

**A geographical interpretation of the interplay
between urban development, conservation, and sense of
place of urban greenspace in Rietvlei Nature Reserve,
Tshwane, South Africa**

by

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Declaration

I hereby declare that the thesis, with the title: A geographical interpretation of the interplay between urban development, conservation, and sense of place of urban greenspace in Rietvlei Nature Reserve, Tshwane, South Africa, which I hereby submit for the degree of at the University of South Africa, is my own work and has not previously been submitted by me for a degree at this or any other institution.

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AE de Jager

Student signature

10/11/2020

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Soli deo Gloria

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Abstract (*English*)

In an increasingly changing world, the attributes of human and physical environments are critical in assessing human quality of life (HQoL). The research sources consulted for this thesis point to specific relationships between urban change, ecosystem services and the HQoL. A variety of models have been developed in the global North to assist urban planners to manage the benefits and stressors related to urban shrinkage, ecosystems and HQoL. In the global South the trend is urban growth rather than shrinkage and few models are available for this context.

Based on a mixed-method case-study approach, the Rietvlei Nature Reserve, located in the rapidly-growing urban peripheral zone between the Tshwane and Ekurhuleni metropolitan areas in the Gauteng province of South Africa, was selected to assess the benefits and stressors of localised urban development, conservation and sense of place. The purpose of the assessment was to develop a Greenspace Stress Model of Urban Impact (GSMUI) that would be of value to local authorities in managing the interplay of the varied functions of a nature reserve as a greenspace in the global South. Land-use changes were analysed using remote-sensing images. Semi-structured interviews were conducted with purposively-selected key informants to evaluate the functions of the Reserve and the objectives of the Ecological Management Plan for the Reserve. The benefits and risks to the Reserve, as well as the sense-of-place aspects, were identified through semi-structured interviews with 18 purposively-selected key informants, 181 on-site face-to-face semi-structured interviews with visitors to the Reserve, group discussions with interest groups and electronic surveys involving 365 respondents. Data were also collected through the researcher's own observations and her participation in activities at the Reserve. The empirical results of the research were verified by 14 purposively-selected key specialist informants, who evaluated and ranked the identified benefits and stressors. Benefits and stressors were not ranked the same from different perspectives.

Using the results of the empirical research, the researcher was able to merge and adapt a number of models developed for the management of greenspaces in the global North in order to develop the GSMUI specifically for the Rietvlei Reserve. Guidelines were also developed for the application of the GSMUI in geographically similar greenspaces in the global South.

Key words

Environmental stress, Geographical interplay, liveability, Rietvlei Nature Reserve (Tshwane), urban growth, water provision, recreation, sense of place, conservation, greenspace

Abstract (*Opsomming - Afrikaans*)

In 'n toenemend veranderende wêreld, is die eienskappe van menslike en fisiese omgewings krities vir die evaluering van menslike lewenskwaliteit (HQoL). Die navorsing wat geraadpleeg is, het spesifieke verwantskappe tussen stedelike verandering, ekosisteedienste en HQoL aangedui 'n Verskeidenheid modelle is in die globale Noorde ontwikkel om stedelike beplanners te help om die voordele en stressors verwant aan ontwikkeling (stedelike inkrimping), ekosisteme en menslike lewenskwaliteit, te bestuur. Onvoldoende modelle is nog ontwikkel vir die om die teenoorgestelde neigings in die globale Suid te bestuur.

'n Gemengdemetodes-gevallstudie-benadering is gevolg om die voordele en stressors van stedelike ontwikkeling, bewaring en sin vir plek in die Rietvlei Natuurreservaat (geleë in die snelgroeïende stedelike randgebiedsone tussen die Tshwane en Ekurhuleni Metropolitaanse gebiede in die Gauteng Provinsie van Suid-Afrika) te ondersoek. Verandering in grondgebruik is deur afstandwaarnemingsbeelde ontleed. Semi-gestruktureerde onderhoude is met doelbewus-geselekteerde sleutelinformante gevoer om die funksies van die Reservaat, sowel as die doelwitte van die Reservaat se ekologiese bestuursplan, te evalueer. Semi-gestruktureerde onderhoude met 18 doelbewus-geselekteerde sleutelinformante, 181 semi-gestruktureerde persoonlike onderhoude met besoekers aan die Reservaat en groepbesprekings is met ereveldwagters en belangegroepes gevoer, en 365 elektroniese vraelyste is ontleed ten einde die voordele en risiko's vir die Reservaat en ook die pleksin te identifiseer. Data is ook deur middel van waarneming en deelname aan aktiwiteite in die Reservaat ingesamel. Die empiriese resultate van die navorsing is geverifieer deur 14 doelbewus-geselekteerde sleutelinformante wat die geïdentifiseerde voordele en stressors geëvalueer en geklassifiseer het. Voordele en stressors is verskillend evalueer uit verskillende oogpunte.

Die gebruik van die empiriese navorsing het die navorser in staat gestel om 'n aantal modelle aan te pas wat vir die bestuur van groenruimtes in die globale Noorde ontwikkel is en te integreer ten einde die GSMUI te skep. Die CSMUI is spesifiek op die bestuur van die Rietvlei Natuurreservaat gemik. Die navorsing bied ook 'n generiese GSMUI met implementeringsriglyne vir geografies-gelyksoortige groenruimtes in die globale Suid.

Sleutelwoorde

Omgewingstres, Geografiese wisselwerking, leefbaarheid, Rietvlei Natuurreservaat (Tshwane), stedelike groei, watervoorsiening, ontspanning, pleksin, bewaring, groenruimte

Abstract (*Isifinyezo esiqukethe umongo wocwaningo – IsiZulu*)

Kumhlaba oququka njalo, isimo sabantu nesemvelo kubalulekile ekuhloleni iqophelo lempilo yabantu i-Human quality of life (HQoL). Ucwaningo oluhloliwe lukhombise ukuthi kukhona ubudlelwane obuthile phakathi kokuncipha/ukwanda, inkonzo yobudlelwane babantu nemvelo kanye ne HQoL. Lokhu kuxhumana kwehlukile kancane ezindaweni zaseNyakatho nomhlaba (ukungcipha kwedolobha) nezindawo zaseNingizimu nomhlaba lapho ukwanda kwamadolobha kugqame khona. Kwakhiwe amamodeli ahluahlukile khona eNyakatho nomhlaba ukusiza abahleli bamadolobha ukuphatha izinzuzo nokuhluphayo okuhambisana nentuthuko (ukuncipha kwedolobha), kanye nesimo sendawo kanye neHQoL. Awekho amamodeli awenziweyo ukusiza ukuphatha isimo esehlukile eNingizimu yomhlaba.

