postgraduate degrees. Very few respondents (0.75%) received a primary level of education only. Statistics South Africa (2012c) indicate that as of 2012 only a small proportion of the population (4.2%) within the eThekwini Municipality received no

schooling, whilst 37.1% received a secondary education and 12.1% completed a higher degree. Similar results/ trends were evidenced in this study, suggesting that the majority of respondents sampled are educated (they have completed secondary level of education and above). The level of education is a vital component to incorporate when addressing resident uses and perceptions of urban green spaces (Jahdi and Khanmohamadi, 2013; Maas *et al*., 2006; Schipperijn *et al*., 2010). Literature has found that different levels of education can influence an individual's behaviour towards green spaces (Jim and Chen, 2006; Sanesi and Chiarello, 2006), inferring that respondents may have different preferences or willingness to support environmental issues depending on their educational level. This is linked to Shan's (2014) assertion that individuals with higher education levels tend to have positive affiliations with their natural environment and are more motivated to learn about nature and socialise with others, more so than individuals with lower education levels. Furthermore, differences in respondents' level of education may also have implications on their social status (employment status and income), which could potentially influence their environmental concerns and attitudes towards urban green spaces.

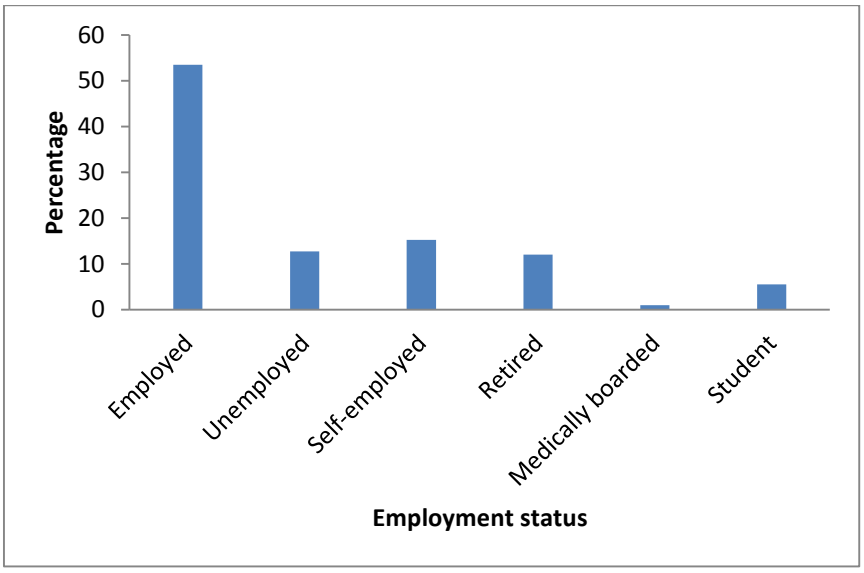

Figure 4.2: Employment status of respondents (n=400)

From the employment profile of the respondents shown in Figure 4.2 it can be seen that the majority of the respondents (68.75%) were either employed or self-employed, while fewer respondents indicated they were retired (12%), medically boarded (1%) or students (5.50%). Additionally, 12.75% of the respondents indicated that they were unemployed.

The results showed that the majority of respondents are employed. Sutherland *et al*. (2009) provided similar findings, indicating that the majority of respondents (74.5%) they interviewed in the SDA are employed. Moreover, the employment status of respondents reflected a strong social and economic foundation in terms of residential livelihoods. This resonates with earlier findings pertaining to the level education of respondents, suggesting that as the majority of the residents are educated, this in turn provides them with employment security. This is an important finding to consider, as Jahdi and Khanmohamadi (2013) illustrated that working class individuals tend to frequent urban green spaces more often as these spaces provide them with an 'escape' from stressful urban lifestyles (for example, work related stress). Furthermore, Neuvonen *et al*. (2007) found that employed individuals tend to have more mobility (more means to travel) and are likely to engage in outdoor recreational activities. This suggests that as the majority of the respondents are employed, it can be assumed that most of them should frequent their surrounding green areas.

Table 4.4: Current occupation of respondents (n=400)

Current occupation	**Percentage**
Labourer/ unskilled	2.75
Sales/ marketing	16.25
Administrator	6.75
Businessperson	14.75
Professional	18.50
Artisan/ technician	10.25
Housewife	13.25
Student	5
Retired	9
Medically boarded	0.50
Pensioner	3

According to data shown in Table 4.4 the occupations of the respondents, were sales/ marketing (16.25%), administrator (6.75%), businessperson (14.75%), professional (18.50%), artisan/ technician (10.25%), housewife (13.25%) and students (5%). Collectively, 12.50% of respondents indicated that they were either retired, medically boarded or pensioners. Only 2.75% of the respondents were labourers/ unskilled.

The eThekwini Municipality (2013) indicates that the formal sector is accountable for 76% of employment within the KwaZulu-Natal, with the informal sector responsible for only 24% of

employment. A similar trend was also identified in this study, with the vast majority of respondents indicating occupations associated with the formal sector (sales/ marketing, administrators, businesses, professional and artisan/ technician). This suggests that a large proportion of the respondents have a steady occupation which resonates with findings in relation to their employment status.

Table 4.5: Total monthly household income in Rands (n=400)

Income	Percentage
1,000-5,000	20
5,000-10,000	16.25
10,000-15,000	15.75
15,000-20,000	5.75
20,000-30,000	9.75
30,000-40,000	4
40,000-50,000	2.25
50,000-60,000	1.50
Don't know	7.25
Confidential	17.50

Table 4.5 shows the total monthly income of the respondents. It can be established that the majority of the respondents (52%) earn between R1,000-R15,000, while only 15.50% of the respondents earn between R15,000 and R30,000 and the least amount of respondents (7.75%) earn between R30,000-R60,000. Furthermore, some respondents were either unaware (7.25%) of or considered their total monthly household income to be confidential (17.50%).

Based on the results above it was evident that over half of the respondents earn between R1,000-R15,000. Additionally, it was evident that fewer respondents earn in the higher income brackets as the percentage of total monthly household income begins to decrease continually when moving from middle to higher income earning brackets. Furthermore, whilst the education levels and employment status within the study population are both reflective of a relatively strong social and economic base, there are definite variations in the total household monthly income. Post-apartheid, the SDA has undergone significant developmental changes and is home to around 285,000 people, with a mixed socio-economic strata comprising of low, middle and high income earners (Adebayo and Musvoto, 2013). This is an important aspect to consider as studies reviewed in Chapter Two (Priego *et al*., 2008; Qureshi *et al*., 2013) revealed that residents concern and use of urban green spaces can be influenced by income status.

Research has shown that individuals of a higher socio-economic status tend to perceive and value urban green spaces to a greater extent than those of lower means (Priego *et al*., 2008). Furthermore, Qureshi *et al*. (2013) indicated that people with more means (higher income) tend to prefer less crowded green spaces such as private golf clubs, resorts or parks, which are often far too expensive (exceed the means) for people within lower income groups to access.

4.3. Respondent uses and perceptions of urban green spaces

The perceptions that a person has towards urban green spaces can significantly influence whether that individual uses a space and the manner in which they use it (Bell *et al*., 2007). Furthermore, this contributes to the general opinion or image that a community has of green spaces and affects the way in which they are managed and maintained (Bell *et al*., 2007; Dunnett *et al*., 2002; Leeuwen *et al*., 2010). Numerous studies reviewed in Chapter Two (Haq, 2011; Lyytimäki, and Sipilä, 2009; Shan, 2014) highlight the benefits, disadvantages and related perceptions of urban green spaces. This section examines respondents' everyday engagements with urban green spaces in order to identify what specific factors are linked (or not) to the uses and perceptions of these spaces. Furthermore, this section interrogates certain aspects of respondent perceptions and uses of green spaces by disaggregating the data based on selected socio-demographic variables (namely, gender, education and income) of the study population (described in section 4.2).

Table 4.6: Respondent opinions/ interpretations of green space (n=400)

Respondent opinions	**Percentage**
Areas containing plant life, trees and wildlife	48.50
Parks and gardens	22.25
Place for relaxation, leisure and recreation (for example, golf course, sports facilities)	24
A place that allows human-nature interactions	3.25
Any open space with no buildings/ industries and contains plants and trees	10.50
Nature reserves, conservancies and protected areas	15.50
Natural areas with no human interference	8.50
Any space containing nature	15
Clean areas with no pollution	5.50

***Responses were coded based on key thematic areas which were identified based on the responses provided. For this open ended question all responses were reviewed and key thematic areas were established and thereafter were coded based on these key thematic areas. These are listed in Table 4.6**

The data shown in Table 4.6 indicates that the majority of the respondents (48.50%) considered green spaces to be areas containing plant life, trees and wildlife. The remaining responses varied: 22.25% of respondents identified these spaces as parks and gardens; 24% indicated that they were places for relaxation, leisure and recreation; 15.50% considered them to be nature reserves, conservancies and protected areas; 15% regarded them to be any space containing nature; and 10.50% indicated that they were any open space with no buildings/ industries that contains plants and trees. The least expressed opinions/ interpretations were a place that allows human-nature interactions (3.25%), natural areas with no human interference (8.50%) and clean areas with no pollution (5.50%).

These data suggest that there was little agreement in terms of respondents' interpretation of urban green spaces. This was unsurprising as Dinnie *et al*. (2013) indicate that assessing residents' opinions of urban green spaces is highly complex since their interpretations vary across different social groups. To elaborate, the socio-economic status of respondents can be structurally differentiated into categories, inferring that there is no singular social order within the community; hence, the interpretations of these green spaces are contested and will differ across individuals (Dinnie *et al*., 2013; Priego *et al*., 2008). However, despite the above, what can be noted was that even though the interpretation of green spaces varied amongst respondents, a common understanding of nature was evident in their responses irrespective of social status. Similar trends were reported by Priego *et al*. (2008) who found that people, regardless of their social status, at the most basic level affiliate urban green spaces with nature.

Table 4.7: Features respondents considered to be green spaces within their community and the greater eThekwini Municipality (multiple responses, n=400)

Features	Community percentage	eThekwini Municipality percentage
Parks	98	95
Sports fields	78	76.25
Race courses	32.75	46
Golf courses	81.25	77.25
Gardens	89.50	85.75
Cemeteries	21	31.25
Nature reserves	95.25	94.50
Farmland	37.25	58.75
Forests	77.25	87.25
Mangroves/ swamps	61	70.75
Beach	0.25	0.25

From the data shown in Table 4.7 it can be seen that the majority of the respondents identified parks (98%), sports fields (78%), golf courses (81.25%), gardens (89.50%), nature reserves (95.25%), forests (77.25%) and mangroves/ swamps (61%) as green spaces within their community. Fewer respondents indicated race courses (32.75%), cemeteries (21%) and farmland (37.25%), with a very small proportion (0.25%) indicating beaches as green spaces within their community. Similar responses were observed with regard to features respondents considered to be green spaces within the eThekwini Municipality. The majority of the respondents also identified parks (95%), sports fields (76.25%), golf courses (77.25%), gardens (85.75%), nature reserves (94.50%), forests (87.25%) and mangroves/ swamps (70.75%) as green areas within the Municipality. However, more respondents (58.75%) associated farmland as green spaces in the Municipality compared with their community. Additionally, fewer respondents also indicated race courses (46%), cemeteries (31.25%) and beaches (0.25%) as green spaces within the Municipality.

When comparing what features respondents consider to be a green space within their community and the eThekwini Municipality, both categories received similar responses. However, it is important to note that just as respondents' opinions differ with regard to their interpretation of green spaces, so too will their opinions of what they consider to be green spaces. Past research has shown that individuals (of different socio-economic and cultural backgrounds) within a community each present their own behavioural patterns, uses and perceptions with respect to their surrounding green areas (Priego *et al*., 2008; Qureshi *et al*.,

2013). In this respect, although social differences exist across the respondents in this study, it was evident that in general significant proportions of respondents gave more consideration towards parks, sports fields, golf courses, gardens, nature reserves and mangroves/ swamps as green spaces. Additionally, results showed that these specific features, which the majority of the respondents considered to be green spaces within their community and the Municipality, resonate closely with their interpretations of these spaces. The features that received the most attention can be categorised as amenity and natural/ semi-natural habitats which contribute significantly to the green fabric of cities and communities (Bell *et al*., 2007; Swanwick *et al*., 2003). Furthermore, literature has shown that most of these green features provide numerous social and ecological benefits that community members tend to make use of (Jahdi and Khanmohamadi, 2013; Jim and Chen, 2006; Qureshi *et al*., 2013). Based on the above, this suggests that respondents' consideration of these green spaces could be linked to their aesthetics, amenities and value use.

Table 4.8: P-values of Chi-square tests between socio-demographic variables and perceptions of what constitutes green spaces within the community (C) and eThekwini (E).

Features		Socio-demographic characteristics		
		Gender	**Education**	**Income**
Parks	C	0.16	0.97	0.92
	E	0.39	0.10	0.47
Sports fields	C	0.52	0.24	0.59
	E	0.32	0.83	0.94
Race courses	C	0.24	0.08	0.16
	E	0.59	0.35	0.47
Golf courses	C	0.43	0.04*	0.38
	E	0.77	0.00*	0.62
Gardens	C	0.58	0.95	0.06
	E	0.98	0.78	0.05*
Cemeteries	C	0.02*	0.25	0.03*
	E	0.06	0.23	0.00*
Nature reserves	C	0.44	0.19	0.92
	E	0.94	0.80	0.87
Farmland	C	0.03*	0.21	0.81
	E	0.24	0.69	0.46
Forests	C	0.36	0.46	0.65
	E	0.97	0.89	0.14
Mangroves/ swamps	C	0.86	0.55	0.02*
	E	0.31	0.54	0.61

*** Significantly different at the 95% confidence interval**

The data shown in Table 4.8 indicates that gender had a limited influence on respondent perceptions of what constitutes a green space in their community and in the Municipality; of the ten categories, only two yielded a significant difference (cemeteries, p=0.02 and farmland, p=0.03 for community). Similarly, education only influenced respondent perceptions of golf courses (p=0.04 for community and p=0.00 for eThekwini) while income influenced respondent perceptions significantly for gardens (p=0.05), cemeteries (p=0.03 and p=0.00) and mangroves/ swamps (p=0.02).

As stated previously, there are difficulties when attempting to discern the relationship between socio-demographic variables and respondent perceptions with respect to green areas in their surroundings (Priego *et al*., 2008; Qureshi *et al*., 2013). Residents' opinions of what they consider to be urban green spaces can vary across different social groups (Dinnie *et al*., 2013).

Socio-demographic differences did exist among the respondents in this study (refer to section 4.2) but the data shown in Table 4.8 suggests these differences in gender, education and income has a limited influence on what respondents considered to be green spaces within their community and the eThekwini Municipality.

The study area comprises of numerous green spaces, including a nature reserve and conservancy, park, golf course, sports field and a large stretch of coastal forest, all of which are either flanked or surrounded by residential areas (see Figure 3.3). This phenomenon of green spaces occurring within an urban matrix is typical of many rapidly developing cities in South Africa.

Table 4.9: Green spaces respondents reside closest to (multiple responses, n=400)

Green spaces	Percentage
None	1.50
Park	72.50
Sports field	58.50
Cemetery	1
Nature reserve	48.25
Golf course	72.75
Private garden	32.25
Forest	13.75

From the data shown in Table 4.9 it is evident that the majority of the respondents indicated that the green spaces nearest to their residence was the golf course (72.75%) and park (72.50%). This was followed by the sports field (58.50%), the nature reserve (48.25%) and private gardens (32.25%). Fewer respondents indicated they reside closest to the forest (13.75%) and cemetery (1%). A very small proportion of respondents (1.50%) stated that their residence was not in close proximity to any green spaces.

It was interesting to note the range of green spaces types that residents identified to be within close proximity of their homes. The forest is a major green space within the area but it is located towards the coast on hilly terrain, which is not the most conducive landscape for housing; this may explain the low percentages observed for this environment. Furthermore, based on the fact that fewer people indicated that they live close to the forest is a good prospect. This is positive for eThekwini in that a green space that harbours a substantial amount of natural biodiversity

(Alvey, 2006; Ezemvelo KZN Wildlife, nd) does not appear to have been extensively encroached upon by housing development. With regard to the other green spaces, research has shown that these spaces can significantly influence the environmental quality and quality of life within cities (Chiesura, 2004; Schipperijn *et al*., 2010; Wright Wendel *et al*., 2012). Moreover, studies have shown that residents who live in close proximity to green spaces tend to have greater interactions with them (Schipperijn *et al*., 2010; Wright Wendel *et al*., 2012). This finding is important to consider, as it permits the assumption that given the close proximity of these particular green spaces to respondents, the majority of them should reflect a similar trend in terms of their use of these spaces. On the other hand, this suggests that if the majority respondents choose not to make use of these green areas, it could be due to other hampering factors. The responses derived from the sample population, presented in this section, provide an insight to both of these scenarios, whilst also contributing to the broader context of knowledge regarding resident-nature interactions within the SDA.

Table 4.10: Respondent use of green spaces (n=400)

Use	**Percentage**
Yes	75.50
No	24.50

Leading on from above, Table 4.10 indicates that the majority of the respondents (75.50%) make use of the green spaces identified earlier but a significant proportion (24.50%) indicated that they do not. Field observations suggested that many residents within the study area, irrespective of their socio-economic status, used green spaces within their communities. This was expected as research has shown that residents who live close to, and are given access to, green spaces will interact with them (Priego *et al*., 2008; Schipperijn *et al*., 2010). However, the perceptions and attitudes which respondents have towards the types of green spaces they use depend on an array factors which is discussed later in this section.

Table 4.11: P-values of Chi-square tests bteween socio-demographic variables and respondents use of green spaces

	Socio-demographic characteristics		
	Gender	**Education**	**Income**
Use of green spaces	0.38	0.03*	0.37

*** Significantly different at the 95% confidence interval**

Data shown in Table 4.11 indicates that respondents use of green spaces was not dependent on their gender and income but was significantly influenced by their education (p=0.03). This is in agreement with the literature reviewed in Chapter Two (section 2.5.6) and Jahdi and Khanmohamadi (2013), who found that educational level can influence an individual's use of green spaces. Furthermore, respondents may have different preferences or willingness to support the use of green spaces depending on their educational level (Jim and Chen, 2006; Sanesi and Chiarello, 2006). This aspect was examined in greater detail below.

Table 4.12: Cross-tabulation between level of education and respondents use of green spaces (n=400)

Level of education	**Use of green spaces**	
	Yes percentage	**No percentage**
Primary school	66.67	33.33
Secondary school	66.67	33.33
Certificate/ diploma	82.26	17.74
Undergraduate degree	88.50	11.50
Postgraduate degree	76.19	23.81

The data in Table 4.12 strengthens the argument made above by showing that respondents with a higher level of education tend to make more use of green spaces. It should also be noted that although numerous studies identify socio-demographic variables such as gender and income e as influential factors in terms of respondents use of green spaces (Pillay and Pahlad, 2014; Priego *et al*., 2008; Qureshi *et al*., 2013), this was not the case in this study. This may be attributed to the close proximity or rather easy accessibility of a wide range of green spaces within the urban matrix in which the respondent households are situated.

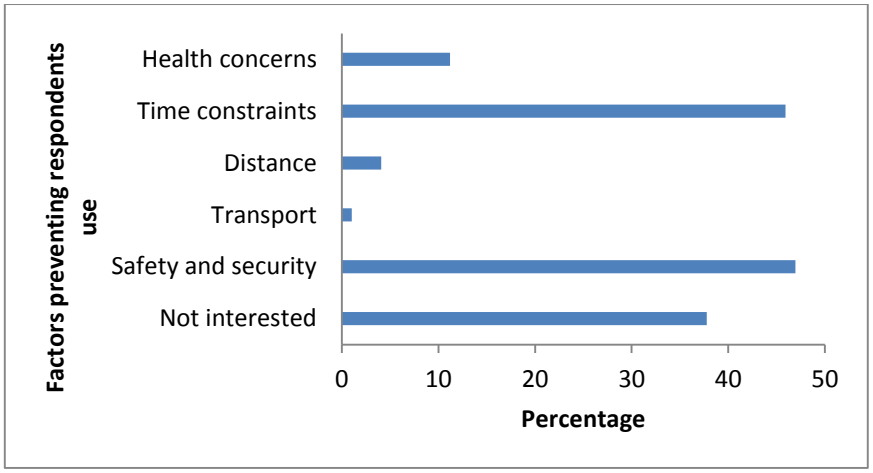

Figure 4.3: Factors preventing respondents' use of green space within their community (multiple responses, n=98)

Data shown in Figure 4.3 suggests that safety and security (46.94%) and time constraints (45.92%) are the most prevalent factors limiting respondents from using green spaces within their community. Additionally, more than a third of the respondents (37.76%) indicated they are not interested in using these spaces. Fewer respondents indicated health concerns (11.22%), transport (1%) and distance (4.08%) as preventative factors regarding the use of these spaces.

Research has shown that there are numerous factors, including those stated above, that influence whether or not respondents will use urban green spaces (Jim and Chen, 2006). Of the respondents who chose not to use green spaces within their community, almost half of them indicated safety and security as a hampering factor. Similar trends were found in studies conducted in Finish and Chinese cities, which revealed that a significant proportion of respondents expressed concerns regarding the safety and security of green space environments and indicated that this was the major factor deterring them from using these spaces (Hunter, 2001; Jim and Chen, 2006). Additionally, a study by Perry *et al*. (2008) within the eThekwini Municipality showed that a significant proportion of respondents perceived open green spaces such as those listed in Table 4.9 as unsafe areas. This suggests that irrespective of the geographic location of these green spaces, respondent may not use them as a consequence of their perceptions of a lack of safety and security at these spaces. In terms of time constraints, distance and transport, other studies have shown that these factors can limit the use of green spaces (Schipperijn *et al*., 2010). However, in this study distance and transport was not a major limiting factor, possibly because green spaces within the selected residential areas were all in relatively close proximity to the respondents' households. The respondents that indicated

limited time as a preventative factor suggests that these individuals may have other more pressing priorities to engage in (for example, work priorities). Literature has shown that people in urban areas are becoming disinterested in green spaces and being unable to go to green spaces as a consequence of work lifestyle (Jim and Chen, 2006; Schipperijn *et al*., 2010). Another interesting finding revealed that although only a minor proportion of respondents (just more than 10%) indicated that health concerns deterred them from using green spaces, this may be linked to the pollution/ dumping in the SDA which has been reported in other studies (Adebayo and Musvoto, 2013; Sutherland *et al*., 2009).

Table 4.13: Green spaces that respondents use (multiple responses, n=302)

Green space	Percentage
Park	57.62
Sports field	39.40
Cemetery	0.33
Nature reserve	37.08
Golf course	28.81
Private garden	33.77
Forest	1.97

From Table 4.13 it is evident that the public green spaces most utilised by respondents are the park (57.62%), sports field (39.40%) nature reserve (37.08%) and the golf course (28.81%). A significant proportion of respondents also indicated that they use their private gardens (33.77%). Only a few respondents indicated that they make use of the cemetery (0.33%) but what was most interesting to note was that only 1.97% of them appeared to use the forest.

Previous research has indicated that green space preference amongst urban dwellers is often difficult to validate empirically (Qureshi *et al*., 2013). This can be attributed to heterogeneous perceptions of community members regarding their natural green areas (Qureshi *et al*., 2013), which are influenced by socio-economic variables as well as the quality of the physical or social environment (Neuvonen *et al*., 2007; Sanesi and Chiarello, 2006). In this regard, it was unsurprising that the respondents interviewed harboured multiple opinions in their use of green space. However, overall, results showed that respondents favoured the use of recreational and social green spaces (parks, sports field, nature reserve and the golf course) within their communities. Additionally, it was found that around a third of respondents made use of private gardens. This aspect was not examined empirically in the survey, however in field observations

indicated that there was a significant amount of backyard gardening in the area, as well as numerous incidences of pavement gardens. Other noteworthy results showed that very few respondents interacted with the surrounding forest. This could be attributed to the locality of this green space, as explained previously for Table 4.9. However, this lack of use of forests may also be a consequence of the controlled access associated with this space (Ezemvelo KZN Wildlife, nd). Access to the site is monitored/ controlled by a park ranger and the manager of the Bluff Nature Reserve, as this forest provides suitable habitats for a number of threatened species in the area (Ezemvelo KZN Wildlife, nd). The array of factors that influenced respondent perceptions and use of green spaces in this study are further linked to the literature using the data presented in Table 4.15.

Table 4.14: Frequency of respondent use of green spaces (n=302)

Frequency of use	Percentage
Very often	15.23
Frequently	46.02
Seldom	39.07

Data shown in Table 4.14 indicates that the majority of respondents (46.02%) use green spaces frequently, while just 15.23% stated that they use these spaces very often. A significant proportion of the respondents (39.07%) did, however, indicate that they seldom use green spaces.