Ngokusebenzisa inqubo exubile, inqubo ye-case study, iRietvlei Nature Reserve (etholakala lapho kwanda khona ngokushesha amadolobha phakathi kweTshwane ne-EKurrhuleni kwiprovinci laseGauteng eNingizima Afrika), yakhethwa ukuhlola izinzuzo nezingcindezi zokuthuthuka kwamadolobha, nokugcina isimo semvelo kanye nobunjalo obuthile bendawo. Injongo yalolu hlolo bekuwukwenza indawo ebizwa iGreenspace Stress Model of Urban Impact (GSMUI) ezosiza iziphathimandla zendawo ukuphatha ukuxhumana okukhona phakathi kwezinhloso ezihluahlukene zeReserve njengendawo eluhlaza kwiNingizimu neAfrika yomhlaba. Kwahlaziywa indlela eguqukayo yokusetshenziswa komhlaba ngokusebenzisa imifanekiso ebheka ikude etholakala kuma mepi akhombisa indikimba (thematic map). Kwenziwa ama-semi-structured interviews nababambiqhaza bolwazi ababalulekile ukuhlola ukusebenza kweReserve kanye nezinhloso zohlelo olubizwa i-Ecological Management Plan for the Reserve. Izinzuzo nezingcindezi zale-Reserve, kanye nobunjalo obuthile bendawo, kwaphawulwa, ngokwenza ama-semi-structured interview nabathile ababalulekile abakhethwa abayi 18 ukuxoxa nabo, futhi kwenziwa nama-semi-structured interview ngokubhekana ubuso nobuso nezivakashi ze-Reserve ezingama 181, kanye nezingxoxo nabaqaphi abathile besiqiwi (rangers) kanye namanye amaqembu athintekayo. Ulwazi lwaqokelelwa futhi ngokuthi abacwaningi babheke lokho okwenzekayo kanye nokubamba iqhaza kwimisebenzi ye-Reserve. Imiphumela yobufakazi bocwaningo yaqinisekiswa ngosolwazi ababalulekile bobuchwepheshe abangu 14 ababekhethelwe le nhloso, abahlola babuya babeka ngamazanga izinzuzo nezingcindezi ukwenzela ukuthi abacwaningi babuye baphinde bakwazi ukwenza enye i-GSMUI.

Ngokusebenzisa imiphumela yobufakazi bocwaningo, umcwaningi wakwazi ukuhlela kabusha amamodeli amaningana athile enziwe ukuphatha izindawo eziluhlaza eNyakatho lomhlaba, ukuze enze GSMUI eqondene nokuphatha iReserve laseRietvlei. Ucwaningo lubuye lwahlinzeka futhi i-GSMUI enable engasetshenziswa njengemikhombandlela yezinye izindawo eziluhlaza ezifana nalezi khona eNingizimu yomhlaba.

Amagama amqoka

Izingcindezi kwindawo yemvelo, ukuxhumana kweJiyografi, ukuphileka endaweni, ukudala kabusha, iRietvlei Nature Reserve (eTshwane), ukwanda kwedolobha, ukuhlinzeka ngamanzi, ubunjalo obuthile bendawo, ukwanda kwedolobha,

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List of Acronyms

CBA	Cost Benefit Analysis
CBD	Central Business District
CLSV	Cumulative Likert Scale Values
CS	Community Survey
CSIR	Council for Scientific and Industrial Research
DAFF	Dissolved Air Flotation and Filtration
EIA	Environmental Impact Assessment
EMP	Ecological Management Plan
ERWAT	East Rand Water Care Company
EWT	Endangered Wildlife Trust
GAC	Granular Activated Carbon
GPEMF	Gauteng Provincial Environmental Framework
GIS	Geographical Information System
GSMUI	Greenspace Stress Model of Urban Impact
IDP	Integrated Development Plan
IUCN	International Union for Conservation of Nature
MOSS	Metropolitan Open Space System
MEA	Millennium Ecosystem Assessment
NEMA	National Environmental Management Act
NGO	Non-Government Organisation
NPA	Net Profit Analysis
NSRI	National Sea Rescue Institute
NSSD	National Strategy for Sustainable Development
POST	Public Open Space Audit Tool
RBV	Relative Benefit Value
RDP	Reconciliation and Development Programme
RNR	Rietvlei Nature Reserve
RSV	Relative Stress Value
SADC	South African Development Community
SAHGCA	South African Hunters and Game Conservation Association
SANBI	South African National Biodiversity Institute
SANPark	South African National Parks
SEDESOL	Secretariat for Social Development
SIA	Social Impact Assessment
SoP	Sense of Place
SPLUMA	Spatial Planning and Land Use Management Act
SWOT	Strengths, Weaknesses, Opportunities, Threats
TALC	Tourist Area Life Cycle
TIEP	Tshwane Integrated Environmental Policy
TSP	Threatened Species Programme
UDL	Urban Development Line
UNESCO	United Nations Environmental Social and Cultural Organisation
UNEP	United Nations Environmental Programme
UK	United Kingdom
US	United States
WCRAI	Wetland Classification and Risk Assessment Index
WESSA	Wildlife and Environmental Society of Southern Africa
WHO	World Health Organisation
WRC	Water Research Commission

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Chapter 1 : Setting the scene for interpreting the geographical interplay between urban development, conservation and sense of place within urban greenspace

1.1 Introduction

Distinct evaluations of the environment and the balance between development and conservation have been evident for centuries. While Aristotle (348–322 BC) regarded nature as a wild beast to be tamed, Plato (422-347 BC) understood the interdependent relationship between humans and the natural environment as he lamented the deforestation around Athens due to shipbuilding and the use of wood for fuel (Ndubisi, 2014).

More contemporary urban development has generally led to major changes in the human-ecological landscape' and consequently population pressures are currently placing strain on the management of environmental resources (Toure *et al*, 2020; Heymans *et al*, 2019). Natural areas surrounded by urbanised environments are under pressure in different parts of the world (Manea *et al*, 2016). On the other hand, when the ecosystem functions are protected, untapped economic potential may not be realised (Potter *et al*, 2017). Should the balance between urban development, conservation and sense of place therefore be disturbed, stressors may develop that could have a detrimental impact on the future availability of urban greenspace.

Urban greenspace has the potential to be a vital resource for promoting the physical as well as the mental health and wellbeing of people living in urban areas (Kondo *et al*, 2018; Jennings *et al*, 2017; De Crom & Nealer, 2017; World Health

Organisation, 2016; Hall & Page, 2014; Irvine *et al*, 2013; Mayer *et al*, 2009), and at the same time has value for the conservation of biodiversity (Hausmann *et al*, 2015). The diversified ecosystem services provided by greenspace are, however, doing more than merely enhancing quality of life through accessing it for recreation (Douglas, 2012). Ecosystem functions and the associated ecosystem services are supporting resilience in the face of climate change (Sinnet *et al*, 2015; Schäffler *et al*, 2013). There is evidence of a growing concern over planetary boundaries of the sustainability of environmental processes, social and economic development (Prescott & Bland, 2020; Brown, 2015).

To understand the geographical interplay between urban development, conservation and sense of place in urban greenspace, it is therefore important not only to consider how urban development impacts on changes in the land use and morphology of the city and the landscape, but also to establish the functions and varied use of a particular greenspace (Govender-Ragubeer *et al*, 2014).

1.2 Rationale and motivation

The place of urban greenspace in the city is reflected in where and how different types of greenspace fit into spatial planning frameworks, as well as the social, cultural, economic and environmental dimensions of the competition for available land (Satgé & Watson, 2018). Considering the relationship between development and conservation leads to questions as to What?, Why? and How? to conserve. The goals of development and conservation are not always symbiotic and if this relationship is not managed well, it could lead to a number of environmental stressors.

1.2.1 Urbanisation and urban development

Urbanisation is a world-wide phenomenon that leads to increasing percentages of people living in cities. In 2018, it was estimated that 55% of the world population was living in cities (Population Reference Bureau, 2018). This estimate does not, however, reflect the spatial differences between the global North and South. The former reflected a level of urbanisation of 79%, while the estimate for the latter was 50% (Population Reference Bureau, 2018). It is expected that the global North will urbanise at a slower rate than the global South as it is already highly urbanised. On the other hand, the global South has different development issues from those of the global North. Furthermore, the identified rate of urbanisation in the global South will place increasing pressure on the demand for open spaces to satisfy human and ecological needs (Toure *et al*, 2020). As such, the interplay between development, conservation and sense of place is especially relevant to the global South context.

In 2013, it was projected that the urban population of the global North would increase from 1,1 billion in 2011 to 1,5 billion in 2050 (Haub & Kaneda, 2013: 7). The urban population in the global South was, however, expected to increase much faster over the same time period, from approximately 2,7 billion to 5,1 billion. Latin America was the most urbanised region in the global South in the early 2000's with 80% of the population of Brazil living in cities (Miller *et al*, 2015). It was projected that the population of Africa would more than double from 1,1 billion in 2013 to 2,4 billion in 2050 (Haub & Kaneda, 2013:7). This trend in mounting urbanisation in Africa has been confirmed in the more recent population data sheet (Population Reference Bureau, 2018).

In 2017, the population of South Africa was estimated at 56,5 million, 65% of which was urban (Population Reference Bureau, 2018). The Gauteng Province was the most urbanised South African province in 2016, with approximately 97,3% of the population living in urban areas (Statistics South Africa, 2018; Lehola, 2017). A further breakdown of the levels of urbanisation in different districts and local municipalities in Gauteng is provided in Table 1.1. Gauteng had a 9,2% population increase between 2011 and 2016 (Statistics South Africa, 2018). National and international migration within and towards Gauteng played and continues to play an important role in the population growth of the province.

Table 1.1: Gauteng population distribution by district and local municipality, Census 2011 and Community Survey (CS) 2016

District/Local municipality	Total population		% change
	Census 2011	CS 2016	
DC42: Sedibeng	916 484	957 528	4,5
GT422 : Midvaal	95 301	111 612	17,1
GT421 : Emfuleni	721 663	733 445	1,6
GT423 : Lesedi	99 520	112 472	13,0
DC48: West Rand	820 995	838 594	2,1
GT481 : Mogale City	362 422	383 864	5,9
GT484 : Merafong City	197 520	188 843	-4,4
GT485 : Rand West City	261 053	265 887	1,9
EKU: Ekurhuleni	3 178 470	3 379 104	6,3
JHB: City of Johannesburg	4 434 827	4 949 347	11,6
TSH: City of Tshwane	2 921 488	3 275 152	12,1
Gauteng	12 272 263	13 399 724	9,2

Source: Adapted from Statistics South Africa, 2018: Table 2.2, p. 8

In 2011, the population of the City of Tshwane was 2,9 million and increased to 3,2 million in 2016 (Statistics South Africa, 2018). Rapid urbanisation and its effect on the urban form are often complex issues and generally result in much controversy (Artmann *et al*, 2019). Even though densification is promoted to counter the multi-dimensional impacts of urban sprawl, there are also concerns over the impact of

densification on urban green space. In areas where densification takes place, this could negatively impact on quality of human life (Horn & van Eeden, 2018; Byrne & Sipe, 2010).

Although various urban planning strategies have been implemented to direct urban spatial development, the inclusion and protection of greenspaces has become an important aspect in the spatial development plans of many cities in the global North (Byrne & Sipe, 2010). This is reflected in green belts, that incorporate urban spatial expanses and parks within neighbourhood cells and that are developed to enhance a sense of community and of the quality of life of the inhabitants within the congested cities (Ndubisi, 2014). In many metropolitan areas, open space systems have been included in urban planning in order to protect the ecosystem services and ensure that the urban area forms an integral part of a green infrastructure (World Health Organisation, 2017; Wolhitz, 2016; Jennings *et al*, 2016; Schäffler *et al*, 2013; CABE, 2009; Millennium Ecosystem Assessment, 2005).

The development trajectory for the global South differs from that of the global North and this has resulted in competing endeavours to access accommodation for a rapidly-growing urban population, but with due consideration being given to the limited availability of open spaces (Toure *et al*, 2020). For example, owing to the rate of migrants entering urban areas, it is not always possible for them to be accommodated within the formal housing sector, which results in the mushrooming of informal settlements that develop within the available open spaces (Dholakia *et al*, 2020). The rapid rate at which migrants enter the city presents a major threat to the formal spatial development plans launched by metropolitan councils in their quest to provide appropriate service delivery. At the same time, however, these

plans serve to protect and conserve the available open spaces, many of which could include sensitive greenspace environments (Hamann *et al*, 2018; City of Tshwane, 2018/19; City of Cape Town, 2012; Atiquil Hac, 2011).