To reiterate, green spaces within the study area are in relatively close proximity to the respondents' households, possibly facilitating their frequent use. Schipperijn *et al*. (2010) showed similar trends for Danish citizens, whose frequency of use of green spaces was high when they were situated close to their households. It is also important to note that a large proportion of respondents indicated they seldom made use of their surrounding green spaces. As in other studies (Sanesi and Chiarello, 2006; Schipperijn *et al*., 2010) this may be attributed to personal factors such as time constraints, more pressing priorities (for example, work and family time) or due to old age or poor health. Also, based on the data shown in Figure 4.3, external factors such as a lack of safety and security may discourage respondents from using green spaces often. These results potentially have implications regarding the environmental awareness of the respondents, as research suggests that people who frequent green areas tend to express more environmental concern than those who do not (Priego *et al*., 2008).

Table 4.15: Motives for respondents use of green spaces within their community (multiple responses, n=302)

Motives	Percentage
Gather resources	0.33
Physical/ emotional/ spiritual wellbeing	60.93
Recreation and leisure	79.14
Socialising	48.68
Educational resource	2.32
Gardening/ agricultural use	23.51

From the data shown in Table 4.15 it is evident that recreation and leisure (79.14%) were the main motives for the use these spaces by respondents, followed by physical/ emotional/ spiritual wellbeing (60.93%) and socialising (48.68%). Additionally, a relatively smaller proportion of respondents indicated that they use green spaces for gardening/ agricultural use (23.51%). A very small proportion of respondents indicated that they use green spaces to gather resources (0.33%) or as an educational resource (2.32%).

The motivates for urban dwellers using a particular green space often reflect their needs and expectations or could possibly be related to their attachment to these green areas (Shan, 2014). The results indicated that the majority of respondents' reasons for using green spaces appealed to the social dimension of the environment and are affiliated with social interaction, recreation, relaxation and contact with nature. This resonates with earlier findings pertaining to the types of green spaces respondents use within their community, which showed that most respondents preferred to use green spaces that offered recreational and leisure benefits. Additionally, similar findings were expressed by residents in Singapore who indicated enjoyment, recreation, relaxation and appreciation of nature as their main motives for using green spaces (Yuen, 1996; Yuen *et al*., 1999). Oguz (2000) found that in Ankara, Turkey, residents primarily used green spaces as an 'escape' from stressful urban lifestyles, as meeting places for friends and family, and as places to relax and contemplate. Australian residents also reflected similar motives: enjoying outdoor activities, experiencing nature and 'escaping' urban pressures (Shan, 2014). In addition, a study by Matsuoka and Kaplan (2008) identified a core set of motives for people using urban green spaces that included human-nature interaction, aesthetic appeal, social interaction and recreation and relaxation. Similar trends were evidenced in this study, suggesting that respondents preferred using green spaces within the study area that contribute to an improved quality of life. These findings potentially have implications for the provision

and maintenance of green spaces within the SDA, as Sutherland *et al*. (2009) maintain that residents' motives for using these areas need to be integrated into future planning efforts.

Table 4.16: Green space resources that respondents would like to access (multiple responses, n=400)

Resource	Percentage
Fuelwood	13.25
Wood for household construction	12
Wood for other household use	22.25
Fruit	66.75
Medicinal plants	39.50
Water from wetland/ river/ borehole	11.50
Recreational spaces	79.75
Green trails and pathways	73.25

Table 4.16 shows the green space resources that respondents would like to access. The majority of the respondents indicated that they would like to have access to recreational spaces (79.75%), green trails and pathways (green corridors) (73.25%), and fruit (66.75%). A relatively smaller proportion of respondents indicated that they would like to have access to medicinal plants (39.50%) and wood for household (22.25%), fuelwood (13.25%) and household construction (12%) use. Water from wetland/ river/ borehole was the least popular respondent selection (11.50%).

The results show that the majority of the respondents would like to access ecological (fruit and medicinal plants) and social (recreational spaces and green trails and pathways) resources within these green spaces. Shackleton and Blair (2013) echoed similar findings indicating that green spaces, even in residential areas, provide many tangible resources to people, including medicinal plants and fruit. The social resources respondents would like to access resonate with earlier findings in relation to their use of and motives for using urban green spaces, which revealed that respondents favoured the use of green spaces that offered recreational and leisure benefits. Therefore, it was unsurprising that respondents indicated a greater desire for resources such as recreational spaces and green trails and pathways. Only a small proportion of respondents indicated they would like more access to resources such as wood for household construction and use, fuelwood and water. This could be attributed to fewer residents in urban areas utilising these particular natural resources directly (McLain *et al*., 2012; Shackleton and

Blair 2013). It is important to note that the sampled population reside in established communities where they have access to municipal service delivery (for example, electricity) and do not rely on traditional sources to support their livelihoods. Ascertaining what resources the community members would like to have access to in these green areas is an important aspect to consider in relation to future planning efforts. Sutherland *et al*. (2009) supports this decision, indicating that it is important to acknowledge what resources residents would like access to within green spaces in the SDA, such that future planning initiatives can accommodate for the provision of these desired resources in green spaces.

Table 4.17: Percentage of respondents that would like increased access to green spaces (n=400)

Access	Percentage
Yes	88.50
No	11.50

Data shown in Table 4.17 indicates that the vast majority of respondents (88.50%) would like increased access to green spaces, whilst 11.50% indicated they do not require increase access.

Table 4.18: P-values of Chi-square tests between socio-demographic variables and respondents desire to have increased access to green spaces

	Socio-demographic characteristics		
	Gender	**Education**	**Income**
Access to green spaces	0.83	0.23	0.29

Differences were considered significant at the 95% confidence interval

It is clearly evident from Table 4.18 that respondents desire to have increased access to green spaces was not significantly influenced by socio-demographic variables like gender, education and income. This supports findings in the literature, which suggest that urban residents in general, regardless of socio-demographic characteristics, tend to seek increased access to green environments (Mass *et al*., 2006).

Table 4.19: Types of green spaces that respondents would like to have increased access to (multiple responses, n=354)

Green spaces	Percentage
Parks	60.45
Sports fields	35.02
Gardens	52.26
Nature reserves	67.23
Golf course	20.62
Race course	14.12

From the data shown in Table 4.19 it is evident that the majority of the respondents would like to have increased access to green spaces such as nature reserves (67.23%) and parks (60.45%) and gardens (52.26%). More than a third (35.02%) of the respondents also identified sports fields, while 20.62% indicated golf courses as green spaces that they would like increased access to. Only 14.12% of respondents indicated that they would like increased access to race courses.

Table 4.20: P-values of Chi-square tests between socio-demographic variables and types of green spaces that respondents would like to have increased access to

Green spaces	Socio-demographic characteristics		
	Gender	Education	Income
Parks	0.35	0.90	0.17
Sports fields	0.65	0.01*	0.14
Gardens	0.04*	0.29	0.19
Nature reserves	0.87	0.15	0.61
Golf course	0.78	0.56	0.65
Race course	0.67	0.12	0.03*

*** Significant at the 95% confidence interval**

Leading on from Table 4.19, the data displayed in Table 4.20 indicates that the types of green spaces that respondents wanted increased access to was very rarely dependent on socio-demographic variables like gender, education and income; significant for one of the six green space types in each case (p=0.04 for gender and gardens; p=0.01 for education and sports fields; p=0.03 for income and race course). However, it is noteworthy that the significant differences identified are all associated with green spaces that appeal to the social dimension of the environment. This is in agreement with findings in the literature, which indicate that urban

residents generally prefer to have access to recreational and social green areas (Giles-Corti *et al*., 2005; Wright Wendel *et al*., 2012).

Table 4.21: Location of green spaces that respondents would like to have increased access to (multiple responses, n=354)

Location	Percentage
In close proximity to residence	32.20
Within the community	79.66
Within neighbouring communities	20.90
Anywhere in eThekwini	29.66

Table 4.21 displays the location of green spaces that respondents would like to have increased access to. The majority of the respondents (79.66%) indicated they would like these spaces located within the community. Similar proportions of respondents indicated they would like green spaces either located in close proximity to their residence (32.20%) or anywhere in eThekwini (29.66%). The minority of the respondents (20.90%) stated that they would like these spaces to be located in neighbouring communities.

The results above presented thus far suggest that a large proportion of the respondents wanted increased access to green spaces. These results are in agreement with Maas *et al*. (2006), who suggested that urban residents tend to seek more access to green environments, because these areas affect their self-perceived health and well-being in a positive way. Furthermore, increasing empirical evidence has shown that green spaces provide restorative, recreational and social experiences that are not only associated with good health status among urban dwellers, but also contribute to an improved environmental quality (Jahdi and Khanmohamadi, 2013; Lee and Maheswaran, 2011). Additionally, results showed that the majority of respondents desired more access to green spaces that appeal to the social dimension of the environment (parks, gardens, nature reserves and sports fields). This resonates with previous findings pertaining to the types of green spaces respondents use and their motives for using urban green spaces. Furthermore, it was evident that most respondents, if granted more access, would like these spaces located within their community. Previous research on the subject reflected similar findings, indicating that in general, residents prefer to have access to large and attractive nearby green areas that provide a range of amenities, recreational use(s) and contribute to an improved quality of life (Giles-Corti *et al*., 2005; Wright Wendel *et al*., 2012). These findings are

important indicators in terms of green space planning, as studies have clearly indicated that increasing the access to green spaces can have important implications on resident health and social cohesion within urban areas (Maller *et al*., 2006; Wright Wendel *et al*., 2012).

Table 4.22: Respondent perceptions of green spaces within their community (n=400, in %)

1-Strongly disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly agree

Statements pertaining to urban green spaces within the community	**1-Strongly disagree**	**2-Disagree**	**3-Neutral**	**4-Agree**	**5-Strongly agree**
Green spaces within my community are clean and well maintained	7	36.75	7.75	40.25	8.25
Air pollution decreases the quality of green space within my community	-	3	9.75	57	30.25
Green spaces within my community create a sense of identity	0.50	8.25	27.25	54.50	9.50
Green spaces within my community provide neighbour-social interaction	1.25	10.25	10.75	61.50	16.25
Green spaces within my community are quiet and peaceful	1.50	12	14.75	64.25	7.50
Green spaces within my community are easily accessible	1.50	7.50	8	69.25	13.75
Green spaces within my community have adequate facilities	15.75	33.75	18.25	28	4.25
Green spaces within my community are unsafe and harbour criminals	1	31	14.75	40	13.25
Green spaces within my community allow people to interact with nature	0.50	6	9.25	76.75	7.50
The quality of the natural environment increases the price of houses within my community	1.50	11.25	22	46.75	18.50
There is lack of knowledge regarding green spaces	0.75	6.50	10.75	58	24

Table 4.22 summarises respondents' level of agreement with specific statements pertaining to urban green spaces within their community. With regard to the statement 'green spaces within my community are clean and well maintained', 48.50% of respondents agreed and strongly agreed that green spaces within the community are clean and well maintained. However, an almost equal proportion of residents (43.75%) disagreed or strongly disagreed with this statement, while 7% of respondents remained neutral on this matter. Additionally, 87.25% of all respondents agreed or strongly agreed with the statement that 'air pollution decreases the

quality of green space within the community'. Very few respondents (3%) did not support this statement and 9.75% chose to remain neutral. These perceptions relate to quality and maintenance concerns, which were also identified in the literature as influential factors among residents regarding their behaviour and attitude towards green spaces (Schipperijn *et al*., 2010; Wright Wendel *et al*., 2013). The SDA, as mentioned earlier, houses some 600 industries, with large concentrations of petrochemical and chemical industries, which contribute heavily to air pollution and hazardous waste in the area (Sutherland *et al*., 2009). Moreover, air pollution plays a significant role in the surrounding communities as many of them are situated in close proximity to industries within the SDA (Adebayo and Musvoto, 2013; Sutherland *et al*., 2009). Consequently, environmental issues in this area are highly controversial, with residents frequently expressing concerns centred on environmental risks, health impacts and disturbance of social amenity (Sutherland *et al*., 2009). Furthermore, Sutherland *et al*. (2009) indicate that many of the recreational grounds within the SDA are not utilised to their maximum potential by residents due to poor maintenance. This suggests that the respondents are not completely satisfied with the quality and maintenance of these green environments and that the Municipality should consider more efficacious maintenance and restoration measures in order to address these pressing resident concerns.

Most of the respondents (64%) agreed or strongly agreed with the statement that 'green spaces within the community create a sense of identity', with fewer respondents (8.75%) disagreeing or strongly disagreeing with the statement and 27.25% indicating a neutral response. Similar responses were observed in relation to the statement 'green spaces within the community provide neighbour-social interaction'. The majority of the respondents expressed positive responses, with 77.75% agreeing or strongly agreeing with the statement. A small proportion of the respondents were not in favour of this statement, with 11.50% disagreeing and strongly disagreeing, while 10.75% indicated a neutral response. The social benefits derived from urban green spaces are widely documented (Lee and Maheswaran, 2011; Maas *et al*., 2006; Qin *et al*., 2013). Literature has found that in some cases green spaces have the ability to enhance neighbour-social interaction, sense of community and encourage outdoor activities (Qin *et al*., 2013). Additionally, it is important to note that despite many respondents expressing concerns regarding the quality and maintenance of green spaces, they still view the social dimensions of these green environments positively. This also resonates with earlier findings pertaining to respondents' motives for using green spaces within the community, which showed that the

majority of respondents' reasons for using green spaces were affiliated with social interaction, recreation, relaxation and contact with nature.

Respondents' level of agreement with the statement 'green spaces within the community are quiet and peaceful' showed that 71.75% agreed or strongly agreed with the statement, while 13.50% disagreed or strongly disagreed and 14.75% indicated a neutral opinion. Gidlöf-Gunnarsson and Öhrström (2007) illustrated that urban green spaces can buffer the effects of noise pollution on health and well-being. Additionally, research has shown that green areas can provide a sense of serenity and 'escape' from stressful urban lifestyles, including chronic noise exposure (Chiesura, 2004; Gidlöf-Gunnarsson and Öhrström, 2007). The majority of the respondents in this study indicated that they consider their surrounding green environments as quiet and peaceful areas, which is an important finding given that these communities are situated in close proximity to a main road (often congested with traffic) and surrounded by many industries. This suggests that these green areas within the SDA mitigate the impacts of road traffic and industrial noise pollution.

A large proportion of the respondents (83%) agreed or strongly agreed with the statement that 'green spaces within the community are easily accessible', with only a few (9%) disagreeing or strongly disagreeing with the statement and 8% of the respondents remaining neutral. However, only 32.25% of the respondents agreed or strongly agreed with the statement 'green spaces within the community have adequate facilities', while more respondents (49.50%) did not support this statement and 18.25% remained neutral. A key finding was that most of the respondents regarded green spaces within the study area as being easily accessible. Again, this can be attributed to the location of the households in relation to the green spaces of interest. In terms of the facilities within the green spaces, noticeable differences were evident among the responses, but the majority of the respondents were not adequately satisfied with the facilities found within these green spaces. Shackleton and Blair (2013) showed similar findings where respondents from two small South African towns indicated the lack of facilities as a factor limiting their use of green spaces. Additionally, Sutherland *et al*. (2009) found that certain green environments within the SDA are not utilised to their maximum potential due to inadequate facilities. This suggests the urgent need to equip these green spaces with sufficient facilities catering for residents' needs in order optimise their use and potential benefits.

With regard to safety concerns, 53.25% of the respondents agreed or strongly agreed with the statement that 'green spaces within the community are unsafe places and harbour criminals', while only 32% of the respondents disagreed or strongly disagreed, and 14.75% indicated neutral. The results indicate that respondents definitely have safety concerns regarding green spaces within the study area. Other studies in China for example, have also shown residents to express attitudes of insecurity towards green areas (Jim, 2004; Jim and Chen, 2006). Additionally, Perry *et al*. (2008) indicate that open green spaces in urban areas in South Africa are often associated with security concerns and are usually deemed to be unsafe. These findings suggest that negative perceptions in relation to safety could possibly hamper the use and image of green areas within the communities and limit the benefits extracted from them.

Table 4.22 showed that 84.25% of respondents agreed or strongly agreed with the statement that 'green spaces within the community allow people to interact with nature', with only a few respondents (6.50%) disagreeing or strongly disagreeing, while 9.25% of the respondents remained neutral. Shan (2014) describes similar findings indicating that resident perceptions in relation to human-nature interactions tend to be positive, which was also the case in this study. This suggests that respondents have an admiration for green environments within their communities and appreciate their value. Furthermore, these responses in relation to community members interacting and appreciating nature resonate with earlier findings pertaining to respondents' interpretations of urban green spaces.

Respondents' concern with regard to the statement 'the quality of the natural environment increases the price of houses within the community' showed that 65.25% of the respondents agreed or strongly agreed with this statement, while a smaller proportion of the respondents (12.75%) disagreed or strongly disagreed. Twenty-two percent of the respondents remained neutral. This study did not further probe the implications of these findings as they were beyond the scope of the study; however, it could be that respondents' perceive green space quality to be important as closer proximity to well-maintained/ natural green spaces increases the market and property value of residential land (Cilliers, 2010; Haq, 2011). However, on the other hand it could be perceived as a disadvantage as shown by Lyytimäki and Sipilä (2009), who indicate that in some cases when people live nearby to green spaces the value of their property rises, but so to do the restrictions (for example, building limitations) that makes it more difficult for them to sell to their property/ land.

Eighty-two percent of the respondents agreed or strongly agreed with the statement that 'there is a lack of knowledge regarding green spaces', while only 7.25% of the respondents disagreed or strongly disagreed and 10.75% stated neutral. Research has shown that within South Africa community members often lack awareness/ knowledge regarding urban green spaces (Cilliers *et al*., 2014). Furthermore, this lack of awareness amongst community members can often directly or indirectly lead to the degradation of green spaces within the area (Cilliers *et al*., 2014). The results of the present study suggest that respondents acknowledge that there is a lack of knowledge regarding green spaces within their communities, thereby indicating the need for environmental education to address this gap.

Table 4.23: P-values of Chi-square tests between socio-demographic variables and respondents perceptions of green spaces within their community

Statements pertaining to urban green spaces within the community	**Socio-demographic characteristics**		
	Gender	**Education**	**Income**
Green spaces within my community are clean and well maintained	0.44	0.29	0.00*
Air pollution decreases the quality of green space within my community	0.37	0.10	0.02*
Green spaces within my community create a sense of identity	0.69	0.07	0.20
Green spaces within my community provide neighbour-social interaction	0.70	0.15	0.06
Green spaces within my community are quiet and peaceful	0.41	0.65	0.15
Green spaces within my community are easily accessible	0.81	0.15	0.28
Green spaces within my community have adequate facilities	0.91	0.28	0.17
Green spaces within my community are unsafe and harbour criminals	0.01*	0.71	0.50
Green spaces within my community allow people to interact with nature	0.71	0.87	0.81
The quality of the natural environment increases the price of houses within my community	0.11	0.30	0.04*
There is lack of knowledge regarding green spaces	0.97	0.97	0.58

***Significantly different at the 95% confidence interval**

Table 4.23 summarises the results of Chi-square tests of socio-demographic variables and respondent level of agreement with specific statements pertaining to urban green spaces within

their community. The data showed respondents' perception of whether green spaces within their community are unsafe and harbour criminals to be significantly gender dependent (p=0.01). As stated previously in Table 4.22, open green spaces in urban areas of South Africa are often associated with security concerns and are usually deemed to be unsafe (Perry *et al*., 2008) and women in particular have been known to be more likely to perceive certain green spaces (such as parks) as being unsafe (Perry *et al*., 2008; Pillay and Pahlad, 2008). Additionally, income was shown to significantly influence respondent level of agreement with the following statements: 'green spaces within my community are clean and well maintained' (p=0.00); 'air pollution decreases the quality of green space within my community' (p=0.02); and 'the quality of the natural environment increases the price of houses within my community' (p=0.04). These perceptions relate to maintenance and quality concerns which numerous studies have shown to be prevalent among urban residents (Haq, 2011; Pillay and Pahlad, 2008; Schipperijn *et al*., 2010; Wright Wendel *et al*., 2013).

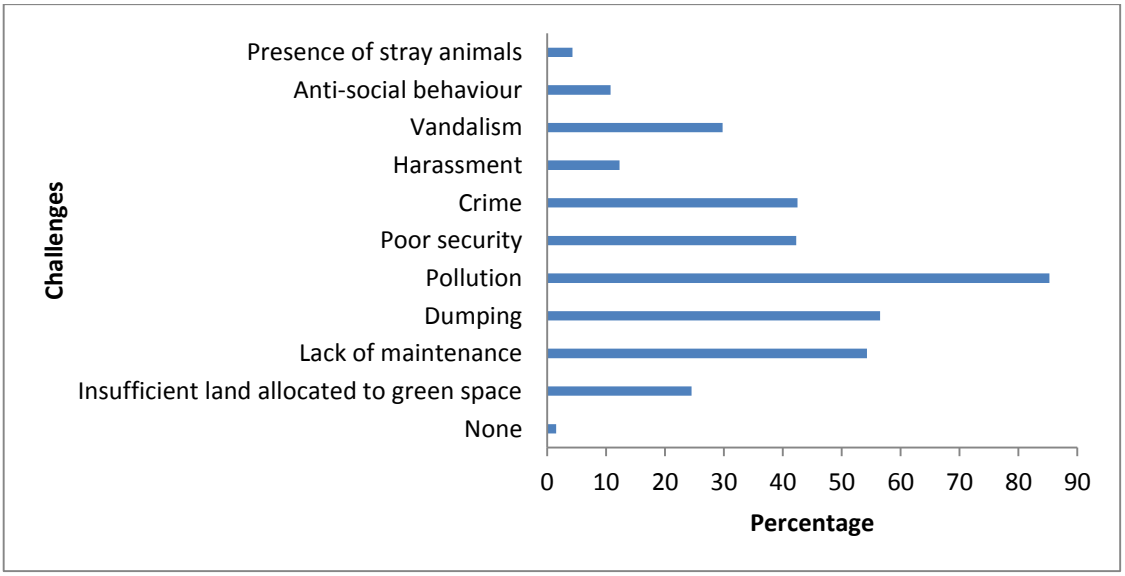

Figure 4.4: Main challenges associated with green spaces within the community (multiple responses, n=400)

From the data shown in Figure 4.4 it can be seen that the majority of the respondents (85.25%) identified pollution as the foremost challenge associated with green spaces. Another noteworthy result was that more than half of the respondents (56.50%) indicated that dumping was a major challenge. Respondents also identified the lack of maintenance (54.25%), poor security (42.25%) and crime (42.25%) as major challenges. Fewer respondents indicated

vandalism (29.75%), insufficient land allocated to green spaces (24.50%), harassment (12.25%), anti-social behaviour (10.75%) and presence of stray animals (4.25%) as challenges. Only 1.50% of the respondents indicated there are no challenges associated with green spaces within the community.

Table 4.24: Types of pollution regarded as a threat to green spaces (n=341)

Types of pollution	Percentage
Air	80.05
Water	1.47
Land	18.48

Leading on from the data shown in Figure 4.4, the data displayed in Table 4.24 illustrates that respondents who indicated pollution as major challenge facing green spaces within their community identified air pollution (80.05%) as the main threat, followed in decreasing order by land (18.48%) and water (1.47%) pollution.

The results showed that the main challenges associated with green spaces within the community resonate with findings pertaining to respondents' negative perceptions of these areas. It was unsurprising that respondents indicated pollution (air pollution in particular) as the foremost challenge associated with green spaces. Earlier responses also revealed air pollution to play a significant role in these communities as many of them are situated in close proximity to industries within the SDA. Additionally, Sutherland *et al*. (2009) assert that dumping is also a concern within the SDA, which was also the case in this study. Moreover, respondents pointed out the lack of maintenance of, and insufficient land allocation to, green areas. This reinforces the assertion in the literature that increasing urbanisation and industrial expansion has negatively impacted on the quality and quantity of green areas (Rafiee *et al*., 2009). In addition, safety and security concerns appear to be a repetitive key apprehension that respondents associate with green spaces. This corroborates with the findings of Perry *et al*. (2008) who indicated that open green spaces in urban areas in South Africa are often deemed as unsafe areas prone to crime, harassment and vandalism. Studies have shown anti-social behaviour and the presence of stray animals as challenges associated with urban green space (Lyytimäki and Sipilä, 2009; Sanesi and Chiarello, 2006), but these did not appear to be major concerns amongst the respondents in the present study. These findings suggest that although respondents identified many advantages associated with green areas in their community, there

are still numerous challenges that need to be addressed, which potentially have implications on the quality of the environment as well as the quality of life within the area.