There is thus a growing challenge for local governments in developing countries and cities to balance the increased need for service delivery with the protection of greenspace. This is further complicated by the lack of institutional capacity, an aging infrastructure, backlogs and the growing lack of funds in the cities of the global South (Lehola, 2017; van Vuuren, 2017). The way in which these challenges are approached has important implications for the quality of life of urbanites and also the management and conservation of available urban greenspaces.

Globally, urban dwellers are placing increasing value on urban green spaces as these enhance their quality of life and allow for the development of an emotional attachment to the physical environment. The various associations urban dwellers have with their physical environment are often reflected in the development of a sense of place or a sense of belonging. These associations, together with the advent of global awareness in respect of more sustainable cities, have resulted in a paradigm shift aimed at intensifying the conservation of greenspaces in urban areas.

According to the New Urban Agenda, African cities need to invest in urban infrastructures that result in low carbon emissions, the restoration of ecosystems, and resource-efficient cities (Swilling & Robinson, 2017). As such, it is important to contribute to the research concerning the interplay between urban development, conservation and sense of place.

1.2.2 Urban development, conservation and sense of place of greenspace

Urban spatial development frameworks affect and provide direction as to how greenspace is to be protected. In South African cities, metropolitan open space systems have for decades been integrated into spatial planning in order to link up different green areas, protect the natural environment and support biodiversity (Cilliers & Cilliers, 2016; City of Tshwane, 2005; CSIR, 2000; Council for the Environment, 1989). It remains essential to plan urban green areas within the broader context of city space (Artman *et al*, 2019). Access to urban greenspace is important for human health and wellbeing (MacKinnon *et al*, 2019; World Health Organisation, 2017; Jennings, 2016; Milliken, 2015).

Humans are dependent on the provisioning of ecosystem functions and yet globally these functions are being increasingly depleted and becoming scarcer (Cohen, 2020; Miller & Spoolman, 2019; Baker & Greenfield, 2019; United Nations, 2015; Millennium Ecosystem Assessment, 2005). Tensions between development, service delivery and the conservation of different types of greenspace are experienced within different geographical areas and in accordance with their associated resolution levels (Artmann *et al*, 2019). Well-known conservation areas such as Yellowstone in the United States of America, Serengeti National Park in Tanzania, Kakadu in Australia and the Kruger National Park in South Africa all have unique natural features that attract visitors worldwide and play an important role in the economies of the countries in which they are located.

Unfortunately, wilderness and conservation areas are being subjected to much pressure owing to not only human needs, but also changing conditions and circumstances over time and the associated sense of place regarding them

(McKinney *et al*, 2018; SANParks, 2016; Quammen, 2006). The pressures experienced in conservation areas are even more intense in confined urban greenspaces (Polidoro *et al*, 2012). In some cases, greenspaces are deliberately destroyed as a result of formal subdivisions being undertaken for housing purposes, industrial installations, commercial buildings, and infrastructural development, while in other cases, greenspaces are occupied by inhabitants in a more haphazard, unplanned way, as in informal settlements.

When evaluating the problem of urban greenspace through the lens of Hardin's Tragedy of the Commons (Rodgers & Mackay, 2018; Garrity, 2012), the assumption is made that everyone would attempt to gain maximum advantage from a common good. Measures for environmental protection are, therefore, important for the sustainable exploitation of greenspace. Since the importance of the natural environment is not necessarily understood in decision-making, environmental legislation in terms of ensuring the protection of conservation areas tends to be ineffectual. As such, it is also important to consider the functions and significance that decision makers are attaching to urban greenspace in their investigations into the importance of greenspace in cities.

Environmental Impact Assessment (EIA) is a commonly used tool to support decisions in line with principles of sustainable development. The focus of EIA has changed from being on the creation of inventories of the biophysical environment towards an assessment of the quality of impact predictions, secondary and tertiary impacts, as well as socio-economic impacts (Noble, 2015). The importance of socio-economic aspects in the functioning of ecosystems has been extended by

authors such as Williams and Stewart (1998) in their application of sense of place in ecosystem management.

In the context of nature conservation in the urban greenspace, sense of place is not only associated with the emotional and spiritual bonds people hold of particular places, but could also be linked to an awareness of the ecosystem services obtained from urban greenspace and to finding ways to avoid environmental degradation.

Nature conservation and green infrastructure are intrinsically linked, because well-functioning ecosystems and biodiversity are important for the ecosystem functions that urban greenspaces provide, and, therefore, the services that they render (Wood *et al*, 2018; Williams, 2017; Sinnet *et al*, 2015).

In terms of the green infrastructural approach, the natural ecosystem functions and the associated benefits or services provided to humans are valued as the ecological basis or framework required from which environmental, social and economic sustainability can be attained (Pasquini & Enqvist, 2019; Lepczyk *et al*, 2017; Mell, 2017). Various elements such as conservation areas, tree-lined streets, parks, gardens, allotments, cemeteries, green roofs, rivers, wetlands and waterways are connected into a functioning system that supports ecological processes (Wolhitz, 2016; Culwick & Robbinsk, 2016). Conservation efforts could therefore be considered to be integrated with planning initiatives in respect of land development, growth management and the built infrastructure rather than in opposition to it. Green infrastructure can also be used to augment grey infrastructure. Connections between land use and ecosystem management

functions are therefore important. Grey infrastructure, including roads, sewers, water provisioning networks and electricity lines should therefore be strategically planned and coordinated in order to conserve ecological functions (Artmann *et al*, 2019; Culwick & Bobbinsk, 2016).

1.2.3 The multi-disciplinary nature of the Rietvlei Nature Reserve case study

The case study under investigation lies at the intersection between various specialisation fields, including Urban Geography, Tourism Geography, Environmental Management, and the sustainability discourse, the last-mentioned with reference to urban liveability and environmental psychology. The conservation of urban greenspace within the context of competing needs, is an important focus of this study. Figure 1.1 illustrates the researcher's positioning of the research within the discipline of Geography.