Table 4.25: Changes to green spaces within the study area observed by respondents over the last five years (multiple responses, n=400)

Changes	Percentage
None	7.50
Housing development	21.75
Pollution/ dumping	60.75
Increase in invader plant species	6
Decrease in quality	42.25
Decrease in quantity	13.75
Poor maintenance	48.50
Decrease in pollution/ dumping	2.75
Decrease in invader plant species	0.25
Improved maintenance	8
Increase in quality	6.75
Increase in quantity	0.50

Data shown in Table 4.25 shows that the majority of the respondents (60.75%) had observed pollution/ dumping to be the most prevalent change to green spaces over the last five years. A significant proportion of the respondents also identified poor maintenance (48.50%) and a decrease in quality (42.25%) as major changes observed in green spaces. Furthermore, 21.75% of the respondents indicated housing development as a change observed in these green spaces. The minority of responses were distributed across the remaining categories: a decrease in quantity (13.75%), improved maintenance (8%), increase in quality (6.75%) and an increase in invasive plant species (6%). Very few respondents had observed a decrease in pollution/ dumping (2.75%), increase in quantity (0.50%) and decrease in invasive plant species (0.25%). It is also noteworthy that only a small proportion of the respondents (7.50%) indicated that they had observed no changes to green spaces.

Key findings showed that respondents identified more negative than positive changes to green spaces within their community. Furthermore, many of the changes observed reflected similar findings in relation to some of the major challenges respondents perceived to be faced by green areas (see Figure 4.4). Respondents' indicated pollution/ dumping and poor maintenance as the most noticeable changes that occurred within these green spaces. This was expected given that these changes were also perceived by residents as major environmental concerns and

challenges facing green spaces. Most importantly, more respondents perceived a decrease rather than an increase in the quantity and quality of these areas. This may be attributed to an expansion in housing and industrial development in the SDA (Sutherland *et al*., 2009) and consequential impacts on the environment, for example land transformation and pollution. This reinforces Sutherland *et al's* (2009) assertion that there is a lack of maintenance of green spaces within the SDA. It was also interesting to note that though, studies have shown that alien plant species are an ever-increasing problem within urban settings (Lyytimäki *et al*., 2008; Lyytimäki and Sipilä, 2009) relatively few respondents appear to have observed this within green spaces in their community. This questions whether environmental education programmes focusing on public awareness of alien invasive plants (for example, those initiated by SANBI) are benefiting/ reaching citizens within the study area. This suggestion is based on the fact that most of the green spaces within the study area were found to harbour a number of alien invasive plant species. The findings discussed above collectively suggest that green spaces within the SDA have decreased in quality and quantity and have been subject to numerous environmental impacts, seemingly as a result of increasing anthropogenic pressures.

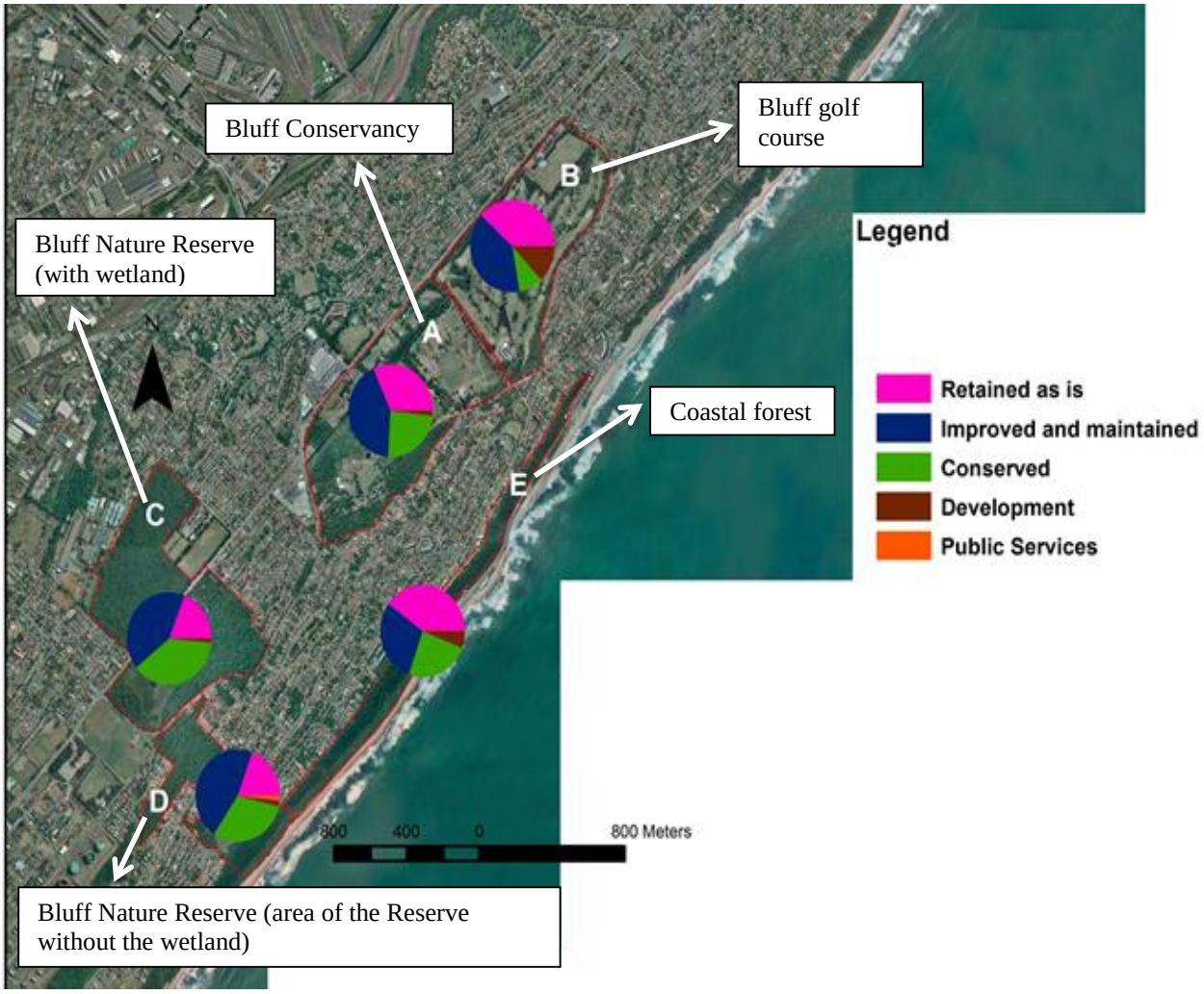

Figure 4.5: Respondent views on how the selected green spaces within the study area should be used (n= 400)

Using the orthophoto shown Figure 4.5 respondent views on how the selected green spaces (indicated as A, B, C, D and E) within the study area should be used is represented spatially. The majority of the respondents (42.25%) felt that the Bluff Conservancy should be improved and maintained, while 31.50% indicated it should be retained as is and 24% stated it should be conserved. A very small proportion of the respondents felt the Bluff Conservancy should be used for development (1.75%) and public services (0.50%). Respondents' views on the Bluff golf course were split between this green space being either improved and maintained (39.25%) or retained as is (38%). The minority of respondents expressed that the Bluff golf course should be conserved (9.25%) or used for development (12.75%) or public services (0.75%). When asked about the Bluff Nature Reserve (the area of the Reserve with the wetland) a significant proportion of the respondents indicated they would like to see this green space improved and

maintained (41.75%) or conserved (37.25%), while 18.8% indicated they would like to see it retained as is. Very few respondents stated that the Bluff Nature Reserve (with wetland) should be used for development (1.50%) or public services (0.75%). The results also showed that the majority of the respondents (46.50%) felt that the Bluff Nature Reserve (the area of the Reserve without the wetland) should be improved and maintained, while 31% indicated it should be conserved, 19.50% indicated it should be retained as is and only a few respondents felt it should be used for development (1.25%) or public services (1.75%). A large proportion of the respondents (39.75%) indicated they would like to see the coastal forest retained as is, while 29.50% stated it should be improved and maintained and 24.25% indicated it should be conserved. Only 6% of the respondents indicated they would like to see this green space used for development and 0.50% felt it should be used for public services.

Based on the above it was evident that the majority of the respondents would like to see these green areas improved and maintained. These perceptions relate to the social quality (maintenance, aesthetics, recreation and crime) of green spaces which were also indicated in the literature as a key apprehension among residents (Jim and Chen, 2006; Perry *et al*., 2008). The results showed that a larger proportion of the respondents felt that the Bluff Conservancy and Bluff Nature Reserve are green areas that should be given the most attention in terms of improvement and maintenance. Both the Conservancy and the Reserve occupy a large proportion of land, providing suitable habitats for many plant and animal species within the study area (Ezemvelo KZN Wildlife, nd; Sutherland *et al*., 2009). The Bluff Nature Reserve alone occupies an area of approximately 45 ha (Ezemvelo KZN Wildlife, nd). In terms of conservation measures, both these green areas although open to the public are monitored (Ezemvelo KZN Wildlife, nd). In addition, the portion of the Bluff Nature Reserve adjacent to the hospital (within the study area) has restricted access to the public and the portion of the Reserve with the wetland is fenced and the general public is allowed within but controlled (Ezemvelo KZN Wildlife, nd). However, important to note is that field observations revealed that both of these green areas are neglected in terms of maintenance (often due to the lack of roving park rangers that monitor these areas).

Therefore, the responses in relation to the improvement and maintenance of the Bluff Conservancy and Bluff Nature Reserve may be attributed to the above or due to the locality of these green spaces which are situated in close proximity to industries. Research has shown that as a result of this ecologically unfriendly development strategy, residents have frequently

expressed concerns regarding the disturbance of social amenities in the SDA (Sutherland *et al*., 2009). Moreover, field observations revealed that the aesthetic quality of the Bluff Conservancy was being compromised due to dumping/ pollution and vandalism. The Bluff Nature Reserve is situated almost adjacent to the many industries and is subject to dangerous levels of air pollution and illegal dumping (Adebayo and Musvoto, 2013; Sutherland *et al*., 2009). In addition, earlier responses pertaining to the safety of these green spaces showed that a significant proportion of the respondents viewed green areas in their community as unsafe; hence, it was expected that they would like to see an improvement in this sense.

In terms of the Bluff golf course, literature has shown that communities have become increasingly aware and demanding in the way these areas are maintained, especially when they pay for the use of it (Bark *et al*., 2011). It must be noted though that golf courses generally require high maintenance as they utilise large amounts of water to preserve the greenery (Bark *et al*., 2011). The need for improvement of the coastal forest could be linked to tourism or estate development, as research has shown that coastal areas are increasingly regarded as prime property especially for residential development and tourism (Ahmed *et al*., 2013). This was also supported in this study by the fact that the most high income properties within the study area are situated along the periphery of the coastal forest.

Another noteworthy finding is that a significant proportion of respondents felt the selected green spaces (see Figure 4.5) should be either be retained as is or conserved. This suggests that respondents value their surrounding green areas and would like to see them protected for future use. Urban green spaces provide numerous social and ecological roles including social integration, recreation, relaxation and contact with nature (Lee and Maheswaran, 2011; Maas *et al*., 2006; Qin *et al*., 2013). Earlier findings in relation to respondents' uses of green spaces showed that interviewees chose to use green spaces within the area for similar reasons. Therefore, it was understandable why many of the community members interviewed would like to see these green areas conserved such that they can continue to derive benefits from them. Furthermore, these green spaces contribute to the aesthetics within the area and can also be a reason why respondents would like to see them conserved.

Very few respondents indicated that they would like to see these green areas used for development and public services. As mentioned earlier, studies have found that resident perceptions of urban green spaces are not only linked to their attitudes and behaviour, but also

to socio-economic factors (Sanesi and Chiarello, 2006; Neuvonen *et al*., 2007; Shan, 2014). Moreover, it is important to note that these are established communities whose concern is not likely focused on development and public services, as they already have access to this. Therefore, it was expected that only a few respondents felt that these areas should be used for more urban than environmental needs. However, this may not necessarily reflect the findings in other communities in the SDA, such as those in a more rural and peri-urban settings where there is a greater need for housing and public services. This is an important aspect for future studies to investigate in order to fully understand how residents from communities with varying socio-economic status view green areas.

Table 4.26: P-values of Chi-square tests between socio-demographic variables and respondent views on how the selected green spaces within the study area should be used

Selected green spaces within the study area	Socio-demographic characteristics		
	Gender	**Education**	**Income**
Bluff Conservancy	0.61	0.98	0.11
Bluff golf course	0.43	0.53	0.09
Bluff Nature Reserve (with wetland)	0.29	0.57	0.71
Bluff Nature Reserve (without wetland)	0.20	0.19	0.09
Coastal forest	0.62	0.82	0.03*

***Significant at the 95% confidence interval**

Data shown in Table 4.26 indicates that while gender and education have no significance influence on respondent views on how green spaces within the study area should be used, respondent views on how coastal forest should be used is dependent on income (p=0.03).

Table 4.27: Cross-tabulation between total monthly household income in Rands and respondent views on how coastal forest within the study area should be used (n=301, in %)

Income	Coastal forest				
	Retained as is	Improved and maintained	Conserved	Development	Public services
1,000-5,000	33.75	27.50	30	7.50	1.25
5,000-10,000	32.31	26.15	29.23	12.31	0
10,000-15,000	41.27	31.75	19.05	7.94	0
15,000-20,000	47.83	30.43	8.70	8.70	4.35
20,000-30,000	46.15	28.21	25.64	0	0
30,000-40,000	43.75	6.25	50	0	0
40,000-50,000	11.11	66.67	11.11	11.11	0
50,000-60,000	16.67	33.33	50	0	0

***Income ranges for each social status within the South African context: poor (R0-R5,500); lower emerging middle class (R5,500-R10,000); realised middle class (R10,000-R18,500); upper middle class (R18,500-R45,000) and affluent (R45,000 and above) (Statistics South Africa, 2011)**

Data displayed in Table 4.27 reinforces the point made above by showing that a large proportion of respondents in higher income groups (>R30,000) would like to see coastal forest either improved and maintained or conserved. It is also encouraging to note that the percentage of respondents in the lower to middle income groups that would like to see the forest 'retained as is' was never lower than 33.75%, whilst percentages of respondents that would like to see the forest used for development or public services was between 0 and 12.31% across all income groups. Coastal forest is an ecologically and commercially important green space (Alvey, 2006; Shackleton *et al*., 2007) and this may explain why the majority of respondents (across all income groups) would not like to see coastal forest transformed for other uses. This bodes well for the conservation and maintenance of this natural green area that provides suitable habitats for a number of threatened species in the study area (Ezemvelo KZN Wildlife, nd).

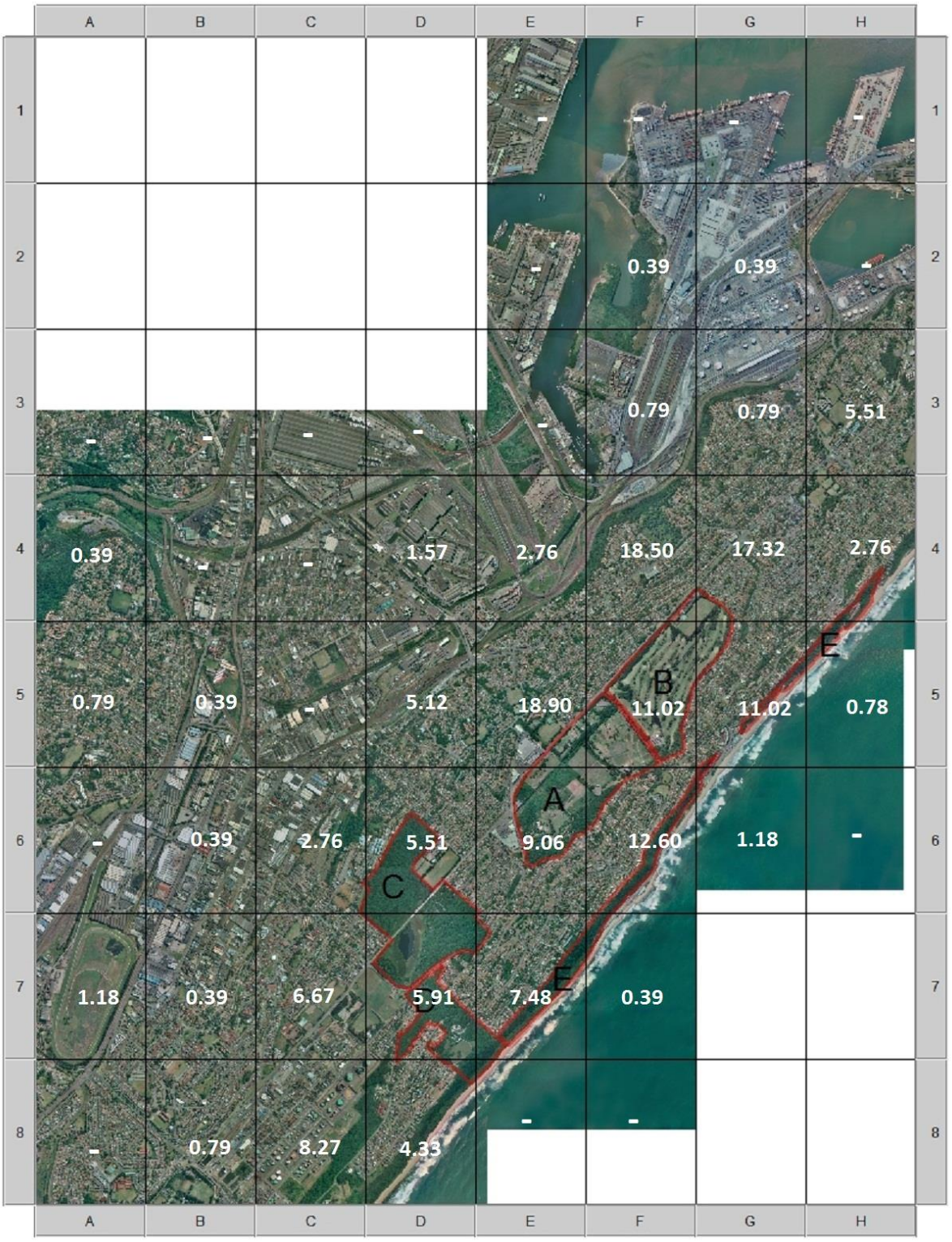

Figure 4.6: Additions to green spaces respondents would like to see within the study area (multiple responses, n=254)

The majority of the respondents (63.50%) indicated they would like to see additional green spaces within the study area, while 36.50% indicated they would not. Figure 4.6 displays the locations of the additions of green spaces respondents' would like to see within the study area. In relation to a grid, the highest levels of additional green spaces requested by the respondents were located in areas/ grids surrounding large green spaces like the Bluff Conservancy and the Bluff golf course and ranged from 1.18% to 18.90%. Similar patterns were evident in areas/ grids surrounding the Bluff Nature Reserve, where respondents' indicated additional green spaces in excess of 2.76% to 9.06%. Respondents indicated much lower levels of additional green spaces, with variations ranging from 0.39% to 0.79%, in very dense built up areas/ grids with a very slight increase (1.18%) in relation to the race course (grid A7).

It was interesting to note that the majority of the respondents showed commonalities in their desire for additional green spaces in areas that already have large green spaces. Furthermore, this may indicate a perception among the respondents for these green areas to be expanded or for environmental corridors to be created that link these areas. Moreover, this resonates with previous findings that a significant proportion of respondents wanted existing green spaces to be retained as is or for the quality to be improved. It is also particularly interesting to note that most of the respondents perceived that it was not ideal to locate additional green spaces close to built areas on the map. This inference is further supported by the fact that very few respondents requested the expansion of green spaces in the most intensively developed/ built areas (port and industry). This suggests that respondents appear to have possessed an understanding that these green spaces within close proximity to built areas, with the exception of the race course, may not be able to be expanded or changed dramatically. It was surprising that the Clairwood race course, an existing large green area that has very high ecological value based on the fact that it houses one of the last intact inland wetland areas in the SDA, was not recognised by most of the respondents as area for expansion. This may be a consequence of a lack of a deeper understanding of ecological value and more specifically green space value amongst respondents.

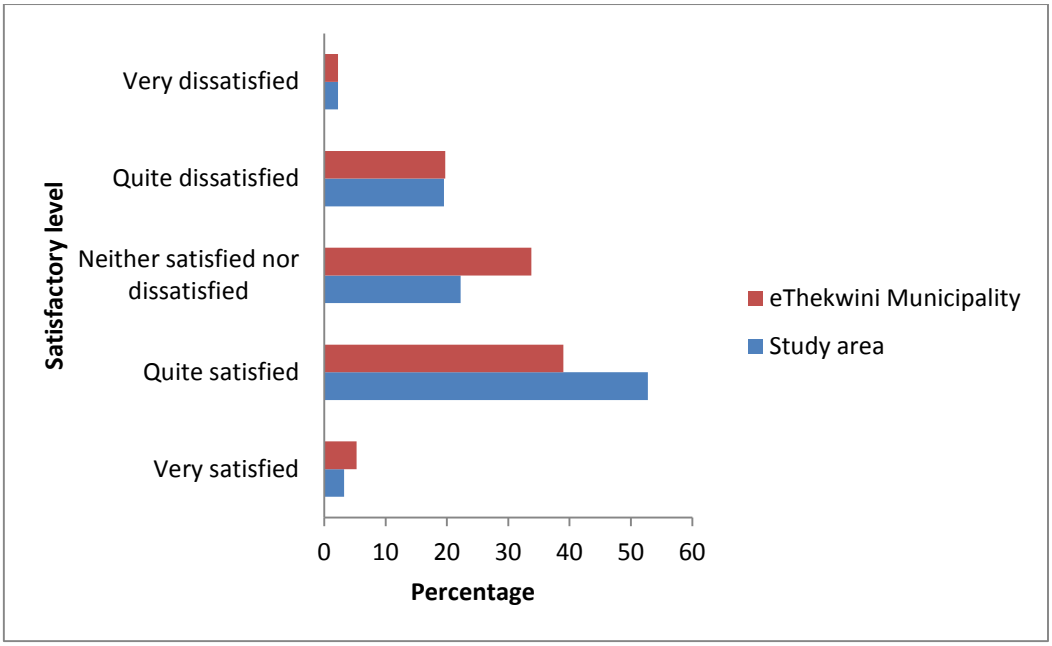

Figure 4.7: Respondent level of satisfaction with the quality of green spaces within the study area and the eThekwini Municipality (n=400)

The data shown in Figure 4.7 suggests that the majority of the respondents were either quite satisfied or very satisfied with the quality of green spaces within the study area (56%) and the greater eThekwini Municipality (44.25%). Fewer respondents (21.8%) indicated that they are quite dissatisfied or very dissatisfied with the quality of green spaces within the study area (21.75%) and the Municipality (22%). Furthermore, 22.25% of the respondents stated that they were neither satisfied nor dissatisfied with the quality of green spaces in the study area, while 33.75% of the respondents were neither satisfied nor dissatisfied with the quality of green spaces in the Municipality.

Overall, results showed that respondents are quite satisfied with the quality of green spaces in the study area and the eThekwini Municipality, more so in their community. Similar findings were also reported by Sutherland *et al*. (2009) who indicated that open green areas within the SDA do hold high value among residents. These findings showed that the majority of the respondents exhibit an intrinsic relationship with these green areas and acknowledge their social and ecological benefits, suggesting that the Municipality should therefore provide more access to and usability of these areas. Furthermore, the Municipality should also focus on addressing the numerous challenges hampering the use and quality of these green environments to ensure they remain intact for future use.

4.4. Environmentally-friendly practices of respondents

There are numerous environmental problems that are responsible for hindering environmental sustainability, however, the most liable factor stems from human behaviour patterns (Steg and Vlek, 2009). Literature suggests that environmentally-friendly behaviour is influenced by numerous factors such as attitudes, level of awareness and socio-demographic variables (Berndt and Gikonyo, 2012). Therefore, understanding human environmental behaviour patterns can be of great importance to policy-makers, behavioural scientists and health professionals (Marquit, 2008), as they can be used to develop and apply interventions in order to reduce environmental impacts (Steg and Vlek, 2009).