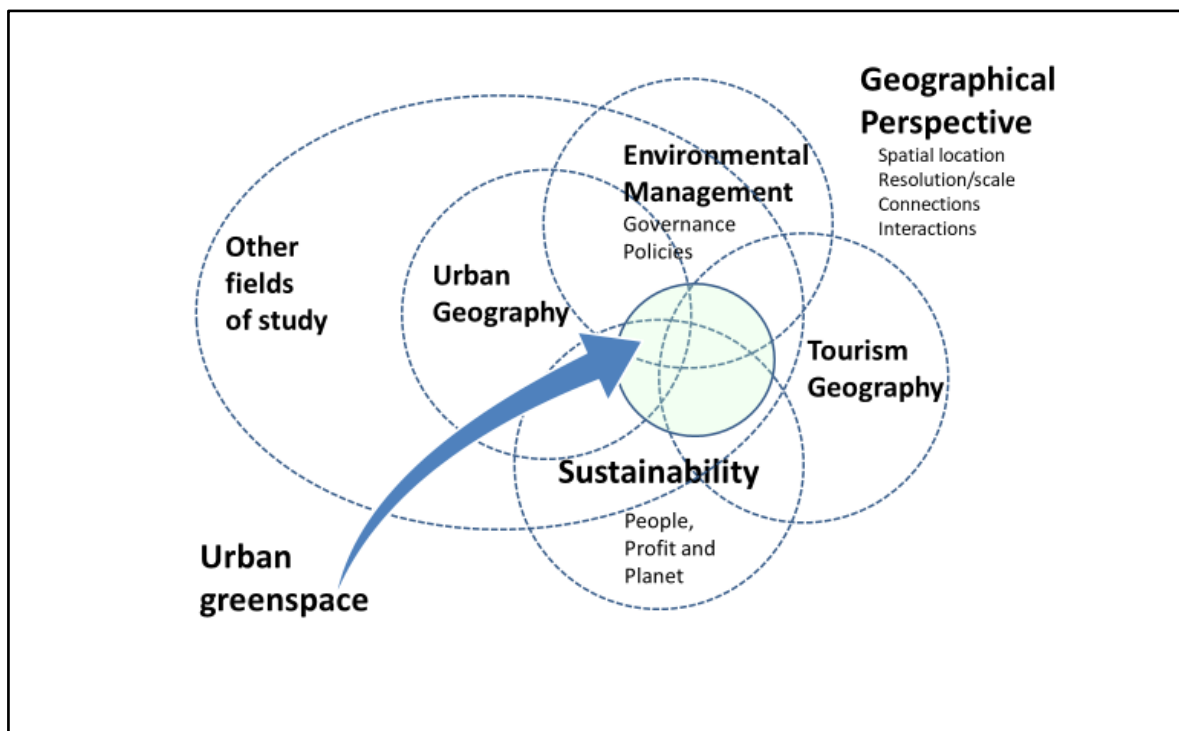


Figure 1.1: The multi-disciplinary nature of the research
Source: Author 2020

The focus on the interplay between development, conservation and sense of place contributes to the integration of material from different disciplines and from the sub-disciplines of Geography.

Urban greenspace, a topic that is widely researched and extends beyond the discipline of Geography, is presented in Chapter 2. Since the study area includes a large body of water, which is a natural resource that is used for satisfying a basic need in the surrounding urban area, the focus of the literature review for this research is mainly on greenspaces that have similar physical characteristics.

Haase and Rink (2014) in their model demonstrating the nexus between urban morphology, ecosystem services and quality of life; and Pacione (2001) in his Stress Model of Urban Impact, focus on the influence of the natural environment on quality of life in the city. Pacione (2001) also combines different approaches to human-environment interaction in his model.

Literature on environmental stress emphasises the fact that stress is fundamentally a relational concept signifying an imbalance between environmental opportunities and the individual's ability to cope or meet their needs. Stress could be caused not only by the physical characteristics of the setting, but also the individual's appraisal of the environment and their vulnerability and reaction to environmental conditions (MacLean & Salama, 2019; Pacione, 2003).

Environmental stressors occur when human needs are not met, or when environmental degradation becomes evident. Not all stressors are of the same intensity and duration: - they can range from ambient stressors, daily hassles, and stressful life events, to cataclysmic events. Where the impact of particular stressors

can be mitigated, the balance is restored. Should the stressors become more intense, however, this could lead to a situation where the capacity to perform the expected functions is exceeded and therewith increased environmental degradation and human vulnerabilities would surface. Environmental awareness is therefore important for an accurate identification of potential stressors, as well as for the identification of appropriate management strategies.

A similar reasoning is found in the tourism literature, where the concept of a Tourist Area Cycle of Evolution (Butler, 1980), also known as the Tourist Area Life Cycle (TALC) model, was applied to illustrate that the attractiveness of a tourist destination is reduced by its over-exploitation. According to this model, the critical range of elements of capacity should be considered in the development and implementation of management plans. Within the tourism context, the degradation of a destination could be turned around through the adoption of measures to mitigate environmental degradation and to re-invent the initial tourism functions of the destination (Liu *et al*, 2019).

Even though sense of place was not specifically mentioned by Pacione (2001), Haase and Rink (2014), or Butler (1980), it could play a potentially important role should these models be adapted. Montgomery (1998) indicated that sense of place is influenced by form, activity and image. The form of urban greenspace can be linked to the ecosystem functions and services, as well as to urban spatial planning. On the other hand, activity can be linked to the particular functions of a greenspace. Image and sense of place are not only associated with the physical characteristics of the greenspace, but also with an understanding of the potential benefits of the greenspace.

In the case of the Rietvlei Nature Reserve, this greenspace not only presents a destination for recreation; it also provides ecosystem functions and services. The ecosystem health and functions of the greenspace potentially influence the quality of life of the urban residents living in the vicinity of the greenspace (Haase & Rink, 2014).

The aim of this study is to illustrate how urban development, conservation and sense of place collectively feed into a Greenspace Stress Model of Urban Impact.

1.3 Problem statement

As already mentioned, Gauteng is experiencing rapid urbanisation (Section 1.2.1), and from 2011 to 2016, the City of Tshwane underwent the third-largest population increase for local authorities in the province (Table 1.1). It is therefore essential to carefully plan for land-use and land-cover changes to provide for the competing demands associated with service delivery, conservation and the potential mental and psychological health benefits associated with greenspaces.