Table 4.28: Environmentally-friendly practices respondents engage in (n=400, in %)

Environmentally-friendly practices	Often	Seldom	Never
Recycling	68.75	16	15.25
Reuse of water	27.50	31.25	41.25
Water harvesting	11.75	17	71.25
Composting of home waste	17.25	24.75	58
Conserving electricity (for example, lights that automatically go off and use of alternate energy sources)	89	7.50	3.50
Planting of trees/ vegetation	42.25	31.25	26.50
Proper disposal of waste	90	8.50	1.50

Table 4.28 is an indication of the environmentally-friendly practices that respondents engage in or not. With regard to recycling, 68.75% of the respondents indicated that they often engage in recycling, while 16% of the respondents seldom recycled and 15.25% of the respondents indicated that they never recycle. Fewer respondents (27.50%) indicated that they often reuse water, 31.25% indicated that they seldom reuse water, whilst the majority of the respondents (41.25%) stated they never reuse water. Similar trends were found in relation to water harvesting with fewer respondents indicating they often (11.75%) or seldom (17%) engage in it, while the majority of respondents (71.25%) stated that they do not. Additionally, while 42% of the respondents indicated they often or seldom engage in composting of home waste, more respondents (58%) stated that they do not. Eighty-nine percent of the respondents indicated that they often conserve electricity, while 7.50% seldom conserve electricity and 3.50% of respondents never conserve electricity. Furthermore, 42.25% of the respondents indicated that they often engage in planting of trees/ vegetation. Similar proportions of respondents indicated

that they seldom (31.25%) or never (26.50%) engage in planting of trees/ vegetation. With regard to proper disposal of waste, 90% of the respondents indicated that they often engage in proper waste disposal, while 8.50% of the respondents seldom engage in this practice and 1.50% of the respondents stated that they never dispose of waste properly.

Table 4.29: Proportion of respondents that dump waste in green spaces within the study area (n=400)

Dump waste	Percentage
Yes	30.75
No	69.25

Table 4.29 shows the proportion of respondents that dump waste in green spaces within the study area and it was surprising to note that 30.75% stated that they do. The majority of the respondents (69.25%) did, however, indicate that they do not dump waste in green spaces within the study area.

Results showed that with the exception of reuse of water, water harvesting and composting of home waste, significant proportions of the respondents indicated that they often engage in numerous environmentally-friendly practices. The general household survey conducted by Statistics South Africa (2011) indicated that the majority of South African residents are aware of the need to engage in environmentally-friendly practices in order to save resources. Additionally, statistics provided by the eThekwini quality of life household survey showed that 36% of the households within the Municipality conserve electricity, 82% of the households engage in proper disposal of waste and 12% of the households practice recycling (eThekwini Municipality, 2011b). However, in terms of waste disposal, issues such as dumping have been identified as one of the major environmental problems of households within the country (Statistics South Africa, 2011). Results showed similar findings with around a third of the respondents indicating that they dump waste in green spaces within the study area, suggesting that this is also an environmental concern within the area. The Municipal survey also showed that 32% of households within the city engage in water reduction practices (eThekwini Municipality, 2011b), however, the respondents in the study showed less interest in these practices (reuse of water and water harvesting). This was expected as household survey reports conducted within the country indicate that these practices are more common in peri-urban and

rural settings (Anderson *et al*., 2010). Also important to note is that earlier findings evidenced that a significant proportion of the respondents frequent green areas within their community, which research exemplifies as a factor that contributes towards environmentally-friendly behaviour (Steg and Vlek, 2009). Based on the findings above, this also appeared to be the case in this study and could potentially have implications regarding the environmental quality and quality of human life within the study area.

4.5. Respondents awareness and perceptions of the D'MOSS programme

The Durban Metropolitan Open Space System is the flagship conservation programme of the eThekwini Municipality (see section 3.2.5; Chapter Three), which calls for the formal creation and preservation of green spaces. The system aims to conserve the city's biodiversity and protect and maintain environmental goods and services for both current and future generations (eThekwini Municipality, 2011a).

Table 4.30: Respondent awareness of the D'MOSS programme (n=400)

Awareness	Percentage
Yes	9.75
No	90.25

Data shown in Table 4.30 suggests that the vast majority of the respondents (90.25%) were unaware of the D'MOSS programme, while only 9.75% indicated that they were aware of it. This suggests that even though respondents understand the importance of green spaces and are supportive of their maintenance and/ or expansion, they are clearly unaware of the major programme designed to achieve these ends within the Municipality.

Table 4.31: D'MOSS objectives respondents are aware of (multiple responses, n=39)

D'MOSS Objectives	Percentage
Improving visual attractiveness	33.33
Improving the quality of life	28.21
Promoting the city as a desirable work and tourist place	30.77
Protection of the environment	92.31
Increasing public awareness for the need of conservation	53.85
Recreation (meeting human health and social needs)	30.77

Data shown in Table 4.31 indicates that even though only 9.75% of the respondents were aware of the D'MOSS programme, a large proportion of these (92.31%) were aware of D'MOSS objectives such as 'protection of the environment', while 53.85% stated that they are aware of the objective 'increasing public awareness for the need for conservation'. Fewer respondents were aware of the objectives 'improving visual attractiveness' (33.33%), 'promoting the city as a desirable work and tourist place' (30.77), 'recreation (meeting human health and social needs)' (30.77%) and improving the quality of life' (28.21%).

The results showed that respondents who were familiar with D'MOSS were most aware of the fact that the programme sought to protect the environment and increase conservation awareness. These are more common, generic, objectives associated with conservation programmes, which could be the reason why more respondents identified these objectives compared to the others. However, the respondents were less aware of D'MOSS objectives that speak to more complex and/ or specific goals. Furthermore, this was indicative that the Municipality has not taken the appropriate measures to ensure that residents have been provided with sufficient information about this programme. In addition, if this issue is adequately addressed and respondents are made more aware of the beneficial goals this programme has to offer, it may influence their behaviour towards the environment in more positive ways.

Table 4.32: Respondent recommendations on how the D'MOSS programme can be improved (multiple responses, n=39)

Measure of improvement	Percentage
Increase spatial extent of D'MOSS boundaries	30.77
Fence D'MOSS areas	61.54
Increase public awareness on conservation	87.18
Improve protection	74.36
Engage in further research to identify and implement better management strategies	56.41

Table 4.32 shows respondent recommendations on how the D'MOSS programme can be improved. Recommendations from the majority of the respondents included increasing public awareness on conservation (87.18%), improving protection (74.36%), fencing D'MOSS areas (61.54%). Fewer respondents suggested engaging in further research to identify and implement better management strategies (56.41%) whilst the minority of the respondents felt that the D'MOSS programme can be improved by increasing the spatial extent of its boundaries (30.77%).

The results suggest that among respondents who are aware of D'MOSS many are not fully satisfied with the current standing/ state of the D'MOSS programme and its specific objectives. Many also felt strongly that the programme's efficacy may be improved by enhancing awareness around it. Respondent recommendations on how the programme can be improved are supported by other studies which have shown that fencing, increasing public awareness, better protection and engaging in follow up research with regard to open and green spaces have all been utilised as viable measures of improvement in the conservation of these areas (Jim, 2004). It is also encouraging to note that D'MOSS has now been introduced as a controlled development layer into all town planning schemes within the eThekwini Municipality, implying that better protection and conservation schemes are underway (Roberts *et al*., 2012). Furthermore, the State of Biodiversity Report released annually by the eThekwini Municipality has also served as a measure of increasing public awareness regarding the D'MOSS programme (eThekwini Municipality, 2012) but its benefits may only be evident in time.

4.6. Spatial assessment of the quality of selected green spaces within the eThekwini Municipality

Apart from looking at the social perspectives on selected urban green spaces within the SDA this study also assessed the integrity of selected green spaces within the Municipality in relation to land-use patterns. This spatially-based assessment of green space quality was conducted on selected spaces within the following types: settlements, tree crops, woodland, forest, grassland and thicket. The quality assessment of these spaces generated using the Adapted typology (developed for this study) is also compared to existing quality assessments that are based on the eThekwini typology (used by the eThekwini Municipality).

4.6.1. Settlements

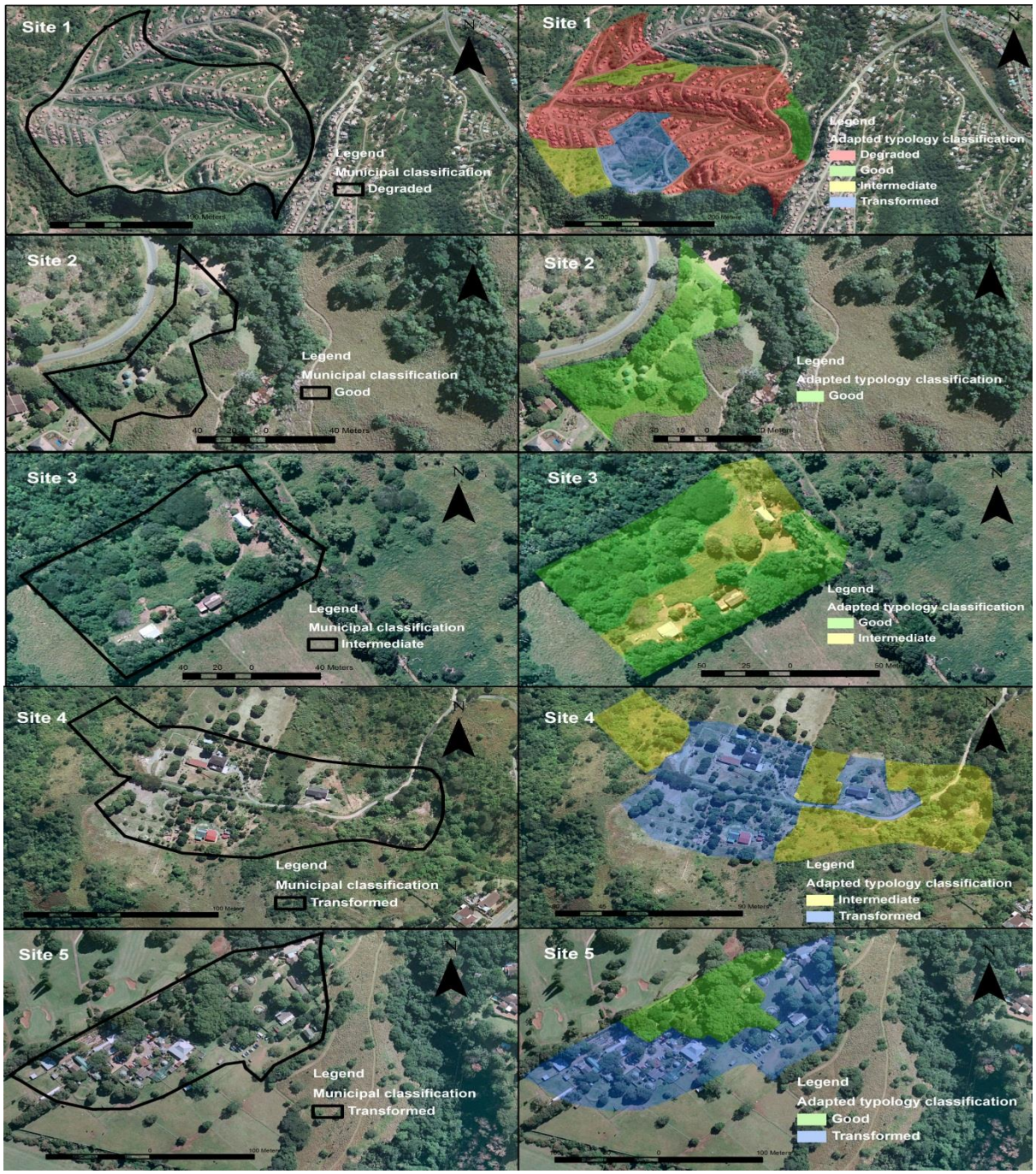

Figure 4.8: Comparison of the quality of green spaces within selected settlement sites using the eThekwini (left) and Adapted (right) typologies. <u>eThekwini typology criteria</u>: Degraded = majority (≥2/3) of site disturbed; Good = majority (≥2/3) of site in natural state; Intermediate = disturbance evident on >1/3 of site but <2/3 of site; Transformed = site completely transformed from natural state. <u>Adapted typology criteria</u>: Degraded = extensive degradation evident within site (>1/2 the area); Good = site appears mostly natural with little, to no, degradation evident; Intermediate = limited degradation evident within site (<1/2 the area); Transformed = site completely transformed from natural state. Coordinates of green space sites analysed given in Appendix B.

Table 4.33: Comparison of the quality of green spaces within selected settlement sites using the eThekwini and Adapted typologies

Site No.	eThekwini typology	Adapted typology				
	Classification and area (m^2)	Classification	Area (m^2) and percentage (%) relative to total site area		Habitat, vegetation type and ecosystem threat status	Infringement
1	Degraded (316,117.52)	Degraded	224,006.05	70.8*	Habitat type: Amenity Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Considerable
		Good	11,240.13	3.6*		
		Intermediate	35,252.59	11.2*		
		Transformed	45,618.75	14.4*		
2	Good (5,700.24)	Good	5,700.24	100*	Habitat type: Semi-natural Vegetation type: Scarp Forest Ecosystem threat status: Least threatened	None
3	Intermediate (14,120.24)	Good	9,245.57	65.5*	Habitat type: Semi-natural Vegetation type: Northern Coastal Forest Ecosystem threat status: Critically endangered	None
		Intermediate	4,874.67	34.5*		
4	Transformed (46,608.55)	Intermediate	21,359.90	45.8*	Habitat type: Amenity Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Considerable
		Transformed	25,248.65	54.2*		
5	Transformed (33,626.12)	Good	9,278.04	27.6*	Habitat type: Amenity Vegetation type: KwaZulu-Natal Sandstone Sourveld Ecosystem threat status: Endangered	Considerable
		Transformed	24,348.07	72.4*		

*$\boldsymbol{Quality\ based\ land\ cover\ percentage} = \left(\frac{\boldsymbol{Area\ degraded/good/intermediate/transformed}}{\boldsymbol{Total\ area\ of\ \ site}}\right) \times \mathbf{100}$

Terminologies: 'Habitat' - habitat type of the site according to Swanwick *et al.* (2003) typology; 'Vegetation' - vegetation type of the site according to SANBI KwaZulu–Natal vegetation type classification (2011); 'Ecosystem threat status' - ecosystem threat status of the site according to the National Biodiversity Assessment (2011); 'Infringement' - the level of infringement on site from land-use activities.

When the quality of the five settlement sites considered above (Figure 4.8 and Table 4.33) was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for four sites (1, 3, 4 and 5). It was only for site 2 that the quality classification was in agreement between the two typologies. However, it must be noted that use of the Adapted typology resulted in the identification of more good and intermediate land than that reflected by the eThekwini typology; good micro-environments were identified in three

sites (1, 3 and 5), while intermediate micro-environments were also identified in three sites (1, 3 and 4). Transformed land remained more or less comparable between both typologies.

Table 4.34: Statistics incorporated into the Adapted typology calculated for all five settlement sites cumulatively

Land cover characteristic and categorisation		**Percentage land cover associated with specific habitat and vegetation type, threat status, and infringement categories***
Habitat type	Amenity habitats	95.2
	Semi-natural habitats	4.8
Vegetation type	KwaZulu-Natal Coastal Belt Grassland vegetation	87.2
	KwaZulu-Natal Sandstone Sourveld vegetation	8.1
	Northern Coastal Forest vegetation	3.4
	Scarp Forest vegetation	1.4
Threat status	Critically endangered land	90.6
	Endangered land	8.1
	Threatened land	1.4
Infringement	Land with considerable infringement	95.2
	Land with no infringement	1.4

***Calculated as a percentage of the cumulative area of all the sites considered for this particular green space type (i.e. sum of the areas of the five sites sampled for settlements which was equivalent to 416,172.66 m^2)**

The quality based land cover percentages calculated for the five settlement sites as part of the Adapted typology (Table 4.33) should be interpreted in combination with the statistics shown in Table 4.34. As mentioned previously in Chapter Three (section 3.2.4), there are two broad habitat categories within which green spaces in the eThekwini Municipality are placed, viz. artificial and natural/ semi-natural. Whilst the eThekwini typology classified all five of the settlement sites investigated as artificial habitats (eThekwini Municipality, 2012), the Adapted typology showed that three of these sites (1, 4 and 5) consisted of amenity habitats covering 95.2% of the land, while sites 2 and 3 contained semi-natural habitats covering 4.8% of the land. Additionally, the Adapted typology showed that four different vegetation types occurred within this green space type: sites 1 and 4 consisted of KwaZulu-Natal Coastal Belt Grassland vegetation covering the majority of land (87.2%); site 5 consisted of KwaZulu-Natal Sandstone Sourveld covering 8.1% of the land while only 4.8% of the land comprised of Northern Coastal Forest (in site 3) and Scarp Forest (in site 2). These results show that the predominant vegetation, viz. KwaZulu-Natal Coastal Belt Grassland, found in the selected settlements sites

was classified as critically endangered. This supports the eThekwini Municipality's (2007) statement that around two thirds of this vegetation type has been/ is being subjected to high levels of transformation and degradation by settlements within the eThekwini Municipality. This is further validated by the orthophotos shown in Figure 4.8 (refer to site 1 and 4 specifically).

In terms of ecosystem threat status (Table 4.33 and Table 4.34), three of the sites (1, 3 and 4) were deemed critically endangered covering the majority of land (90.6%) while site 5, encompassing 8.1% of the land, was categorised as endangered and a minor 1.4% of the land (site 2) was categorised as least threatened. With regard to infringement (Table 4.33 and Table 4.34), three of the sites assessed (1, 4 and 5) were subject to considerable disturbance, collectively covering 95.2% of the land, while a meagre 4.8% of the land (sites 2 and 3) were considered to have no infringement on vegetation.

Based on the above it is also important to incorporate an indicator of threat and infringement status in any typology used to assess green space quality. For example, when the data obtained for settlement green spaces using the Adapted typology (Table 4.33) were interpreted using the orthophotos for these sites (Figure 4.8), it was evident that green spaces located in close proximity to settlements were exposed to higher levels of infringement and had definite areas that were degraded or transformed (for example, site 1, 4 and 5), compared with sites situated further away (for example, site 2 and 3) which were more intact. This resonates with evidence from the social survey which distinctly showed that the quality of green spaces within selected communities in the eThekwini Municipality has significantly decreased due to issues such as pollution, lack of maintenance, increased housing development and insufficient land allocation (section 4.3: Figure 4.4 and Table 4.25). Furthermore, findings from the social survey also showed that almost a third of respondents indicated that they themselves dump waste in these areas. Similar trends have been identified in numerous studies (Jim, 2004; Pauleit *et al*., 2005; Zhou and Wang, 2011), all of which indicated that green space habitats have become increasingly prone to higher levels of degradation and transformation associated with urban development.

Another interesting finding showed that the settlement green space sites most exposed to degradation and transformation (for example, sites 1, 4 and 5) were not under D'MOSS protection (Source for raw data: eThekwini Municipality, 2012), which could explain their poor

quality. Furthermore, all the settlement green spaces categorised as degraded or transformed (sites 1, 4 and 5) consisted of amenity habitats which, according to Swanwick *et al*. (2003), are generally the predominant habitat type found within urban areas (for example, housing green space). Amenity habitats are usually deemed to have a limited ecological value, serving mainly as a landscape backdrop (Swanwick *et al*., 2003). However, larger areas of intact green space were found further away from the settlements and were not exposed to any infringement (sites 2 and site 3). These results confirmed perception gained via the social survey (section 4.3: Figure 4.5 and Figure 4.6) and can be attributed to the fact that these particular sites have been designated by the eThekwini typology as nature reserves and also fall under D'MOSS protection (Source for raw data: eThekwini Municipality, 2012). This is probably based on the fact that these sites consisted of Scarp Forest (site 2) and Northern Coastal Forest (site 3) vegetation, both of which have been allocated a high conservation status within the eThekwini Municipality (eThekwini Municipality, 2007). The social survey data also showed that nature reserves are regarded as important green environments, with many respondents warranting that these areas be improved and maintained or conserved (section 4.3: Figure 4.5).

Table 4.35: Deviation index for selected settlement sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies

0- No deviation, 1- Minimal deviation, 2- Moderate deviation, 3- High deviation

Site No.	**Deviation index**
1	1
2	0
3	2
4	2
5	1
Cumulative percentage deviation*	40%

$$*Cummulative\ percentage\ deviation\ of\ Adapted\ typology\ quality\ from\ eThwekini\ typology\ quality\ for\ settlements = \left(\frac{Sum\ of\ site\ deviation\ scores\ (6)}{Maximum\ possible\ deviation\ (3) \times No.of\ \ sites\ (5)}\right) \times 100$$

The deviation indices calculated for the settlements sites investigated (Table 4.35) revealed that four sites deviated from the classification defined by the eThekwini typology. There was moderate deviation evident in sites 3 and 4, while sites 1 and 5 showed minimal deviation. Only one site (2) reflected no deviation from the eThekwini typology. In summary, the quality of the five settlement green spaces assessed using the eThekwini typology collectively deviated by approximately 40% from that assessed using the more discriminatory Adapted typology. This is probably a reflection of the pockets of intact and intermediate land present in close proximity to settlements as evidenced in Figure 4.8. These areas generally occupy small proportions of the total land area and are often subject to high pressures of infringement but it is important to note that even these smaller polarised green environments hold tremendous value as they contribute to the aesthetics, recreational use, creation of green corridors and improved environmental quality within urban areas (Giles-Corti *et al*., 2005; Wright Wendel *et al*., 2012).

Overall, it was evident that quality based land cover differed moderately when sites were compared using the eThekwini and Adapted typologies. This resulted in some green micro-habitats within larger green spaces being potentially misclassified in terms of their ecological integrity when using the eThekwini typology and, possibly not being prioritised for conservation and/ or restoration. This prevents residents and government from harnessing their full potential, for example, as green corridors or as greenery in residential areas, which the social survey also revealed to be a desire among respondents (section 4.3: Table 4.16).

4.6.2. Tree crops

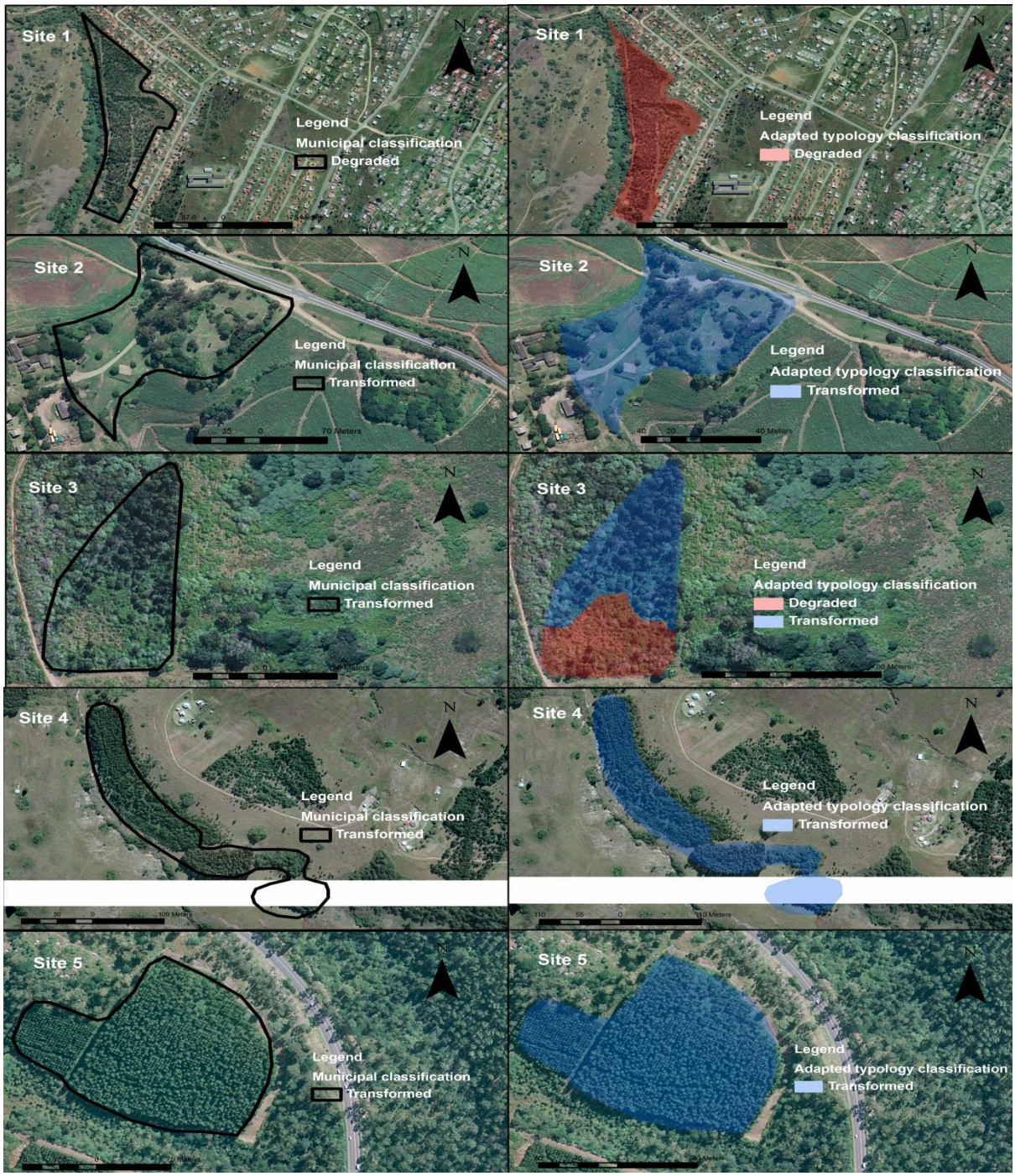

Figure 4.9: Comparison of the quality of green spaces within selected tree crop sites using the eThekwini (left) and Adapted (right) typologies. <u>eThekwini typology criteria</u>: Degraded = majority (≥2/3) of site disturbed; Good = majority (≥2/3) of site in natural state; Intermediate = disturbance evident on >1/3 of site but <2/3 of site; Transformed = site completely transformed from natural state. <u>Adapted typology criteria</u>: Degraded = extensive degradation evident within site (>1/2 the area); Good = site appears mostly natural with little, to no, degradation evident; Intermediate = limited degradation evident within site (<1/2 the area); Transformed = site completely transformed from natural state. Coordinates of green space sites analysed given in Appendix B.

Table 4.36: Comparison of the quality of green spaces within selected tree crop sites using the eThekwini and Adapted typologies

Site No.	eThekwini typology	Adapted typology				
	Classification and area (m^2)	Classification	Area (m^2) and percentage (%) relative to total site area		Habitat, vegetation type and ecosystem threat status	Infringement
1	Degraded (65,951.59)	Degraded	65,951.59	100*	Habitat type: Functional Vegetation type: KwaZulu-Natal Hinterland Thornveld Ecosystem threat status: Least threatened	Considerable
2	Transformed (28,875.50)	Transformed	28,875.50	100*	Habitat type: Functional Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Considerable
3	Transformed (11,667.44)	Degraded	4,513.60	38.7*	Habitat type: Functional Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	None
		Transformed	7,153.84	61.3*		
4	Transformed (29,042.82)	Transformed	29,042.82	100*	Habitat type: Functional Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	None
5	Transformed (36,163.48)	Transformed	36,163.48	100*	Habitat type: Functional Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	None

*$\boldsymbol{Quality\ based\ land\ cover\ percentage} = \left(\frac{\boldsymbol{Area\ degraded/good/intermediate/transformed}}{\boldsymbol{Total\ area\ of\ \ site}}\right) \times \mathbf{100}$

Terminologies: 'Habitat' - habitat type of the site according to Swanwick *et al.* (2003) typology; 'Vegetation' - vegetation type of the site according to SANBI KwaZulu–Natal vegetation type classification (2011); 'Ecosystem threat status' - ecosystem threat status of the site according to the National Biodiversity Assessment (2011); 'Infringement' - the level of infringement on site from land-use activities.

When the quality of the five tree crop sites displayed above (Figure 4.9 and Table 4.36) was compared between the Adapted and eThekwini typologies, the quality classification only differed between typologies for site 3. The quality classification for the remaining sites (1, 2, 4 and 5) was in agreement between the typologies. However, it should be noted that the use of the Adapted typology resulted in the identification of more degraded land; a degraded micro-environment was identified in site 3.

Table 4.37: Statistics incorporated into the Adapted typology calculated for all five tree crop sites cumulatively

Land cover characteristic and categorisation		Percentage land cover associated with specific habitat and vegetation type, threat status, and infringement categories*
Habitat type	Functional habitats	100
Vegetation type	KwaZulu-Natal Coastal Belt Grassland vegetation	61.6
	KwaZulu-Natal Hinterland Thornveld vegetation	38.4
Threat status	Critically endangered land	61.6
	Least threatened land	38.4
Infringement	Land with considerable infringement	55.2
	Land with no infringement	44.8

***Calculated as a percentage of the cumulative area of all the sites considered for this particular green space type (i.e. sum of the areas of the five sites sampled for tree crops which was equivalent to 171,700.83 m^2)**

The quality based land cover percentages calculated for the five tree crop sites as part of the Adapted typology (Table 4.36) should be interpreted in combination with the statistics shown in Table 4.37. In terms of habitat type, the eThekwini Municipality classified all five of the selected tree crop sites as artificial habitats (eThekwini Municipality, 2012), whilst the Adapted typology classified the tree crops sites investigated as functional habitats. It should be noted that these tree crop sites (Figure 4.9 and Table 4.36) have been designated by the eThekwini typology as plantations (Source for raw data: eThekwini Municipality, 2012). In addition, findings in the literature indicate that green spaces associated with farming, plantations or horticultural practices are usually classified as functional habitats (Dunnet *et al*., 2002; Swanwick *et al*., 2003). This statement was further validated by the Adapted typology, which showed that the five tree crop sites investigated all consisted of functional habitats (Table 4.36 and Table 4.37).

Furthermore, the Adapted typology showed that two different vegetation types occurred within this green space type: sites 2, 3, 4 and 5 consisted of KwaZulu-Natal Coastal Belt Grassland covering the majority of land (61.6%), while 38.4% of the land comprised of KwaZulu-Natal Hinterland Thornveld (site 1). The results (Table 4.36 and Table 4.37) also showed that the predominant vegetation type, viz. KwaZulu-Natal Coastal Belt Grassland, found in the selected tree crop sites was classified as critically endangered. This is in agreement with findings by the

Municipality which indicate that this vegetation type has been/ is being subjected to high levels of transformation by settlements and cultivation practices (eThekwini Municipality, 2007).

In terms of the ecosystem threat status (Table 4.36 and Table 4.37), four sites (2, 3, 4 and 5) were classified as critically endangered covering the majority of land (61.6%), with site 1 only classified as least threatened covering 38.4% of the land. With regard to infringement (Table 4.36 and Table 4.37), two of the sites assessed (1 and 2) were subject to considerable infringement constituting 55.2% of the land, while the remaining sites (3, 4 and 5) were not encroached upon, collectively leaving 44.8% of the land undisturbed.

With the above in place, it is also important to interrogate the quality based land cover and infringement status for the selected tree crops sites (Table 4.36) in order to adequately assess integrity of the land. The assessment of the data obtained from the orthophotos for these sites (Figure 4.9) revealed that tree crops in close to settlements were more prone to degradation (for example, site 1) than those situated further away (for example, site 4 and 5). This resonates with findings described for settlements in the previous section, which also showed that green areas located nearby to settlements were exposed to higher levels of infringement and where characterised by areas that were evidently degraded (Figure 4.8). Furthermore, this reinforces the assertion in the literature that increasing urban pressures have resulted in the degradation of green spaces (Zhou and Wang, 2011).

Another interesting result showed that the majority of sites (2, 3, 4 and 5) comprised of land that was classified as transformed. However, it should be noted that in this green space type if a site was classified as transformed, this was not necessarily indicative of a poor quality based land cover. Tree crops are commercial entities of land (Sanchez and Leakey, 1997; Verlarde and Tomich, 2006), inferring that the land has been transformed to grow vegetation. Furthermore, even though tree crops may have a low ecological value, in some cases research has found that these environments have a high environmental importance as they can significantly aid in carbon sequestration (Verlarde and Tomich, 2006).

Table 4.38: Deviation index for selected tree crop sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies

0- No deviation, 1- Minimal deviation, 2- Moderate deviation, 3- High deviation

Site No.	Deviation index
1	0
2	0
3	2
4	0
5	0
Cumulative percentage deviation*	13.3%

$$*Cummulative\ percentage\ deviation\ of\ Adapted\ typology\ quality\ from\ eThwekini\ typology\ quality\ for\ tree\ crops = \left(\frac{Sum\ of\ site\ deviation\ scores\ (2)}{Maximum\ possible\ deviation\ (3) \times No.of\ \ sites\ (5)}\right) \times 100$$

The deviation indices calculated for the tree crop sites investigated (Table 4.38) revealed that only one site deviated from the classification defined by the eThekwini typology. There was moderate deviation evident in site 3, while sites 1, 2, 4 and 5 exhibited no deviation from the eThekwini typology. In summary, the quality of the five tree crop sites assessed using the eThekwini typology collectively deviated by approximately 13.3% from that assessed using the more discriminatory Adapted typology. This is a relatively minor deviation and can be attributed to the identification of more degraded land as evidenced in Figure 4.9.

Overall, it was evident that quality based land cover differed minimally when sites were compared using the eThekwini and Adapted typologies. However, a few degraded micro-habitats were potentially misclassified as transformed when using the eThekwini typology; the implication of this misclassification is that these micro-habitats could possibly be inadequately/ inappropriately prioritised for conservation and/ or restoration. More importantly, it should be noted that transformed tree crop habitats potentially hold environmental importance within an urban setting. These environments can significantly aid in carbon sequestration, particularly in rapidly developing cities such as eThekwini, whilst simultaneously contributing to commercial activities.

4.6.3. Woodland

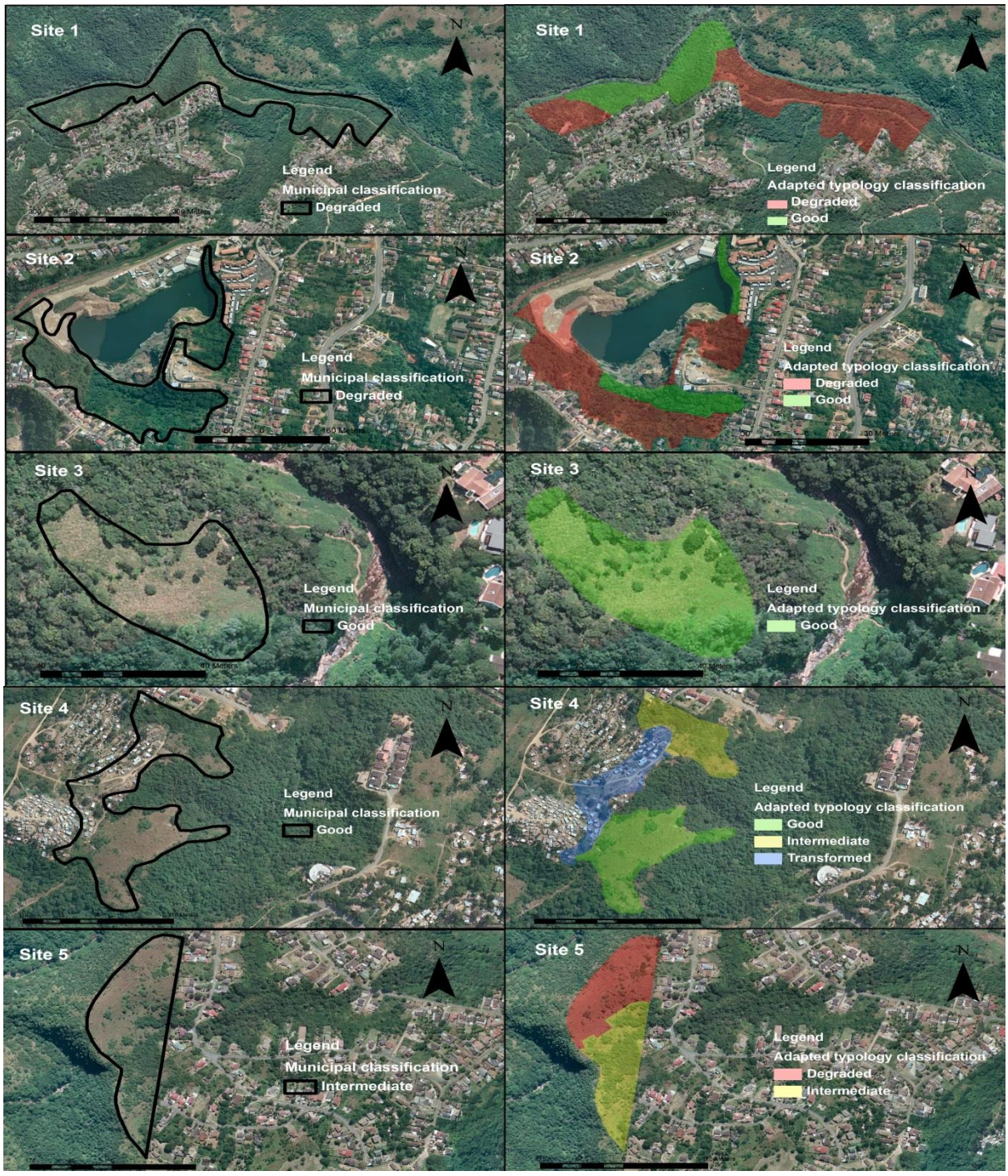

Figure 4.10: Comparison of the quality of green spaces within selected woodland sites using the eThekwini (left) and Adapted (right) typologies. <u>eThekwini typology criteria</u>: Degraded = majority (≥2/3) of site disturbed; Good = majority (≥2/3) of site in natural state; Intermediate = disturbance evident on >1/3 of site but <2/3 of site; Transformed = site completely transformed from natural state. <u>Adapted typology criteria</u>: Degraded = extensive degradation evident within site (>1/2 the area); Good = site appears mostly natural with little, to no, degradation evident; Intermediate = limited degradation evident within site (<1/2 the area); Transformed = site completely transformed from natural state. Coordinates of green space sites analysed given in Appendix B.

Table 4.39: Comparison of the quality of green spaces within selected woodland sites using the eThekwini and Adapted typologies

Site No.	eThekwini Municipality	Adapted typology				
	Classification and area(m^2)	Classification	Area (m^2) and percentage (%) relative to total site area		Habitat, vegetation type and ecosystem threat status	Infringement
1	Degraded (249,674.32)	Degraded	165,501.13	66.3*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Considerable
		Good	84,173.18	33.7*		
2	Degraded (86,352.88)	Degraded	66,642.64	77.2*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Thornveld Ecosystem threat status: Critically endangered	Considerable
		Good	19,710.23	22.8*		
3	Good (6,062.15)	Good	6,062.15	100*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Thornveld Ecosystem threat status: Critically endangered	None
4	Good (38,517.59)	Good	17,474.94	45.4*	Habitat type: Semi-natural Vegetation type: Northern Coastal Forest Ecosystem threat status: Critically endangered	Considerable
		Intermediate	9,798.19	25.4*		
		Transformed	11,244.46	29.2*		
5	Intermediate (57,247.09)	Degraded	28,650.49	50*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Thornveld Ecosystem threat status: Critically endangered	Considerable
		Intermediate	28,596.60	50*		

*$\boldsymbol{Quality\ based\ land\ cover\ percentage} = \left(\frac{\boldsymbol{Area\ degraded/good/intermediate/transformed}}{\boldsymbol{Total\ area\ of\ site}}\right) \times \mathbf{100}$

Terminologies: 'Habitat' - habitat type of the site according to Swanwick *et al.* (2003) typology; 'Vegetation' - vegetation type of the site according to SANBI KwaZulu–Natal vegetation type classification (2011); 'Ecosystem threat status' - ecosystem threat status of the site according to the National Biodiversity Assessment (2011); 'Infringement' - the level of infringement on site from land-use activities.

When the quality of the five woodland sites considered above (Figure 4.10 and Table 4.39) was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for four sites (1, 2, 4 and 5). It was only for site 3 that the quality classification was in agreement between the typologies. Furthermore, it must be noted that use of the Adapted typology resulted in the identification of more good, degraded and transformed land than that reflected by the eThekwini typology; good micro-environments were identified in three sites (1, 2 and 4), while transformed and degraded micro-environments were identified in site 4 and 5, respectively. The use of the Adapted typology also led to the identification of

less intermediate land than that reflected by the eThekwini typology (site 5) and an additional intermediate micro-environment in site 4.

Table 4.40: Statistics incorporated into the Adapted typology calculated for all five woodland sites cumulatively

Land cover characteristic and categorisation		**Percentage land cover associated with specific habitat and vegetation type, threat status, and infringement categories***
Habitat type	Semi-natural habitats	100
Vegetation type	KwaZulu-Natal Coastal Belt Grassland vegetation	57
	KwaZulu-Natal Coastal Belt Thornveld vegetation	34.2
	Northern Coastal Forest vegetation	8.8
Threat status	Critically endangered land	100
Infringement	Land with considerable infringement	98.6
	Land with no infringement	1.4

***Calculated as a percentage of the cumulative area of all the sites considered for this particular green space type (i.e. sum of the areas of the five sites sampled for woodland which was equivalent to 437,854.03 m^2)**

The quality based land cover percentages calculated for the five woodland sites as part of the Adapted typology (Table 4.39) should be interpreted in combination with the statistics shown in Table 4.40. In terms of habitat type, whilst the eThekwini typology classified all five of the woodland sites investigated as artificial habitats (eThekwini Municipality, 2012), the Adapted typology showed that all of these sites consisted of semi-natural habitats. Additionally, the Adapted typology showed that three different vegetation types occurred within this green space type: sites 1, 2 and 5 consisted of KwaZulu-Natal Coastal Belt Thornveld covering 34.2% of the land; site 1 consisted of KwaZulu-Natal Coastal Belt Grassland vegetation covering 57% of the land; and only 8.8% of the land comprised of Northern Coastal Forest (site 4).

Leading on from above, the results (Table 4.39 and Table 4.40) show that all vegetation types found in the selected woodland sites were classified as critically endangered. This resonates with findings made by the eThekwini Municipality (2007) which indicate that these vegetation types are becoming less extensive as they have been/ are being subjected to high levels of transformation and degradation by settlements within the eThekwini Municipality. Evidence of the above was further validated by the Adapted typology (Figure 4.10 and Table 4.39), which

showed that the vegetation types subjected to the highest level of degradation (sites 1 and 2) were considerably encroached upon by settlements. Additionally, it must be noted that the Adapted typology classification of these selected green spaces as semi-natural habitats has potential implications regarding the conservation of vegetation within these environments. Studies have found that semi-natural vegetated habitats are usually designated with higher conservation priorities (Bell *et al*., 2007; Swanwick *et al*., 2003). Therefore, designating these selected green areas as semi-natural habitats may aid in preventing further degradation and transformation of the natural vegetation found within them. This is a particularly important consideration because in terms of ecosystem threat status, all five of the woodland sites were deemed critically endangered (Table 4.40). With regard to infringement (Table 4.39 and Table 4.40), four of the sites assessed (1, 2, 4 and 5) were subject to considerable disturbance, collectively covering 98.6% of the land, while a meagre 1.4% of the land (site 3) was considered to have no infringement.

Woodlands are considered to be one of the most threatened ecosystems within eThekwini and as a result of this, now constitute the largest proportion of D'MOSS land, covering over 17,700 ha (eThekwini Municipality, 2011a). Additionally, the selected woodland sites under investigation all fall under D'MOSS protection (Source for raw data: eThekwini Municipality, 2012). However, it was found when the data obtained for woodland green spaces using the Adapted typology (Table 4.39) were interpreted using the orthophotos for these sites (Figure 4.10), it was evident that woodlands in close proximity to settlements were severely encroached upon and more prone to degradation and transformation (for example, site 2 and 4), than those situated further away (for example, site 3). This resonates with earlier findings from the social survey pertaining to the vulnerability of green spaces in close proximity to residential areas (section 4.3: Figure 4.4 and Table 4.25). Furthermore, similar trends were evidenced by Luoga *et al*. (2002) and Syampungani (2008), who showed that the key drivers affecting woodland degradation were mainly deforestation, land clearing for development and wood extraction for energy. Additionally, Shackleton *et al*. (2007) indicated that there has been an increase in deforestation, particularly in the communal areas of the KwaZulu-Natal, due to the conversion of large tracts of woodland for cultivation and human settlements.

Table 4.41: Deviation index for selected woodland sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies

0- No deviation, 1- Minimal deviation, 2- Moderate deviation, 3- High deviation

Site No.	Deviation index
1	2
2	1
3	0
4	2
5	2
Cumulative percentage deviation*	46.7%

$$*Cummulative\ percentage\ deviation\ of\ Adapted\ typology\ quality\ from\ eThwekini\ typology\ quality\ for\ woodland = \left(\frac{Sum\ of\ site\ deviation\ scores\ (7)}{Maximum\ possible\ deviation\ (3) \times No.of\ \ sites\ (5)}\right) \times 100$$

The deviation indices calculated for the woodland sites investigated (Table 4.41) revealed that classifications for four sites deviated between the typologies. There was moderate deviation evident in sites 1, 4 and 5 while site 2 showed minimal deviation. Only one site (3) reflected no deviation between typologies. In summary, the quality of the five woodland green spaces assessed using the eThekwini typology collectively deviated by approximately 46.7% from that assessed using the more discriminatory Adapted typology. This is probably a reflection of the pockets of intact, degraded and transformed land present in close proximity to settlements as evidenced in Figure 4.10.

Overall, it was evident that quality based land cover differed moderately when sites were compared using the eThekwini and Adapted typologies. Some micro-habitats of differentiated ecological integrity were potentially misclassified when using the eThekwini typology; the implication of this misclassification is that these micro-habitats could possibly be inadequately/ inappropriately prioritised for conservation and/ or restoration. This is particularly important to consider given that woodlands are ecologically important ecosystems that play a vital role in sequestering large amounts of carbon, particular within the rapidly growing cities such as eThekwini (eThekwini Municipality, 2007). According to the eThekwini Municipality (2007), around 58% of carbon stock on land is stored in broadleaved woodland vegetation. Therefore, these polarised intact micro-environments can potentially be used to maximise this ecosystem's

contribution to climate mitigation within the eThekwini Municipality by maintaining their integrity/ conserving them.

4.6.4. Forest

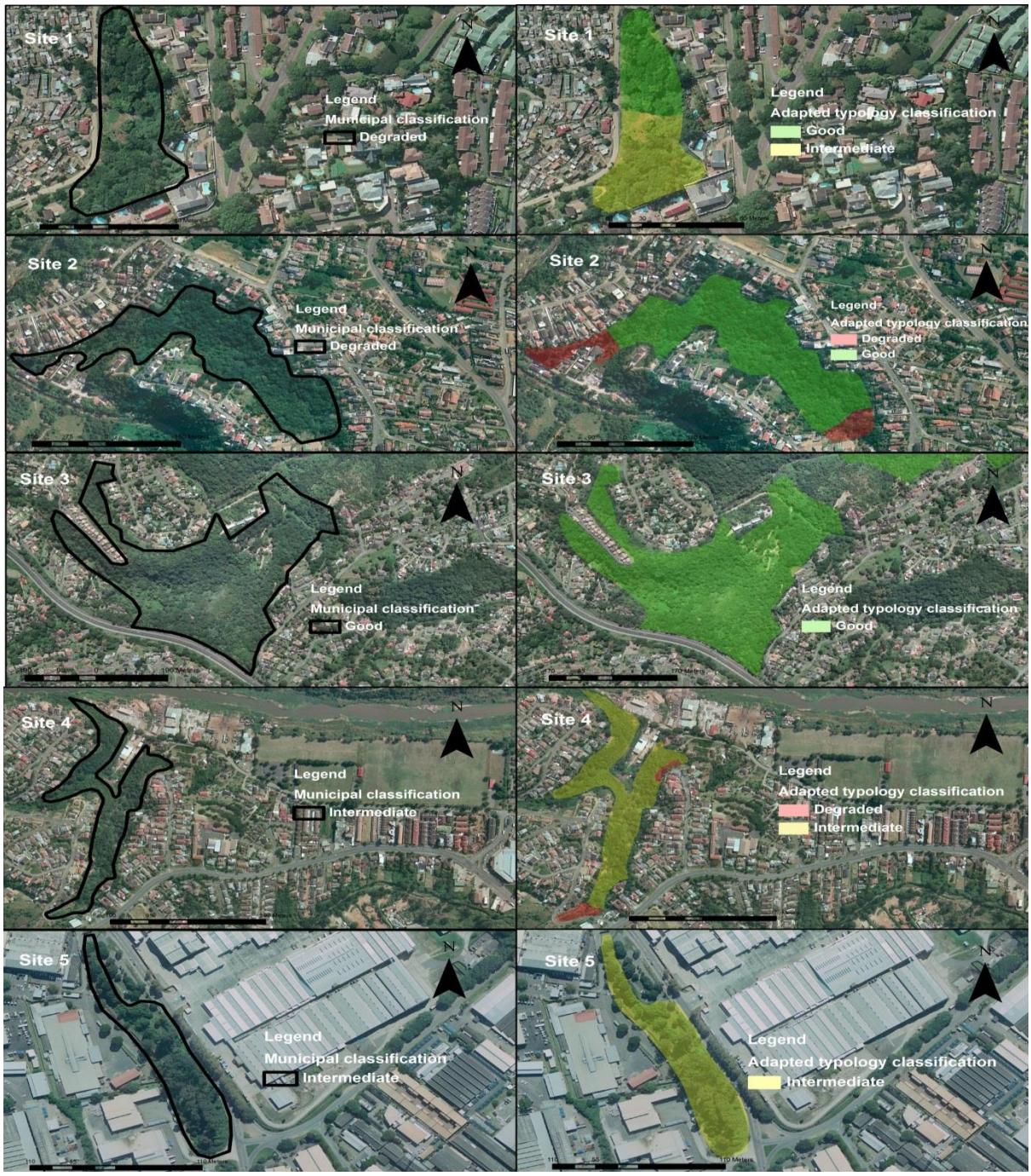

Figure 4.11: Comparison of the quality of green spaces within selected forest sites using the eThekwini (left) and Adapted (right) typologies. <u>eThekwini typology criteria</u>: Degraded = majority (≥2/3) of site disturbed; Good = majority (≥2/3) of site in natural state; Intermediate = disturbance evident on >1/3 of site but <2/3 of site; Transformed = site completely transformed from natural state. <u>Adapted typology criteria</u>: Degraded = extensive degradation evident within site (>1/2 the area); Good = site appears mostly natural with little, to no, degradation evident; Intermediate = limited degradation evident within site (<1/2 the area); Transformed = site completely transformed from natural state. Coordinates of green space sites analysed given in Appendix B.