The Rietvlei Nature Reserve is a large natural area within the City of Tshwane. Furthermore, it is linked via green corridors to other green nodes in the Tshwane Metropolitan Open Space System (City of Tshwane, 2005). Based on the literature survey and an initial exploration of the research area to orientate herself, the researcher made the assumption that there are potential benefits for decision makers and users of the Rietvlei Nature Reserve. Should the balance between development, conservation and sense of place be disturbed, however, definite stressors would emerge which could have a negative outcome on the sustainability of the Rietvlei Nature Reserve as a green space, as well as on the overall

development of the metropolitan areas surrounding it. Priority was therefore given to an investigation into the magnitude of this interplay and to justify the need to develop a Greenspace Stress Model of Urban Impact to be used by all concerned to better manage the greenspace.

1.3.1 Research question

What are the environmental benefits, risks and stressors that are currently evident in the Rietvlei Nature Reserve that might affect the management functions of Rietvlei as a critical urban greenspace?

1.3.2 The context of the Rietvlei Nature Reserve

The Rietvlei Nature Reserve in Tshwane was analysed from a geographical perspective to demonstrate how urban development and increasing human needs/demands could influence the functions and use of a conservation area situated on the urban fringe of a fast-growing metropolitan area.

The Tshwane Metropolitan Municipality was established in May, 2000, when 13 former town councils and municipalities were amalgamated (City of Tshwane, 2014 (a)). In 2011, the Metsweding District Municipality, consisting of *Nokeng tsa Taemane* (Cullinan) and *Kungwini* (Bronkhorstpruit), were incorporated into the Tshwane Metropolitan Municipality (Figure 1.2).

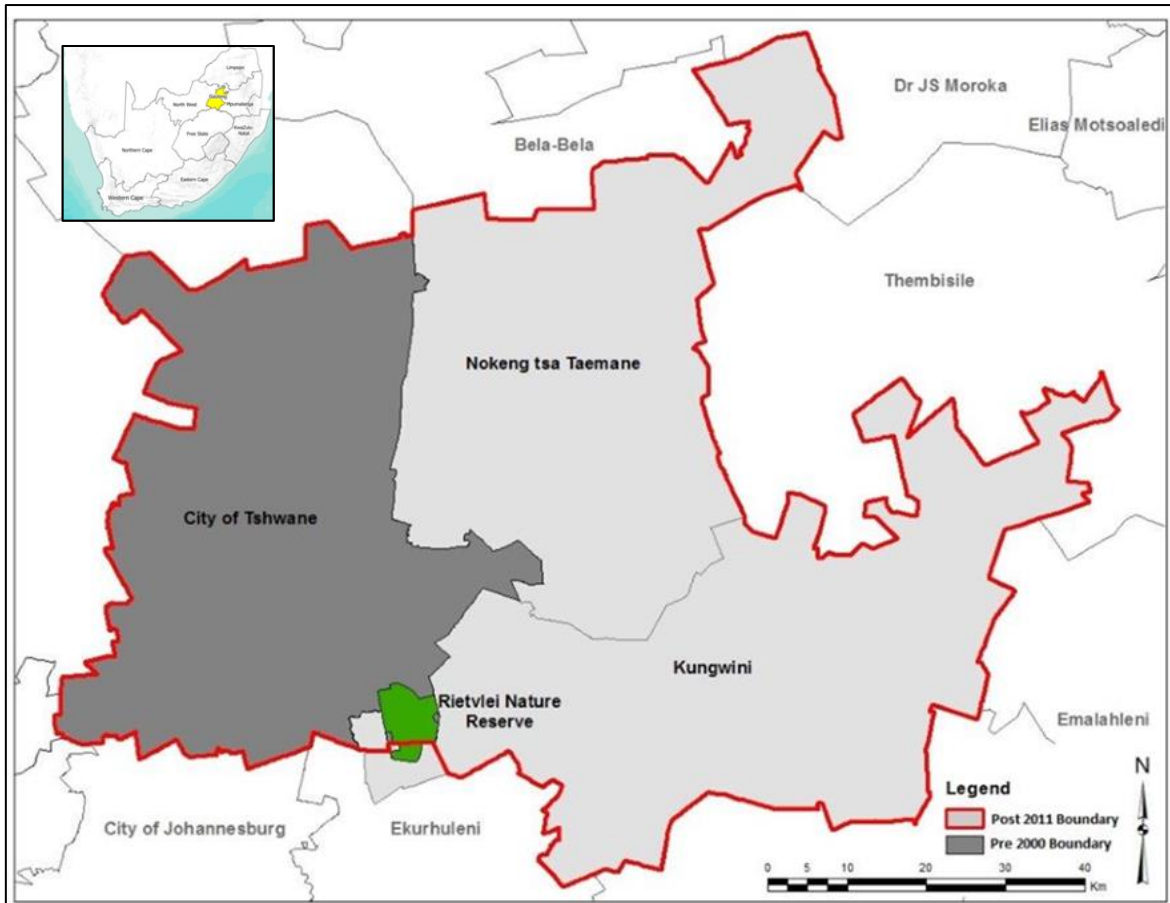


Figure 1.2: The location of the Rietvlei Nature Reserve within the re-demarcated municipal boundaries of Tshwane Metropolitan Municipality: 2000 and 2011

Source: Compiled by S. Carow Data: ESRI data in a box (2018)

After the municipal restructuring process, the municipal area of Tshwane covered an area of 6 345 km², making it the largest metropolitan land area in Africa and the third largest in the World (City of Tshwane, 2018/19).

Within a fifteen-year period (1996 to 2009), Gauteng lost 229 953 hectares of natural habitat to urban-related activities and land-use occupation (Gauteng Provincial Government, 2017:106). It was therefore considered important to carefully monitor the remaining available greenspace, especially the natural areas.

The Rietvlei Nature Reserve is a conservation area that is especially vulnerable to the impacts of urban development. Measuring about 40 km², Rietvlei Nature Reserve is located 18 km from the Pretoria Central Business District, and on the urban fringe between two growing metropolitan areas, namely Tshwane and Ekurhuleni (Figure 1.2). Owing to the availability of land for development and the changing characteristics of land use from agricultural to industrial, economic and residential functions, an urban fringe area, such as that in which the Rietvlei Nature Reserve is located, is considered to be a typically dynamic zone (Horn & van Eeden, 2018; Wadduwage *et al*, 2017).

The relative location of the Rietvlei Nature Reserve within the Gauteng city region and the regional development corridor between Tshwane and Johannesburg further add to the development pressures on the Rietvlei Nature Reserve (Hamann *et al*, 2018; Brand *et al*, 2017; Gauteng Province, 2011). This is especially relevant in terms of the provincial activity corridor linking Johannesburg; Edenvale; Kempton Park; Tembisa and Pretoria (Brand, 2014). The Pretoria-Kempton Park development corridor along the R21/Nelson Mandela Drive, linking O.R. Tambo International Airport and the industrial areas of Ekurhuleni to the Tshwane CBD, runs adjacent to the Reserve.