Table 4.42: Comparison of the quality of green spaces within selected forest sites using the eThekwini and Adapted typologies

Site No.	eThekwini Municipality	Adapted typology				
	Classification and area (m^2)	Classification	Area (m^2) and percentage (%) relative to total site area		Habitat, vegetation type and ecosystem threat status	Infringement
1	Degraded (11,941.54)	Good	4,984.50	41.7*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Considerable
		Intermediate	6,957.04	58.3*		
2	Degraded (75,372.46)	Degraded	11,015.97	14.6*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Considerable
		Good	64,356.49	85.4*		
3	Good (202,864.56)	Good	202,864.56	100*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Forest Ecosystem threat status: Critically endangered	Considerable
4	Intermediate (54,394.52)	Degraded	4,142.70	7.6*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Thornveld Ecosystem threat status: Critically endangered	Considerable
		Intermediate	50,251.81	92.4*		
5	Intermediate (17,945.45)	Intermediate	17,945.45	100*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Vulnerable	Considerable

*$\boldsymbol{Quality\ based\ land\ cover\ percentage} = \left(\frac{\boldsymbol{Area\ degraded/good/intermediate/transformed}}{\boldsymbol{Total\ area\ of\ \ site}}\right) \times \mathbf{100}$

Terminologies: 'Habitat' - habitat type of the site according to Swanwick *et al.* (2003) typology; 'Vegetation' - vegetation type of the site according to SANBI KwaZulu–Natal vegetation type classification (2011); 'Ecosystem threat status' - ecosystem threat status of the site according to the National Biodiversity Assessment (2011); 'Infringement' - the level of infringement on site from land-use activities.

When the quality of the five forest sites considered above (Figure 4.11 and Table 4.42) was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for three sites (1, 2 and 4). It was for two sites (3 and 5) that the quality classification was in agreement between the typologies. However, it was evident that use of the Adapted typology resulted in the identification of more good and intermediate land than that reflected by the eThekwini typology; good micro-environments were identified in two sites (1 and 2), while intermediate micro-environments were also identified in two sites (1 and 4). Moreover, use of the Adapted typology resulted in the identification of less degraded land than

that reflected by the eThekwini typology (sites 1 and 2); however, an additional degraded micro-environment was identified in site 4.

Table 4.43: Statistics incorporated into the Adapted typology calculated for all five forest sites cumulatively

Land cover characteristic and categorisation		**Percentage land cover associated with specific habitat and vegetation type, threat status, and infringement categories***
Habitat type	Semi-natural habitats	100
Vegetation type	KwaZulu-Natal Coastal Belt Grassland vegetation	29
	KwaZulu-Natal Coastal Forest vegetation	56
	KwaZulu-Natal Coastal Belt Thornveld vegetation	15
Threat status	Critically endangered land	100
Infringement	Land with considerable infringement	100

***Calculated as a percentage of the cumulative area of all the sites considered for this particular green space type (i.e. sum of the areas of the five sites sampled for forest which was equivalent to 362,518.52 m^2)**

The quality based land cover percentages calculated for the five forest sites as part of the Adapted typology (Table 4.42) should be interpreted in combination with the statistics shown in Table 4.43. The habitat type of the selected forest sites were classified as semi-natural habitats by both typologies. Additionally, the Adapted typology indicated that three different vegetation types occurred within this green space type: site 3 consisted of KwaZulu-Natal Coastal Belt Forest covering the majority of the land (56%); sites 1, 2 and 5 consisted of KwaZulu-Natal Coastal Belt Grassland vegetation covering 29% of the land; and only 15% of the land comprised of KwaZulu-Natal Coastal Thornveld (site 4). According to the eThekwini Municipality (2007), collectively these vegetation types occupy almost two thirds of the Municipality, however, over the past several years significant proportions of these vegetation types have been transformed due to the expansion of urban settlements. Furthermore, the relatively undisturbed portions of these vegetation types are usually confined to land situated close to river systems (eThekwini Municipality, 2007). However, many of these river systems provide a water source/ supply particularly for informal settlements within the Municipality, hence people residing in these areas have often encroached on forests in an attempt to access the river in them (eThekwini Municipality, 2013). These statements were further validated by the Adapted typology (Table 4.42 and Table 4.43), which showed that the five forest sites

investigated were all classified as critically endangered and with considerable infringement on vegetation.

When data obtained for the indicators of threat and infringement status for forest green spaces using the Adapted typology (Table 4.42) was interpreted using the orthophotos for these sites (Figure 4.11), it was evident that these green spaces were exposed to the highest levels of infringement in comparison to the previous green space types assessed. However, paradoxically these forest sites also comprised the highest percentage of good and intermediate land relative to other ecosystem conditions, despite their susceptibility to the infringement pressures stated above. This trend can be explained using evidence from the social survey, which showed that a significant proportion of respondents' valued forests as important green spaces, expressing the imperative need to see these environments retained or conserved (section 4.3: Figure 4.5). Moreover, it was found that fewer respondents make use of forests, often because these environments are not always easily accessible, hence safeguarding these green areas to some extent (section 4.3: Table 4.13).

Research on this subject has shown that forest environments have become one of most protected biomes in the country (eThekwini Municipality, 2007; Mensah, 2014; Shackleton, 2006), which also explains why the sites which reflected the most intact (site 3) and intermediate (site 4) land, both fell under D'MOSS protection (Source for raw data: eThekwini Municipality, 2012). Furthermore, in KwaZulu-Natal, joint ventures between the eThekwini Municipality and Department of Water Affairs and Forestry have been undertaken to generate strict development guidelines on how to enhance the protection of forests within the province (eThekwini Municipality, 2007). In addition, the eThekwini Municipality has also implemented policies indicating that any development in the vicinity of forests requires a setback of no less than 40 m from the forest edge (eThekwini Municipality, 2007).

Table 4.44: Deviation index for selected forest sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies

0- No deviation, 1- Minimal deviation, 2- Moderate deviation, 3- High deviation

Site No.	Deviation index
1	3
2	3
3	0
4	1
5	0
Cumulative percentage deviation*	46.7%

$$*Cummulative\ percentage\ deviation\ of\ Adapted\ typology\ quality\ from\ eThwekini\ typology\ quality\ for\ forest = \left(\frac{Sum\ of\ site\ deviation\ scores\ (7)}{Maximum\ possible\ deviation\ (3) \times No.of\ \ sites\ (5)}\right) \times 100$$

The deviation indices calculated for the forest sites investigated (Table 4.44) revealed that three sites deviated from the classification defined by the eThekwini typology: high deviation was evident in sites 1 and 2, while site 4 showed minimal deviation. Only two sites (3 and 5) reflected no deviation from the eThekwini typology. In summary, the quality of the five forest green spaces assessed using the eThekwini typology collectively deviated by approximately 46.7% from that assessed using the more discriminatory Adapted typology. This is probably a reflection of the large tracts of intact and intermediate land identified in close proximity to urban settlements as evidenced in Figure 4.11.

Overall, it was evident that quality based land cover differed moderately when sites were compared using the eThekwini and Adapted typologies: some micro-habitats consisting of significant tracts of intact land within larger green environments were potentially misclassified when using the eThekwini typology. This is important to consider as forests are structurally diverse ecosystems harbouring many endemic species and species of high conservation value (Alvey, 2006; eThekwini Municipality, 2007). In addition, forests like woodlands play a critical role in carbon sequestration as they hold far greater carbon densities than other ecosystems (Alvey, 2006). Furthermore, these green spaces also have amenity value that adds to the aesthetics of eThekwini (eThekwini Municipality, 2007).

4.6.5. Grassland

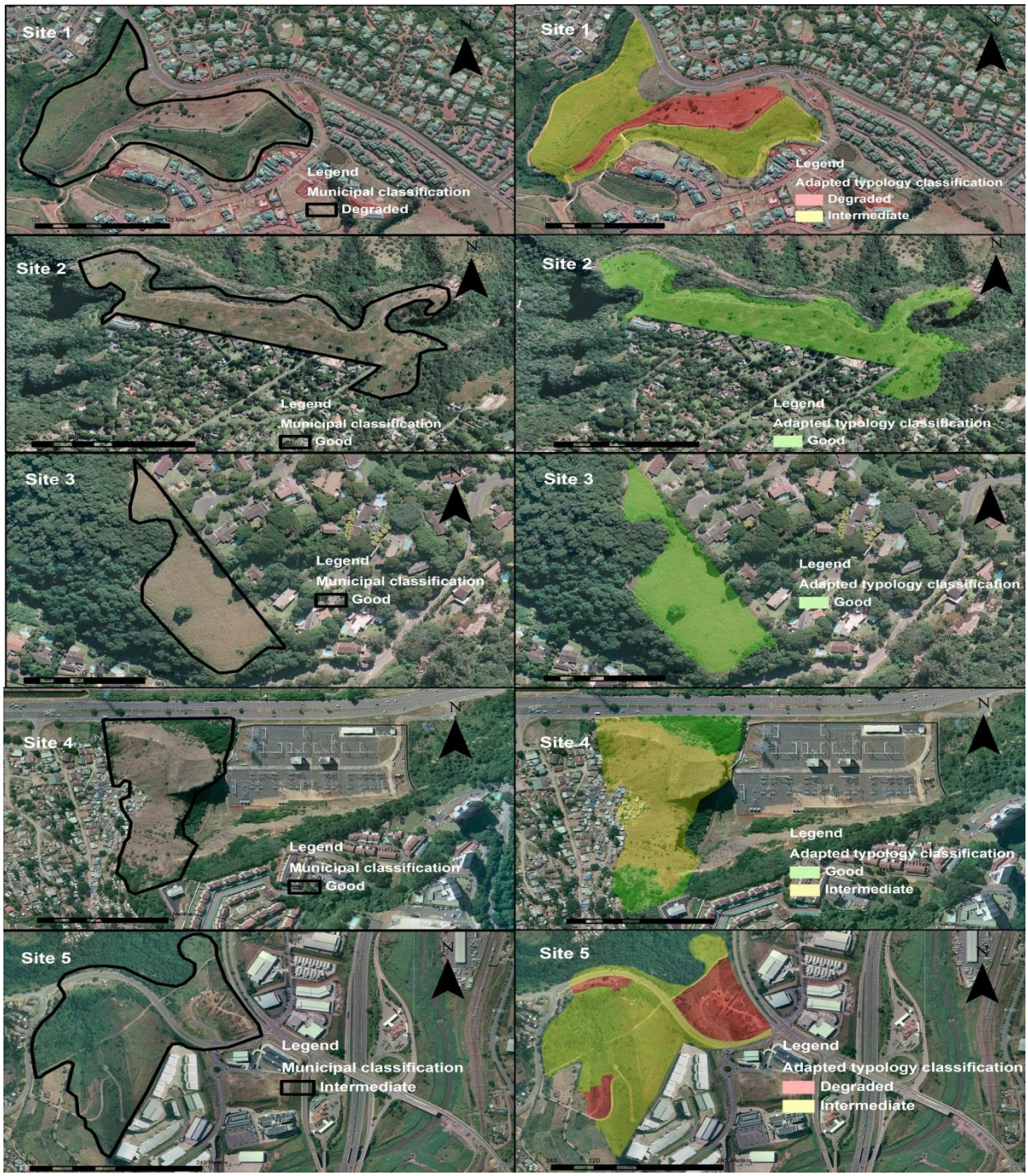

Figure 4.12: Comparison of the quality of green spaces within selected grassland sites using the eThekwini (left) and Adapted (right) typologies. <u>eThekwini typology criteria</u>: Degraded = majority (≥2/3) of site disturbed; Good = majority (≥2/3) of site in natural state; Intermediate = disturbance evident on >1/3 of site but <2/3 of site; Transformed = site completely transformed from natural state. <u>Adapted typology criteria</u>: Degraded = extensive degradation evident within site (>1/2 the area); Good = site appears mostly natural with little, to no, degradation evident; Intermediate = limited degradation evident within site (<1/2 the area); Transformed = site completely transformed from natural state. Coordinates of green space sites analysed given in Appendix B.

Table 4.45: Comparison of the quality of green spaces within selected grassland sites using the eThekwini and Adapted typologies

Site No.	eThekwini Municipality	Adapted typology				
	Classification and area (m^2)	Classification	Area (m^2) and percentage (%) relative to total site area		Habitat, vegetation type and ecosystem threat status	Infringement
1	Degraded (87,560.03)	Degraded	20,784.69	23.7*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Considerable
		Intermediate	66,775.34	76.3*		
2	Good (13,5958)	Good	13,5958	100*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Sandstone Sourveld Ecosystem threat status: Endangered	Considerable
3	Good (10,736.09)	Good	10,736.09	100*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Moderate
4	Good (34,274.88)	Good	9,165.79	26.7*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Considerable
		Intermediate	25,109.08	73.3*		
5	Intermediate (223,621.40)	Degraded	58,488.84	26.2*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Moderate
		Intermediate	165,132.56	73.8*		

*$\boldsymbol{Quality\ based\ land\ cover\ percentage} = \left(\frac{\boldsymbol{Area\ degraded/good/intermediate/transformed}}{\boldsymbol{Total\ area\ of\ site}}\right) \times \mathbf{100}$

Terminologies: 'Habitat' - habitat type of the site according to Swanwick *et al.* (2003) typology; 'Vegetation' - vegetation type of the site according to SANBI KwaZulu–Natal vegetation type classification (2011); 'Ecosystem threat status' - ecosystem threat status of the site according to the National Biodiversity Assessment (2011); 'Infringement' - the level of infringement on site from land-use activities.

When the quality of the five grassland sites considered above (Figure 4.12 and Table 4.45) was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for three sites (1, 4 and 5). It was for sites 2 and 3 that the quality classification was in agreement between the typologies. However, it must be noted that use of the Adapted typology resulted in the identification of more intermediate land than that reflected by the eThekwini typology; intermediate micro-environments were identified in three sites (1,

4 and 5). Use of the Adapted typology also led to the identification of less good land than that reflected by the eThekwini typology in site 4.

Table 4.46: Statistics incorporated into the Adapted typology calculated for all five grassland sites cumulatively

Land cover characteristic and categorisation		**Percentage land cover associated with specific habitat and vegetation type, threat status, and infringement categories***
Habitat type	Semi-natural habitats	100
Vegetation type	KwaZulu-Natal Coastal Belt Grassland vegetation	72.4
	KwaZulu-Natal Sandstone Sourveld vegetation	27.6
Threat status	Critically endangered land	72.4
	Endangered land	27.6
Infringement	Land with considerable infringement	52.4
	Land with moderate infringement	47.6

***Calculated as a percentage of the cumulative area of all the sites considered for this particular green space type (i.e. sum of the areas of the five sites sampled for grassland which was equivalent to 492,150.39 m^2)**

The quality based land cover percentages calculated for the five grassland sites as part of the Adapted typology (Table 4.45) should be interpreted in combination with the statistics shown in Table 4.46. The habitat type of the selected grassland sites were classified as semi-natural by both typologies but the use of the Adapted typology resulted in the identification of two vegetation types within this green space type: sites 1, 3, 4 and 5 consisted of KwaZulu-Natal Coastal Belt Grassland vegetation covering the majority of land (72.4%), while only 27.6% of the land comprised of KwaZulu-Natal Sandstone Sourveld (site 2).

These results (Table 4.45 and Table 4.46) show that the vegetation type, viz. KwaZulu-Natal Sandstone Sourveld, found in only one of the selected grassland sites (2) was classified as endangered whilst the vegetation type associated with the remaining sites, viz. KwaZulu-Natal Coastal Belt Grassland vegetation, was classified as critically endangered. This may be a reflection of the fact that large portions of KwaZulu-Natal Sandstone Sourveld have recently been placed under formal protection in private, provincial and municipal nature reserves, owing to the fact that very few untransformed patches of this vegetation type remain (eThekwini Municipality, 2007). This is further validated by the orthophotos shown in Figure 4.12, which

actually depicts site 2, which is located within the Kraantzkloof Nature Reserve (Source for raw data: eThekwini Municipality, 2012).

In terms of ecosystem threat status (Table 4.45 and Table 4.46), four sites (1, 3, 4 and 5) were classified as critically endangered covering the majority of the land assessed for this green space type (72.4%), while only site 2 was classified as endangered comprising 27.6% of the land. With regard to infringement (Table 4.45 and Table 4.46), three of the sites assessed (1, 2 and 4) were subject to considerable infringement covering 52.4% of the land, while site 3 and site 5 were subject to moderate infringement covering a slightly smaller proportion (47.6%) of the land.

Based on the above it is also important to incorporate the threat and infringement status in order to assess the quality of this green space type. When the data obtained for grassland green spaces using the Adapted typology (Table 4.45) was interpreted using the orthophotos for these sites (Figure 4.12), it was evident that large tracts of intact and intermediate land exist within the grassland sites investigated, however, these areas are exposed to higher levels of disturbance from both settlements and industry. Similar trends were evident in a study by Cilliers *et al*. (2004) who indicated that urbanisation has become increasingly responsible for the loss of biodiversity and fragmentation within grasslands. In South Africa many natural areas within the grassland biome have been disturbed by cultivation, livestock grazing and/ or unplanned fires, which have collectively eroded the biodiversity in a number of grassland sites (Cilliers *et al*., 2004). The literature also suggests that the conservation status of grasslands within the country is very poor, with a select few sites under formal protection (Cilliers *et al*., 2004; Neke and Du Plessis, 2004). Additionally, it should be noted that only the sites that fell under D'MOSS protection (sites 2 and 3) (Source for raw data: eThekwini Municipality, 2012) contained areas of intact green space.

Table 4.47: Deviation index for selected grassland sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies

0- No deviation, 1- Minimal deviation, 2- Moderate deviation, 3- High deviation

Site No.	Deviation index
1	3
2	0
3	0
4	3
5	1
Cumulative percentage deviation*	46.7%

$$*Cummulative\ percentage\ deviation\ of\ Adapted\ typology\ quality\ from\ eThwekini\ typology\ quality\ for\ grassland = \left(\frac{Sum\ of\ site\ deviation\ scores\ (7)}{Maximum\ possible\ deviation\ (3) \times No.of\ \ sites\ (5)}\right) \times 100$$

The deviation indices calculated for the grassland sites investigated (Table 4.47) revealed that three sites deviated from the classification defined by the eThekwini typology. There was high deviation evident in sites 1 and 4, while site 5 showed minimal deviation. Only two sites (2 and 3) reflected no deviation from the eThekwini typology. In summary, the quality of the five grassland green spaces assessed using the eThekwini typology collectively deviated by approximately 46.7% from that assessed using the more discriminatory Adapted typology. This is probably a reflection of the pockets of intermediate land identified in close proximity to settlements and industry as evidenced in Figure 4.12.

Overall, it was evident that quality based land cover differed moderately when sites were compared using the eThekwini and Adapted typologies. Some micro-environments of differentiated ecological integrity were potentially misclassified when using the eThekwini typology. The misclassification of large tracts of intermediate land could compromise the conservation and/ or restoration and management of a number of the grassland sites investigated here. This is important to consider given that literature has shown that grasslands are one of the South Africa's most threatened biomes, with very few of these environments left intact and/ or conserved in the country (Cilliers *et al*., 2004; Neke and Du Plessis, 2004).

4.6.6. Thicket

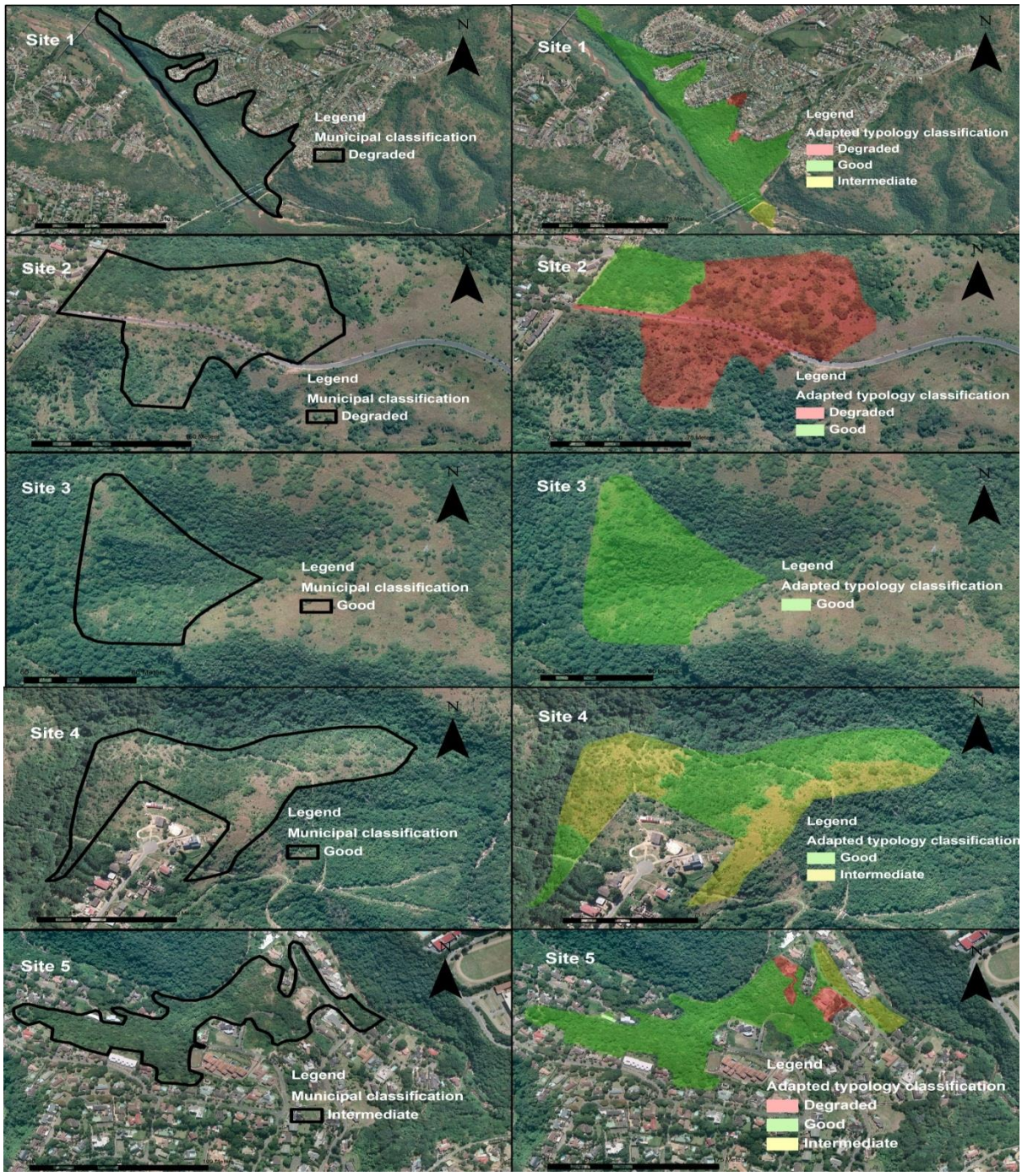

Figure 4.13: Comparison of the quality of green spaces within selected thicket sites using the eThekwini (left) and Adapted (right) typologies. <u>eThekwini typology criteria</u>: Degraded = majority (≥2/3) of site disturbed; Good = majority (≥2/3) of site in natural state; Intermediate = disturbance evident on >1/3 of site but <2/3 of site; Transformed = site completely transformed from natural state. <u>Adapted typology criteria</u>: Degraded = extensive degradation evident within site (>1/2 the area); Good = site appears mostly natural with little, to no, degradation evident; Intermediate = limited degradation evident within site (<1/2 the area); Transformed = site completely transformed from natural state. Coordinates of green space sites analysed given in Appendix B.