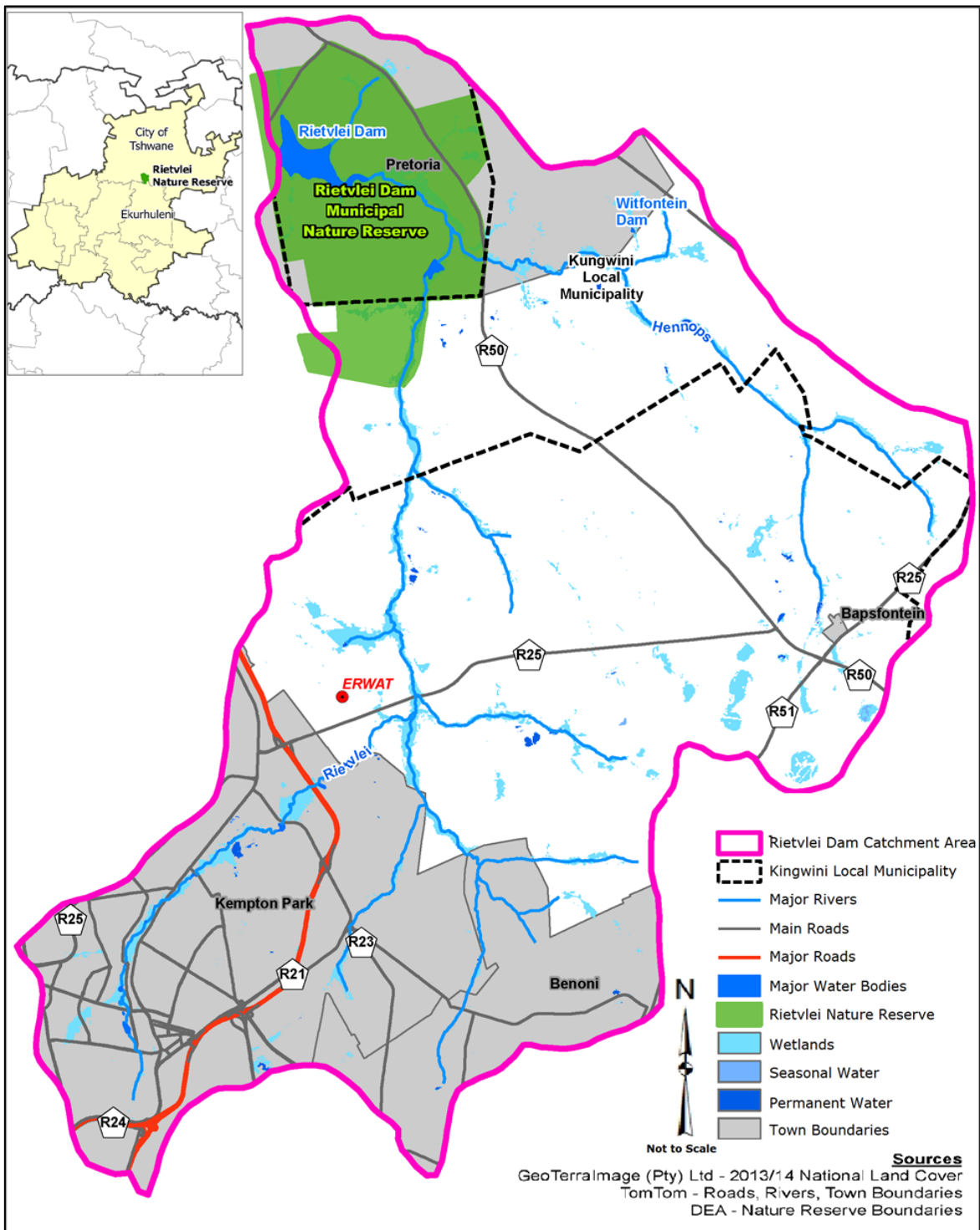


Figure 1.3: The relative location of the Rietvlei Nature Reserve between two growing metropolitan areas

Source: Adapted from unpublished map compiled by GeoTerralImage (Pty) Ltd

The result of the geographical location of the Rietvlei Nature Reserve (RNR) within a region of South Africa that is experiencing the highest population growth is that development pressures on the existing open space are intensifying since, as it is, there is already limited land available for development. As was experienced in the former Kungwini area, uncontrolled development of necessity places a burden on the existing infrastructure (City of Tshwane, 2014 (b)). A further danger of uncontrolled development is that land that has an intrinsic value - that extends beyond the provision of housing for people - could be lost. It can therefore be assumed that the interplay between competing needs and demands on the limited space (land) available might not be in the best interests of the future sustainability of an urban greenspace such as the Rietvlei Nature Reserve.

The presence of a strong source of water in the Fountains Valley was one of the reasons for the original sites selected for human settlement, and the subsequent development of the city of Pretoria (Dippenaar, 2013; van Tonder & van Vollenhoven, 2008). Fountains, in the Groenkloof Nature Reserve, originally provided sufficient water for Pretoria, but by 1929, this water source could no longer adequately supply the water needs of the growing city. Parliament therefore approved the Rietvlei Water Scheme to supplement the supply of water to the city (Dippenaar, 2013).

At the time of the research, both the Groenkloof and the Rietvlei Nature Reserves were considered to be important sources of water for the City of Tshwane - even though the city also relies on water from external sources (Dippenaar, 2013). The Rand Water Board and the Magalies Water Board provide for 81,3% of the city's water needs, with 18,7% from its own dams, boreholes and springs, which include

the Fountains Valley and the Rietvlei Nature Reserve (City of Tshwane, Water and Sanitation Division, Public Works and Infrastructure Development, 2015).

The Rietvlei Water Treatment Plant at the Rietvlei Dam is one of three operational water treatment plants in Tshwane. The other two are the Temba Water Treatment Plant at the Leeukraal Dam, and the Roodeplaat Water Treatment Plant at the Roodeplaat Dam (Figure 1.4).