Table 4.48: Comparison of the quality of green spaces within selected thicket sites using the eThekwini and Adapted typologies

Site No.	eThekwini Municipality	Adapted typology				
	Classification and area (m^2)	Classification	Area (m^2) and percentage (%) relative to total site area		Habitat, vegetation type and ecosystem threat status	Infringement
1	Degraded (245,391.25)	Degraded	6,751.82	2.8*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Thornveld Ecosystem threat status: Critically endangered	Considerable
		Good	227,332.44	92.6*		
		Intermediate	11,306.99	4.6*		
2	Degraded (129,495.88)	Degraded	103,410.30	79.9*	Habitat type: Functional Vegetation type: KwaZulu-Natal Coastal Belt Grassland Ecosystem threat status: Critically endangered	Minimal
		Good	26,085.58	20.1*		
3	Good (26,428.02)	Good	26,428.02	100*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Thornveld Ecosystem threat status: Critically endangered	None
4	Good (47,645.33)	Good	23,379.59	49.1*	Habitat type: Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Thornveld Ecosystem threat status: Critically endangered	Moderate
		Intermediate	24,265.74	50.9*		
5	Intermediate (87,022.75)	Degraded	6,696.83	7.7*	Habitat type :Semi-natural Vegetation type: KwaZulu-Natal Coastal Belt Thornveld Ecosystem threat status: Critically endangered	Considerable
		Good	71,802.40	82.5*		
		Intermediate	8,523.51	9.8*		

*$\boldsymbol{Quality\ based\ land\ cover\ percentage} = \left(\frac{\boldsymbol{Area\ degraded/good/intermediate/transformed}}{\boldsymbol{Total\ area\ of\ site}}\right) \times \mathbf{100}$

Terminologies: 'Habitat' - habitat type of the site according to Swanwick *et al.* (2003) typology; 'Vegetation' - vegetation type of the site according to SANBI KwaZulu–Natal vegetation type classification (2011); 'Ecosystem threat status' - ecosystem threat status of the site according to the National Biodiversity Assessment (2011); 'Infringement' - the level of infringement on site from land-use activities.

When the quality of the five thicket sites considered above (Figure 4.13 and Table 4.48) was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for four sites (1, 2, 4 and 5). It was only for site 3 that the quality classification was in agreement between the typologies. However, it must be noted that use of the Adapted typology resulted in the identification of more good land than that reflected by the eThekwini typology; good micro-environments were identified in four sites (1, 2, 4 and 5). Moreover, use of the Adapted typology resulted in the identification of less degraded (sites 1 and 2) and intermediate (site 5) land than that reflected by the eThekwini typology; however, additional intermediate micro-environments were identified in two sites (1 and 4).

Table 4.49: Statistics incorporated into the Adapted typology calculated for all five thicket sites cumulatively

Land cover characteristic and categorisation		**Percentage land cover associated with specific habitat and vegetation type, threat status, and infringement categories***
Habitat type	Semi-natural habitats	100
Vegetation type	KwaZulu-Natal Coastal Belt Thornveld vegetation	75.8
	KwaZulu-Natal Coastal Belt Grassland vegetation	24.2
Threat status	Critically endangered land	100
Infringement	Land with considerable infringement	62
	Land with minimal infringement	24.2
	Land with moderate infringement	8.9
	Land with no infringement	4.9

***Calculated as a percentage of the cumulative area of all the sites considered for this particular green space type (i.e. sum of the areas of the five sites sampled for thicket which was equivalent to 535,983.22 m^2)**

The quality based land cover percentages calculated for the five thicket sites as part of the Adapted typology (Table 4.48) should be interpreted in combination with the statistics shown in Table 4.49.The habitat type of the selected thicket sites was classified as semi-natural by both typologies. Additionally, the Adapted typology showed that two different vegetation types occurred within this green space type: sites 1, 3, 4 and 5 consisted of KwaZulu-Natal Coastal Belt Thornveld vegetation covering 75.8% of the land, while 24.2% of the land (site 2) comprised of KwaZulu-Natal Coastal Belt Grassland, which is technically not thicket.

Nevertheless, these results (Table 4.48 and Table 4.49) show that the all the vegetation types, viz. KwaZulu-Natal Coastal Belt Thornveld and KwaZulu-Natal Coastal Belt Grassland, found in the selected thicket sites were classified as critically endangered. According to the eThekwini Municipality (2007), the remaining undeveloped portions of these vegetation types are usually confined to land located close to catchments. Additionally, significant proportions of these vegetation types have been/ are being subjected to high levels of transformation and degradation by settlements and, to a lesser extent, sugar cane farming within the eThekwini Municipality (eThekwini Municipality, 2007). When located in close proximity to settlements it is evident that these vegetation types represent a mosaic of patchy thicket vegetation and this

is further validated by the orthophotos shown Figure 4.13 (refer to sites 1, 2, 4 and 5 specifically).

In terms of ecosystem threat status (Table 4.48 and Table 4.49), all sites were classified as critically endangered. With regard to infringement (Table 4.48 and Table 4.49), two of the sites assessed (1 and 5) were subject to considerable infringement, collectively covering 62% of the land, while site 4 was subject to moderate infringement covering 8.9%. Site 2 was subject to minimal infringement covering 24.2% of the land and only a meagre 4.9% of the land (site 3) was considered to have no infringement on vegetation.

Based on the above it is also important to incorporate the threat and infringement status into an assessment of the quality of this green space type. When the data obtained for thicket green spaces using the Adapted typology (Table 4.48) were interpreted using the orthophotos for these sites (Figure 4.13), it was evident that large tracts of intact and intermediate thicket were identified in close proximity to settlements, as evidenced in the orthophotos shown Figure 4.13 (refer to sites 1, 4 and 5 specifically). Research on this subject has shown that in some instances the lack of accessibility of these green areas has been known to actually safeguard their ecological integrity (Lloyd *et al*., 2002; McConnachie *et al*., 2008). To elaborate, if these areas are not easily accessible this could potentially shield them or at the very least reduce their susceptibility to urban pressures. This also resonates with findings from the social survey which showed that respondents perceived sites that were relatively inaccessible to be of better quality or more intact (section 4.3: Figure 4.5).

Table 4.50: Deviation index for selected thicket sites: how much the quality of these green spaces differed between the Adapted and eThekwini typologies

0- No deviation, 1- Minimal deviation, 2- Moderate deviation, 3- High deviation

Site No.	Deviation index
1	3
2	1
3	0
4	2
5	3
Cumulative percentage deviation*	60%

$$*Cummulative\ percentage\ deviation\ of\ Adapted\ typology\ quality\ from\ eThwekini\ typology\ quality\ for\ thicket = \left(\frac{Sum\ of\ site\ deviation\ scores\ (9)}{Maximum\ possible\ deviation\ (3) \times No.of\ \ sites\ (5)}\right) \times 100$$

The deviation indices calculated for the thicket sites investigated (Table 4.50) revealed that four sites deviated from the classification defined by the eThekwini typology. There was high deviation evident in sites 1 and 5, while site 4 showed moderate deviation and site 2 minimal deviation. Only one site (3) reflected no deviation from the eThekwini typology. In summary, the quality of the five thicket green spaces assessed using the eThekwini typology collectively deviated by approximately 60% from that assessed using the more discriminatory Adapted typology. This is probably a reflection of the large tracts of intact and intermediate land present in close proximity to settlements as evidenced in Figure 4.13.

In relation to the above, it is worth noting that out of all the thicket sites analysed, only one site (2) was not under D'MOSS derestriction (Source for raw data: eThekwini Municipality, 2012). This may be reflective of the high conservation priority granted to the Thicket biome by the eThekwini Municipality (eThekwini Municipality, 2007). However, research has shown that only 5% of this biome is under formal conservation in the country as a whole and due to increasing urban pressures, large portions of thicket (even those under formal conservation) have become increasingly vulnerable to land transformation (eThekwini Municipality, 2007; Pote *et al.*, 2006). The data presented in this section (Table 4.48) have a bearing on this subject, as it was evident that quality based land cover differed moderately when sites were compared using the eThekwini and Adapted typologies, resulting in some green micro-habitats within

larger green spaces being potentially misclassified in terms of their ecological integrity when using the eThekwini typology. Furthermore, this infers that even within conserved environments such as the above (refer to sites 1, 4 and 5 specifically), there are minimally and moderately degraded and intermediate micro-habitats which either need to be restored and/ or better managed.

4.6.7. Summary for the collective spatial assessment of the quality of selected green spaces within the eThekwini Municipality

Table 4.51: Summary of key results of the six green space types investigated

Green space type	No. of sites that differed in quality classification between typologies	No. of D'MOSS sites	Infringement comments	Cumulative percentage deviation (%)
Settlement	4	2	Green spaces located in close proximity to settlements were exposed to higher levels of degradation than those situated further away which were more intact.	40
Tree crops	1	None	Tree crop sites in close to settlements were more prone to degradation. The majority of sites comprised of land that was classified as transformed.	13.3
Woodland	4	5	The woodland sites subjected to the highest level of degradation were considerably encroached upon by settlements.	46.7
Forest	3	2	The forest sites were exposed to the highest levels of infringement in comparison to the previous green space types assessed. However, paradoxically these forest sites also comprised the highest percentage of good and intermediate land relative to other ecosystem conditions, despite their susceptibility to the infringement pressures.	46.7
Grassland	3	2	Large tracts of intact and intermediate land exist within the grassland sites investigated, however, these areas are exposed to higher levels of disturbance from both settlements and industry.	46.7
Thicket	4	4	It was evident that large tracts of intact and intermediate thicket were identified in close proximity to settlements.	60

Table 4.51 provides a summary of key results of the six green space types investigated in this study. The following attributes are provided in the table which include: green space type; number of sites that differed in quality classification between typologies; number of D'MOSS sites; infringement comments and cumulative percentage deviation. The spatial analyses

revealed that the five thicket green space sites assessed using the eThekwini typology collectively deviated by approximately 60% (the highest cumulative deviation across all green space types analysed) from that assessed using the Adapted typology. Another interesting finding showed that none of the selected tree crop sites contained D'MOSS areas, while the woodland and thicket sites investigated comprised the most D'MOSS areas. Additionally, the results indicated that green space sites in close proximity to settlements and industry were found to have higher levels of degradation than those situated further away which were more intact. These aspects are explained in greater detail in the next chapter (see section 5.2.2 in Chapter Five).

4.7. Conclusion

This chapter summarised the main findings emanating from both primary and secondary data pertaining to green spaces investigated in this study. Overall, the social results showed that there is a tremendous support for the retention, maintenance, and in some cases creation, of green spaces amongst the respondents. However, the results of the social survey also suggest that there are still numerous challenges that need to be addressed in order to optimise user benefits derived from these spaces. It was evident that respondents' opinions with regard to maintenance, upkeep and value of green spaces are heterogeneous. Additionally, it was found that selected socio-demographic variables (namely, gender, education and income) of the study population had a limited influence on certain aspects of respondents' uses and perceptions of green spaces. In terms of the spatial analyses, the results revealed that selected green spaces within the Municipality when classified using the more discriminatory Adapted typology, can be shown to contain micro-habitats that are either more degraded or more intact than that reflected by the typology presently used by the eThekwini Municipality. Identification of these incidences of land quality misclassification and an appreciation of vegetation and habitat type, threat and infringement status may improve the conservation and management strategies for the various green space types investigated here. Close proximity to settlements, in particular, were shown to have highly detrimental effects on land quality across most of the green spaces types assessed. The findings from the socio-spatial studies discussed in this chapter were in turn used to draw some preliminary conclusions and recommendations on green space quality assessment and management in the eThekwini Municipality and these are featured in the following chapter.

CHAPTER FIVE: CONCLUDING REMARKS AND RECOMMENDATIONS

5.1. Introduction

Over the past 20 years research on urban green spaces has flourished, covering topics such as urban green space design, uses and values as well as urban environmental quality (Byrne and Sipe, 2010; Cilliers *et al.*, 2013). However, most literature on the subject is generally case specific and very seldom characterised by a multi-disciplinary approach. The central objective of this study was to examine the quality/ integrity and value of green spaces within the eThekwini Municipality in relation to resident perceptions and land-use patterns, in an attempt to forward recommendations on the conservation and management of these spaces. As explained in Chapter Three, the study adopted a multi-disciplinary approach to address the research objectives outlined in Chapter One. This chapter provides a summary of the key findings emanating from the study in relation to the research objectives and thereafter presents recommendations on urban green space conservation and management and future research considerations and approaches.

5.2. Summary of the results and key research findings in relation to the objectives

5.2.1. To examine social perspectives on the value and use of green spaces within the eThekwini Municipality using areas surrounding the Bluff Conservancy (all situated within the SDA) as illustrative examples

In order to assess the social perspectives on the use and value of green spaces within the eThekwini Municipality, the following aspects were considered: socio-economic and demographic characteristics of respondents, respondents' uses and perceptions of urban green spaces, environmentally-friendly practices of respondents and respondents' awareness and perception of the D'MOSS programme.

5.2.1.1. Socio-economic and demographic characteristics of respondents

Understanding the socio-economic and demographic characteristics of the sampled population was a necessary exercise as numerous studies (as indicated in the literature review) emphasise the importance of examining these variables when evaluating human-nature relations. The

results obtained here showed that the study population comprised of an almost equal proportion of males to females, who were predominantly young to middle-aged individuals. Over half the households surveyed comprised of one to three persons. Furthermore, the majority of the respondents were educated (completed secondary level of education and above) and employed. However, definite variations were evident in respondents' total household monthly income, indicative of a mix of socio-economic strata (low, middle and high income earners) within the sampled population.

5.2.1.2. Respondent uses and perceptions of urban green spaces

The way in which people perceive urban green spaces can significantly influence their behaviour (negatively or positively) towards green areas (Budruk *et al*., 2009; Dinnie *et al*., 2013; Pillay and Pahlad, 2014). Therefore, this study assessed respondents' perspectives on the uses and values of their surrounding green spaces. It was found that even though there was little agreement amongst respondents' in terms of their interpretation of urban green spaces within their community and the eThekwini Municipality, a common understanding of nature was evident in their responses irrespective of social status. In general, significant proportions of respondents gave more consideration towards parks, sports fields, golf courses, gardens, nature reserves and mangroves/ swamps as green spaces. When interrogated further, these results also suggest that respondents' recognition of these green spaces could be linked to their aesthetics, amenities and value use. Additionally, it was evident that selected socio-demographic variables (gender, education and income in particular) had a limited influence on what respondents considered to be green spaces within their community and the eThekwini Municipality.

Other findings showed that the majority of respondents reside in close proximity to a range of green space types within the study area and make use of them. Research has shown that residents who live close to, and are given access to, green spaces will interact with them (Priego *et al*., 2008; Schipperijn *et al*., 2010). However, it should be noted that respondents' use of green spaces was not dependent on their gender and income but was significantly influenced by their educational level. It was also found that respondents with a higher level of education tend to make more use of green spaces.

Another interesting finding was that respondents who chose not to make use of their surrounding green spaces indicated safety and security, time constraints and no interest as the most preventative factors, which were also identified in the literature as constraining factors, limiting the use of these areas (Jim and Chen, 2006; Perry *et al*., 2008; Schipperijn *et al*., 2010). On the other hand, the respondents who engaged and interacted with these green areas favoured the use of recreational and social green spaces (parks, sports field, nature reserve and the golf course) within their communities and frequently used them. This can be attributed to the close proximity or rather easy accessibility of a wide range of green spaces within the urban matrix in which the respondent households are situated. Additionally, the results indicated that the majority of respondents' motives for using green spaces appealed to the social dimension of the environment and are associated with social interaction, recreation, relaxation and contact with nature. The conclusion that can be drawn here is that respondents preferred using green spaces that contribute to an improved quality of life.

In terms of the green space resources respondents would like to access, the results showed that the majority of the respondents would like to access ecological (for example, fruit and medicinal plants) and social (for example, recreational spaces and green trails and pathways) resources within green spaces in their community. Furthermore, it was found that a large proportion of the respondents wanted increased access to green spaces and that their desire to have increased access to green spaces was not significantly influenced by socio-demographic variables like gender, education and income. Additionally, results showed that the majority of respondents desired increased access to green spaces that appeal to the social dimension of the environment (parks, gardens, nature reserves and sports fields), which correlated with previous findings pertaining to the types of green spaces respondents use and their motives for using urban green spaces. Moreover, it was evident that most respondents, if granted more access, would like these spaces located within their community. It was also noted that the type of green spaces that respondents wanted increased access to was very rarely dependent on socio-demographic variables like gender, education and income.

With regards to respondents' level of agreement with specific statements pertaining to urban green spaces within their community, it was evident that respondents generally expressed more positive than negative views on green spaces, which bodes well for respondents' potential impact on green spaces and conservation efforts within the area (Schipperijn *et al*., 2010; Wright Wendel *et al*., 2012). Additionally, results showed respondents' perceptions regarding

the safety and security of green spaces within their community to be significantly gender dependent. Moreover, income was shown to significantly influence respondents' perceptions related to maintenance and quality concerns of these green spaces. In terms of the main challenges associated with green spaces within the community, respondents identified pollution (air pollution in particular) as the foremost challenge. In addition, dumping, lack of maintenance, safety and security and insufficient land allocated to green areas, were also found to be key concerns respondents associated with green spaces.

The results showed that respondents identified more negative than positive changes to green spaces within their community. Furthermore, many of the changes observed reflected similar findings in relation to some of the major challenges they perceived to be faced by green areas. Most importantly, it was noted that more respondents perceived a decrease rather than an increase in the quantity and quality of green spaces.

Results pertaining to respondent views on how the selected green spaces within the study area should be used, showed that the majority of the respondents would like to see these green areas improved and maintained. These perceptions relate to the social quality (maintenance, aesthetics, recreation and crime) of green spaces which were also indicated in the literature as a key apprehension among residents in terms of their use of these areas (Jim and Chen, 2006; Perry *et al*., 2008). Another noteworthy finding was that a significant proportion of respondents felt that the selected green spaces should either be retained as is, or conserved. This suggests that respondents value their surrounding green areas and would like to see them protected for future use. Furthermore, analysis of the data showed that while gender and education have no significant influence on respondent views on how green spaces within the study area should be used, respondent views on how coastal forest should be used was dependent on income. In this regard, a large proportion of respondents in higher income groups (>R30,000) would like to see coastal forest either improved and maintained, or conserved. It was also interesting to note that the majority of the respondents indicated they would like to see additional green spaces within the study area. Moreover, leading on from the above it was evident that respondents showed commonalities in their desire for additional green spaces in areas that already have large green spaces. Additionally, respondents perceived that it was not ideal to locate additional green spaces close to built areas. Overall, results showed that respondents are quite satisfied with the quality of green spaces in the study area and the eThekwini Municipality. In summary,

these findings suggest that the majority of the respondents exhibit an intrinsic relationship with these green areas and acknowledge their social and ecological benefits.

5.2.1.3. Environmentally-friendly practices of respondents

Environmentally-friendly practices followed by residents are an important component to consider when investigating human-nature relationships (Steg and Vlek, 2009). This study assessed the environmentally-friendly practices respondents engage in. Results showed that with the exception of reuse of water, water harvesting and composting of home waste, significant proportions of the respondents indicated that they often engage in numerous environmentally-friendly practices (for example, recycling, conserving electricity, planting of trees/ vegetation and proper disposal of waste). However, it must be noted that around a third of the respondents indicated that they dump waste in green spaces within the study area, suggesting that this is also an environmental concern within the area. Nevertheless, overall it was evident that the majority of respondents are environmentally conscious; a factor which bodes well for respondents' behaviour towards green spaces as well as environmental quality and quality of life within the study area.

5*.2.1.4. Respondents awareness and perceptions of the D'MOSS programme*

The Durban Metropolitan Open Space System is the flagship conservation programme of the eThekwini Municipality (eThekwini Municipality, 2012), which calls for the formal creation and preservation of green spaces. The results obtained here though, showed that the vast majority of the respondents were unaware of the D'MOSS programme. This suggests that even though respondents understand the importance of green spaces and are supportive of their maintenance and/ or expansion, they are clearly unaware of the major programme designed to achieve these ends within the Municipality. Moreover, it was found that respondents who were familiar with D'MOSS were most aware of the fact that the programme sought to protect the environment and increase conservation awareness. However, the respondents were less aware of D'MOSS objectives that speak to more complex and/ or specific goals. Additionally, findings revealed that among respondents who were aware of D'MOSS, many were not fully satisfied with the current standing/ state of the D'MOSS programme and its specific objectives, with a significant proportion of respondents also indicating that the programme's efficacy may be improved by enhancing awareness around it.

5.2.2. To assess the appropriateness of the typology presently used by the eThekwini Municipality to describe the status of green spaces

This aspect of the study firstly assessed the integrity of selected green spaces within the Municipality in relation to land-use patterns. A spatially-based assessment of green space quality was conducted on selected spaces within the following types: settlements, tree crops, woodland, forest, grassland and thicket. The quality assessment of these spaces generated using this Adapted typology (developed for this study) was then compared to existing quality assessments based on the eThekwini typology (used by the eThekwini Municipality).

5.2.2.1. Settlements

The results showed that when the quality of the five selected settlement sites was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for four sites. Additionally, analysis of the selected settlement sites found that green spaces located in close proximity to settlements were exposed to higher levels of infringement and had definite areas that were degraded or transformed, compared with sites situated further away, which were more intact. Another interesting finding was that the settlement green space sites most exposed to degradation and transformation were not under D'MOSS protection (Source for raw data: eThekwini Municipality, 2012), which could explain their relatively poorer quality. Larger areas of intact green space were found further away from the settlements and were not exposed to any infringement. This was attributed to the fact that these particular sites were designated by the eThekwini typology as nature reserves and most often also fell under D'MOSS protection (Source for raw data: eThekwini Municipality, 2012). The deviation indices (see section 3.6.2 in Chapter Three for explanation) calculated for the settlements sites investigated revealed that four sites deviated from the eThekwini typology. Overall, it was evident that the quality of settlement green spaces differed moderately between assessments made using the eThekwini and Adapted typologies. This has potentially resulted in some green micro-habitats within larger green spaces being misclassified in terms of their quality as a consequence of using the eThekwini typology and possibly not being prioritised for conservation and/ or restoration.

5.2.2.2. Tree crops

The results showed that when the quality of the five tree crop sites investigated was compared between the Adapted and eThekwini typologies, the quality classification only differed between typologies for one site. In addition, it was found that tree crop sites in close proximity to settlements were more prone to degradation than those situated further away. This correlated with findings described for settlement green spaces (described above), which also showed that green areas located close to settlements were exposed to higher levels of infringement and where characterised by areas that were evidently degraded. Another interesting finding, was that the majority of tree crop sites assessed comprised of land that was classified as transformed. However, this was not necessarily indicative of poor green spaces quality as tree crops are commercial land entities (Sanchez and Leakey, 1997; Verlarde and Tomich, 2006), i.e. the land has been transformed to grow vegetation. The deviation indices calculated for the tree crop sites investigated revealed that only one site deviated from the classification given by the eThekwini typology. Overall, it was evident that quality based land cover differed minimally between the eThekwini and Adapted typologies.

5.2.2.3. Woodland

The results showed that when the quality of the five selected woodland sites was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for four sites. Furthermore, it was evident that the woodland sites under investigation all fell under D'MOSS protection (Source for raw data: eThekwini Municipality, 2012). Woodland sites in close proximity to settlements were severely encroached upon and more prone to degradation and transformation, than those situated further away. This resonated with evidence from the social survey pertaining to the vulnerability of green spaces in close proximity to residential areas. The deviation indices calculated for the woodland sites investigated revealed that classifications for four sites deviated between the typologies. Overall, it was evident that quality based land cover differed moderately when sites were compared using the eThekwini and Adapted typologies. Some micro-habitats of differentiated ecological integrity could therefore have been potentially misclassified when using the eThekwini typology; the implication of this misclassification is that these micro-habitats could possibly be inadequately/ inappropriately prioritised for conservation and/ or restoration.

5.2.2.4. Forest

The results showed that when the quality of the five selected forest sites was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for three sites. Additionally, it was evident that the forest sites were exposed to the highest levels of infringement, in comparison to the other green space types assessed. However, paradoxically these forest sites also comprised the highest percentage of good and intermediate land relative to other ecosystem conditions, despite their susceptibility to infringement pressures. This trend was explained using evidence from the social survey, which showed a significant proportion of respondents' valued forests as important green spaces, expressing the imperative need to see these environments retained or conserved. It was also noted that the sites which reflected the most intact and intermediate land, both fell under D'MOSS protection (Source for raw data: eThekwini Municipality, 2012). The deviation indices calculated for the forest sites investigated revealed that three sites deviated from the eThekwini typology. Overall, it was evident that quality based land cover differed moderately when sites were compared using the eThekwini and Adapted typologies: some micro-habitats consisting of significant tracts of intact land within larger green environments were therefore possibly misclassified when using the eThekwini typology. This implies that patches of these structurally diverse ecosystems, which harbour many endemic species and species of high conservation value (Alvey, 2006; eThekwini Municipality, 2007), may possibly be inadequately/ inappropriately managed.

5.2.2.5. Grassland

The results showed that when the quality of five selected grassland sites was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for three sites. It was evident that large tracts of intact and intermediate land exist within the grassland sites investigated, however, these areas are exposed to higher levels of disturbance from both settlements and industry. Additionally, it was noted that only the sites that fell under D'MOSS protection contained areas of intact green space. The deviation indices calculated for the grassland sites investigated revealed that three sites deviated from the classification defined by the eThekwini typology. Overall, it was evident that quality based land cover differed moderately when sites were compared using the eThekwini and Adapted typologies. Some micro-environments of differentiated ecological integrity were therefore possibly misclassified

when using the eThekwini typology; the misclassification of large tracts of intermediate land could potentially compromise the conservation and/ or restoration and management of a number of the grassland sites investigated.

5.2.2.6. Thicket

The results showed that when quality of the five selected thicket sites was compared between the Adapted and eThekwini typologies, the quality classification differed between typologies for four sites. Furthermore, it was evident that large tracts of intact and intermediate land were identified in close proximity to settlements within the thicket sites investigated. In addition, of all the thicket sites analysed, only one site was not under D'MOSS protection (Source for raw data: eThekwini Municipality, 2012). This was possibly reflective of the high conservation priority granted to the Thicket biome by the eThekwini Municipality (eThekwini Municipality, 2007). The deviation indices calculated for the thicket sites investigated revealed that four sites deviated from the classification defined by the eThekwini typology. Overall, it was evident that quality based land cover differed moderately when sites were compared using the eThekwini and Adapted typologies, resulting in some green micro-habitats within larger green spaces being potentially misclassified in terms of their ecological integrity when using the eThekwini typology. As with the other green spaces types, these misclassified micro-habitats may therefore be inadequately/ inappropriately managed.

5.3. Recommendations

The combination of results obtained in this study is used here to address the final objective of this study, which is to generate recommendations for the conservation and management of green spaces within the eThekwini Municipality. More specifically, the recommendations made are designed to provide useful information that can aid the eThekwini Municipality and urban planners to increase user benefits of green spaces as well as enhance the conservation, management and longevity of green spaces within the Municipality.

5.3.1. Recommendations to increase user benefits of urban green spaces

The analysis of data from this study has shown that the integration of resident perceptions with the ecological values of green spaces is paramount to achieving an integrated sustainable urban

landscape. Furthermore, Whitmarsh (2009) states that understanding local residential use of green spaces provides local municipalities with vital information when determining which areas should be given more attention as well as when considering the expansion of these spaces. An important recommendation is therefore that the eThekwini Municipality should increase the number of green spaces, preferably within densely populated communities as well as improve existing greenery within the city. Furthermore, the Municipality needs to adopt management strategies that not only conserve green spaces but also mechanisms to make communities aware of the benefits of green spaces and how they can access these benefits. In addition, these areas should be made more accessible and useable, and have value added benefits to communities who are intrinsically supporting them. Roberts *et al*. (2012) support this notion by suggesting that as eThekwini continues to urbanise, the continual provision and expansion of green spaces within the city can be seen as an important adaptation tool, replacing the need for certain infrastructure, as these spaces offer numerous ecological and social services to both residents and nature.

Secondly, the findings reveal that respondents chose to interact most with green spaces that appeal to the social dimension of the environment, warranting the need for more aesthetically pleasing and functional green areas which also contribute to the quality of the environment and human life within the area. Moreover, these green spaces should also provide numerous benefits at lower personal cost (for example, financial, time and distance), as research has shown that these areas are likely to attract more users, thus improving human health and well-being within communities (Mell, 2010; Priego *et al*., 2008; Schipperijn *et al*., 2010).

Importantly, the data collected via the social survey suggests the imperative need for a greater dissemination of environmental education and awareness on green spaces and the D'MOSS programme to communities within the Municipality. The Municipality should consider hosting open seminars and public events educating communities on the importance of their surrounding green spaces and objectives of the D'MOSS programme. As Raymond *et al*. (2010) assert, environmental education initiatives can significantly influence people's behaviour towards urban green spaces in a positive manner, promoting the longevity of these areas. Moreover, studies have shown that in reality socio-economic development, particularly in terms of education and income, can improve people's awareness and value given to the green environment (Raymond *et al*., 2010, Shan, 2014). Therefore, the Municipality should also improve the socio-status of residents by creating more employment opportunities thus allowing

people to provide for their families, prompting education, which can lead to improved awareness and perception of urban green spaces (Shan, 2014).

A fourth recommendation is related to safety issues and the condition (maintenance and facilities) of certain green spaces within the eThekwini Municipality. These pressing concerns warrant the need for the Municipality to improve security measures within these green spaces. For example, local authorities should be asked to assist by patrolling these areas or staff should be employed to specifically monitor them. Facilities such as lavatories (for men and women) and playgrounds for children with proper lighting are possible additions that could improve their quality and enhance their appeal. An improvement in terms of the quality of the environment is a critical factor not only for human well-being, but also to protect green spaces because it impacts on the perceptions of, and desirability for, green spaces in a community (Maas *et al*., 2009; Priego *et al*., 2008; Schipperijn *et al*., 2010). Furthermore, another concern that requires attention is that of dumping. Municipal officials need to impose punitive measures (for example, fines) that discourage people from dumping in open green areas. The issues mentioned above need to be addressed and remedied in order to obtain a higher standard of urban greenery. Maas *et al*. (2009) agree that mitigating these concerns can lead to the improved quality, perception and longevity of green spaces within cities.

In addition, findings from the social survey indicate that people's perceptions of urban green spaces are heterogeneous. Therefore, in order to capture this evidently diverse understanding of the social order of urban dwellers and their values and perceptions in relation to urban green spaces, it is recommended that future studies survey a larger sample population, possibly incorporating multiple communities from different socio-economic strata.

5.3.2. Recommendations for urban green space conservation and management within the eThekwini Municipality

While recognising the relevance of this study in the wider context of urban green spaces, the particular circumstances of eThekwini and its spatial context should also be noted (see section 4.6 in Chapter Four). In this sub-section recommendations are forwarded for the conservation and management of urban green spaces within the eThekwini Municipality.

The spatial analysis of selected green spaces within the Municipality classified using the more discriminatory Adapted typology reflected a more nuance description of green spaces, ensuring that quality characteristics are incorporated into the assessment of the these environments. Furthermore, the analysis of these green spaces using the Adapted typology revealed incidences of land quality misclassification that resulted in the identification of micro-habitats that are either more degraded or more intact than that reflected by the eThekwini typology. According to Van Herzele and Wiedemann (2003), GIS applications such as those employed in the Adapted typology are useful when designing new strategies to approach urban greening. The benefit of adopting a typology such as the Adapted typology developed and assessed as part of this study is that it facilitates a systematic breakdown and more detailed status of green spaces. This is achieved by generating a detailed assessment of the quality and full range of differentiated landscapes/ levels of ecological integrity that occur within these environments. Moreover, the Adapted typology permits a system that categorises these green spaces in their entirety (Swanwick *et al*., 2003), producing a quantitative and qualitative inventory of all the micro-habitats within them. Additionally, the spatial approach used in this study can potentially assist in further describing the key attributes of urban green spaces within the Municipality, ensuring that a variety of qualities/ characteristics are provided which may aid in green space planning and management efforts within the city.

This is important to consider, especially in a rapidly growing city such as eThekwini, which is plagued by the imminent threat of resource scarcity (Roberts *et al*., 2012). Therefore, in consideration of the discussion above, it is recommended that the eThekwini Municipality reassess the typology used to assess green space quality within the city. The restoration or enhancement of polarised sub-environments should be advocated by the Municipality, as this can potentially improve the ecosystem functions (particularly as a climate mitigation service) and human benefits derived from these existing green spaces. Furthermore, in order to enhance greenery within eThekwini and identify opportunities for enhanced conservation, it is recommended that the Municipality not only look to create and maintain open spaces, but devote more attention towards green open spaces of ecological value. Similar approaches have been utilised in the cities of Nanjing and Copenhagen (Bilgili and Gökyer, 2012). These cities have looked to integrate a network of conserved green spaces around which development can occur (Bilgili and Gökyer, 2012).

It is important to note though, that the sample size of green spaces used to calculate the deviation indices presented in this study is particularly small. However, the deviation percentages calculated indicate that there is definitely significant deviation from the existing eThekwini typology, necessitating a more widespread analysis that incorporates more of the green spaces within the eThekwini Municipality. In addition, this study looked at the *status quo* of selected green spaces at a given time. It is recommended that future studies use a temporal analysis which may help urban planners to understand why certain green spaces have remained more intact than others and to predict future changes for these spaces.

It should also be noted that the use of spatial tools, such as GIS, alone may be insufficient to adequately evaluate the integrity of urban green spaces. Findings from this study indicate that it is not sufficient to manage green spaces in urban settings which are relatively small and have very high value using a generic approach. This is especially true for rapidly developing cities like eThekwini in which certain green spaces have become a burden (Perry *et al*., 2008) and are actually hampering development. This suggests a need for higher level analyses when assessing and designing management strategies for green spaces, using both spatial tools (use of remote sensing to discriminate between vegetation and buildings), social surveys and ground-truthing to evaluate and understand the integrity of green spaces (Otunga *et al*., 2014). An inter-disciplinary approach to green space management such the one recommended here can create more robust classifications of urban green spaces and more location- and context-specific management plans.

5.4. Concluding remarks

In an era of increasing urbanisation, understanding the dynamics of human-nature relationships has become more important than ever. This has sparked a global emphasis on the preservation and expansion of urban green spaces in the planning and development of cities (Tan *et al*., 2013). Additionally, both planners and scholars have become noticeably more aware of the role urban green spaces play in mitigating the mounting challenges of urbanisation. In recognising the need to improve the management of green spaces within urban environments such as eThekwini, this study aims to show the importance of integrating social and spatial aspects in understanding the use, value and quality of urban green spaces.

Using a combination of social and spatial analytical methods in combination with the vast literature on the functionality and management of urban green spaces, this study also illustrates the interactions between green spaces and the social landscape within eThekwini. In this regard, perceptions and behaviour, either positive or negative, impact on the quality and preservation of urban green spaces (Jim and Chen, 2006). Overall, it is abundantly clear that the respondents in this study emphatically support the creation and maintenance of green spaces within their community and the Municipality. However, respondents also identified numerous challenges which are hampering the quality and perceptions of green spaces within their community. The fact that people perceive a green space to be of poor quality, can actually add to its degradation, as perceptions can inform the behaviour of people (Jim and Chen, 2006; Schipperijn *et al*., 2010). In terms of the classification of urban green spaces it is evident that resident perceptions agree with patterns revealed by the spatial analysis included in the more nuanced Adapted typology developed and assessed in this study.

Furthermore, this study also showed that in order to enhance urban greenery, future planning efforts need to be diversified in their methods such that they accommodate for differentiated levels of ecological integrity within various landscapes. The vision for planners or future researchers should be informed by a critical evaluation of the status (quality/ integrity) of green spaces, acknowledging their value to the people and natural environment, whilst also innovating ways to maximise and access their benefits.

To conclude, this study contributed to the growing body of literature on urban green spaces, supporting the evidence that these spaces play a vital role in shaping a sustainable urban landscape. Additionally, the methodological approach adopted in the study and the Adapted typology developed can be adapted for, and applied to, other cities.

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APPENDIX A: URBAN GREEN SPACE QUESTIONNAIRE

Good day, I am undertaking a survey of green spaces within your community on behalf of a student, Mr Sarushen Pillay for his Masters degree at the University of KwaZulu-Natal. May I ask you a few questions in this regard? Your answers will be treated confidentially and anonymously. If at anytime during the interview you do not wish to continue, please feel free to do so. Thank you for your participation.

Section A: Demographic profile of respondents

A1.Gender (Note, do not ask):

1. Male	2. Female

A2. Age (in years) _____

A3. How many persons currently reside in your household?_____

A4. What is your highest level of education completed?

1.None	2. Primary school	3. Secondary school	4. Certificate/Diploma	5. Undergraduate degree	6. Postgraduate degree	7.Other, specify

A5.What is your employment status?

1 Employed	2. Unemployed	3. Self-employed	4. Retired	5. Medically boarded	6. Student	7.Other, specify

A6.What is your current occupation?

1. Labourer/unskilled	2. Sales/marketing	3. Administrator	4. Business person	5. Professional	6. Artisan/technician	7.Housewife
8.Student	9. Other, specify					

A7. What is the total household monthly income (in Rands)?

1.Don't know	2. <1000	3. 1000-2000	4. 2000-4000	5. 4000-6000	6. 6000-8000	7. 8000-10000	8.10000-12000	9.>12000, specify

Section B: Respondents use and perception of urban green space

B1. What in your opinion does green space mean?_____

B2. What do you consider to be green spaces in your community and the eThekwini Municipality? (Multiple responses permitted)

	Community	eThekwini Municipality
1.None		
2.Parks		
3.Sports fields		
4.Race courses		
5.Golf courses		
6.Gardens		
7.Cemeteries		
8.Nature reserves		
9.Farmland		
10.Forests		
11.Mangroves/swamps		
12. Other, specify		

B3. Please indicate the green space that you live closest to. (Multiple responses permitted)

1.None	2.Park	3. Sports field	4. Cemetery	5. Nature reserve	6.Golf course
7.Private garden	8.Forest	9.Other,specify			

B4. Do you make use of green spaces within your community?

1.Yes	2.No

B5. If no or do not use them regularly, what prevents you from doing so?

(Multiple responses permitted)

1.Not interested	2.Safety and security	3.Transport	4.Distance
5.Time constraints	6.Health concerns	7.Other, specify	

B6. If yes, which do you make use of? (Multiple responses permitted)

1.Park	2. Sports field	3. Cemetery	4. Nature reserve	5.Golf course
6.Private garden	7.Forest	8.Other, specify		

B7. If yes, how often do you make use of them?

1.Very often	2.Frequently	3.Seldomly

B8. If yes, what do you use green spaces within your community for? (Multiple responses permitted)

1.Gather resources	2. Physical, emotional and spiritual well-being	3. Recreational and leisure	4. Socialising	5. Educational resource
6.Gardening/land for agricultural use	7.Other, specify			

B9. Would you like to have access to the following resources in your green spaces?

	Yes	No
1.Fuelwood		
2.Wood for household construction		
3.Wood for other household use		
4.Fruit		
5.Medicinal plants		
6.Water from wetland/river/borehole		
7.Recreational spaces		
8.Green trails and pathways		

B10.Would you like to have more access to green open spaces?

1.Yes	2.No

B11.If yes, what type? (Multiple responses permitted)

1.Parks	2. Sports fields	3.Gardens	4. Nature reserves	5.Golf course
6.Race course	7.Other, specify			

B12. Where should they be located? (Multiple responses permitted)

1. In close proximity to my house	2. In the community	3. In neighbouring communities	4.Anywhere in eThekwini

B13. Please rate your level of agreement with the following statements with regard to green spaces within your community:
1-Strongly disagree, 2-Disagree, 3-Neutral, 4-Agree, 5-Strongly agree

	1-Strongly disagree	2-Disagree	3-Neutral	4-Agree	5-Strongly agree
a. Green spaces within my community are clean and well maintained					
b. Air pollution decreases the quality of green space within my community					
c. Green spaces within my community create a sense of identity					
d. Green spaces within my community provide neighbour-social interaction					
e. Green spaces within my community are quiet and peaceful					
f. Green spaces within my community are easily accessible					
g. Green spaces within my community have adequate facilities					
h. Green spaces within my community are unsafe and harbour criminals					
i. Green spaces within my community allow people to interact with nature					
j. The quality of the natural environment increases the price of houses within my community					
k. There is lack of knowledge regarding green spaces					

B14. What would you say are the main challenges regarding green spaces within your community? (Multiple responses permitted)

1.None	2.Insufficient land allocated for green space	3. Lack of maintenance	4.Dumping	5. Pollution	6.Poor security
7.Crime	8.Harresment	9.Vandalism	10.Anti-social behaviour	11.Presence of stray animals	12.Other, specify

B15. If pollution, what type of pollution is the main threat?

1.Air	2.Water	3.Ground

B16. Over the last 5 years what changes have you observed regarding green spaces within your community? (Multiple responses permitted)

1.None	2.Housing development	4.Pollution/dumping	5.Increase in alien invasive plants	5.Decrease in quality	6.Decrease in quantity
7.Poor maintenance	8.Decrease in pollution/dumping	9.Decrease in alien invasive plants	10.Improved maintenance	11.Increase in quality	
12.Increase in quantity	12.Other, specify				

B17. Here is a map of your area, how do you think the following green spaces should be used?

	1.Retained as is	2.Improved and maintained	3.Conserved	4.Development (e.g. housing)	5.Public services	6. Other, specify
A-Bluff conservancy						
B-Bluff golf course						
C-Bluff nature reserve (with wetland)						
D-Bluff nature reserve						
E-Coastal forest						

B18.Are there any additions you would like to see in terms of green spaces within your community? Where should these additions be on the map?

1.None	2.Additions (specify where)

B19. Overall, how satisfied are you with quality of green spaces within your community?

1. Very satisfied	2. Quite satisfied	3. Neither satisfied nor dissatisfied	4. Quite dissatisfied	5. Very dissatisfied

B20. Overall, how satisfied are you with quality of green spaces within Durban?

1. Very satisfied	2. Quite satisfied	3. Neither satisfied nor dissatisfied	4. Quite dissatisfied	5. Very dissatisfied

Section C: Environmental friendly practices of respondents

C1.Do you engage in the following environmentally-friendly practices?

	Often	Seldom	Never
1.Recycling			
2.Reuse of water			
3.Water harvesting			
4.Composting of home waste			
5.Conserving electricity (e.g. lights that automatically go off, use of alternate energy sources)			
6.Planting of trees/vegetation			
7.Proper disposal of waste			

C2.Do you or anyone in your community dump waste in surrounding green areas?

1.Yes	2.No

Section D: Respondents awareness and perceptions of D'MOSS

Note: The Durban city has a programme called the Durban Metropolitan Open Space System (D'MOSS) programme to protect the environment.

D1.Are you aware of the D'MOSS programme?

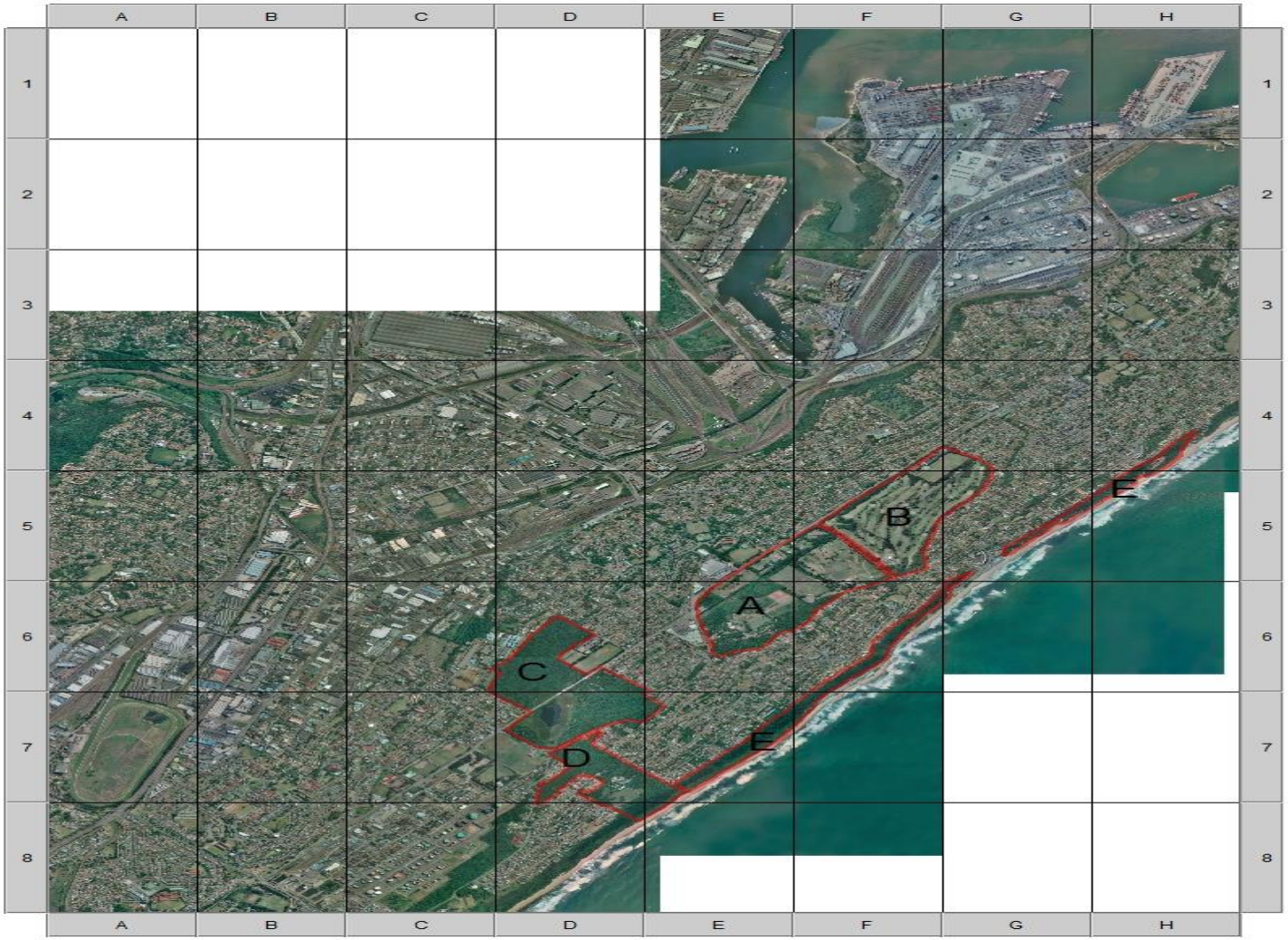
1.Yes	2.No

D2.If yes, which objectives of the programme are you aware of? (Multiple responses permitted)

1.Improving the visual attractiveness	2.Improving the quality of life	3.Promoting the city as a desirable work and tourist place	4. Protection of the environment
5.Increasing public awareness for the need of conservation	6.Recreation (meeting human health and social needs)	Other, specify	

D3. If yes, how do you think the D'MOSS programme can be improved? (Multiple responses permitted)

1.Increase spatial extent of D'MOSS boundaries	2.Fence D'MOSS areas	3.Increase public awareness on conservation	4.Improve protection
5.Engage in further research to identify and implement better management strategies	6.Other, specify		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APPENDIX B: COORDINATES (IN DECIMAL DEGREES) OF GREEN SPACE SITES EXAMINED IN THIS STUDY

Green space type	Site number	Y (DD)	X (DD)
Settlements	1	-14,566.470	-3,311,214.657
	2	-14,681.691	-3,292,147.585
	3	-6,316.157	-3,309,909.469
	4	-13,280.457	-3,295,647.937
	5	-16,411.001	-3,297,692.028
Tree crops	1	-34,033.778	-3,288,752.705
	2	7,619.801	-3,282,447.153
	3	9,804.902	-3,276,684.595
	4	-22,028.262	-3,308,934.431
	5	-16,372.964	-3,303,051.701
Woodland	1	-8,046.649	-3,305,064.667
	2	-3,544.036	-3,299,017.590
	3	-6,970.445	-3,300,597.122
	4	-4,401.501	-3,299,880.669
	5	-7,122.348	-3,296,410.016
Forest	1	1,577.580	-3,298,229.166
	2	-3,416.533	-3,299,502.334
	3	-8,901.184	-3,305,655.436
	4	-4,585.314	-3,298,021.758
	5	-12,055.125	-3,298,509.424
Grassland	1	4,080.143	-3,290,588.679
	2	-14,799.866	-3,294,463.596
	3	-10,492.123	-3,300,080.741
	4	860.897	-3,299,588.281
	5	-829.160	-3,295,182.912
Thicket	1	-5,090.200	-3,296,997.653
	2	-7,343.496	-3,303,947.705
	3	-6,178.178	-3,295,907.824
	4	-7,841.659	-3,296,634.163
	5	-5,838.305	-3,300,419.421