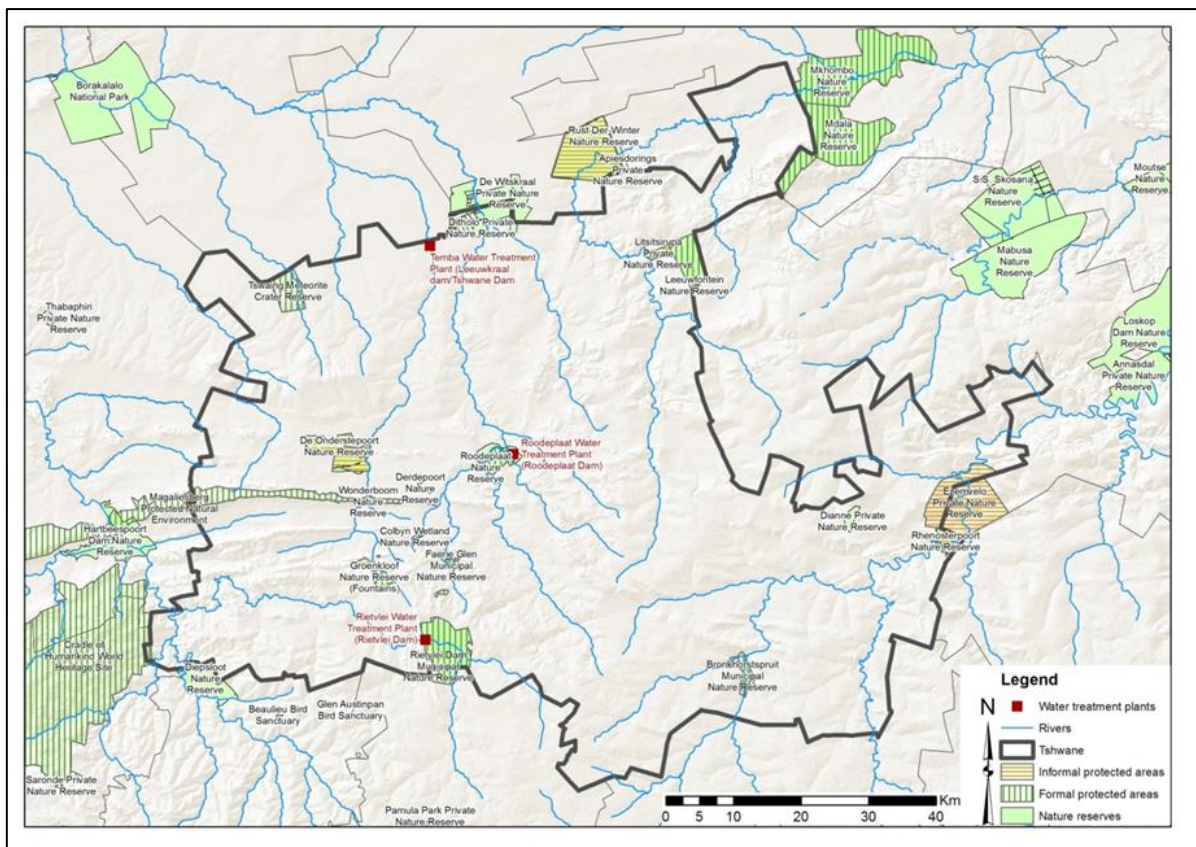


Figure 1.4: Nature Reserves in the Tshwane Metropolitan Area
 Source: Compiled by S. Carow Data: ESRI data in a box (2018)

High-density urban development increases runoff and the risks of pollution and water contamination. Conservation areas were therefore proclaimed around water sources in the former Pretoria municipal area as a groundwater protection strategy (Dippenaar, 2013). The Roodeplaat Dam Nature Reserve, for example, surrounds the Roodeplaat Dam, while the Bon Accord Dam lies adjacent to the Onderstepoort

Nature Reserve (Figure 1.4). These urban greenspaces are, however, multi-functional and support the ecosystem benefits associated with a green infrastructure.

The Groenkloof Nature Reserve was the first game sanctuary on the African continent to be proclaimed around the Fountains Valley in 1895 (van Tonder & van Vollenhoven, 2008). Owing to its proximity to the high-density residential urban centre, this nature reserve has become a popular recreational area for urban residents.

The Rietvlei Nature Reserve accommodates the Rietvlei and Marais dams, the Rietvlei purification plant, as well as wetlands, aquifers and boreholes that provide water to the water-provisioning network of the City of Tshwane¹ (South African Water Research Commission, 2018; Dippenaar, 2013).

The Rietvlei Nature Reserve was however selected as the geographical area for this research, with the focus being on the greenspace functions of the Reserve and the changing characteristics of the surrounding urban land-use patterns within the urban fringe area (Hamann *et al*, 2018; Manganyi, 2006). The relative location of the Rietvlei Nature Reserve, which lies adjacent to a spatial development corridor and within the jurisdiction areas of different municipalities, adds a further dimension - worth noting - to the case, and enhances the interplay between urban development, conservation and sense of place.

¹ Further details on the functions of this greenspace are explored in Chapter 4 of this thesis.

From the time that the researcher first visited the Rietvlei Nature Reserve in 1990, she observed continuous changes in the landscape surrounding the Reserve. This ultimately led to her formulation of the research question related to the consequences of the visible interplay between urban development and the associated rising level of human needs on the one hand, and conservation management challenges and visitors' perceptions of sense of place, on the other.

The rationale behind this research was not to identify a profile of the typical visitor to the Rietvlei Nature Reserve, but rather to obtain supportive information regarding the benefits and risks of the Reserve from a variety of sources relevant to the case (Gentles *et al*, 2015). The research process included the holding of individual face-to-face interviews with purposively-selected informants, visitors, and dedicated interest groups, such as the Hennops River Catchment Forum, Friends of Rietvlei, Rietvlei Birders, Rietvlei Photographers, Honorary Rangers and members of the Pretoria Yacht Club.

1.3.3 Importance of the research

Rapid urbanisation leads firstly to increased population numbers in cities, and secondly, to pressure on the land-use functions associated with urban development (Hamann, 2018). As such, it becomes increasingly more difficult to adequately manage the available resources that are required to meet the needs of the growing urban population. Local case studies and innovative tools are therefore required to clarify the nature of the resultant challenges and to assist in the management of greenspace within fast-growing urban areas.

Furthermore, it is important to compile case studies applicable to the global South to strengthen the Southern theories that reflect realities that differ from those of the global North, where most of the research on urban greenspace is conducted. As such, this research is an attempt at adding to the body of literature from especially the global South to demonstrate the influence of rapid urban development and expansion challenges in order to protect the existing urban greenspaces in question.

In the case of a multi-functional urban greenspace, the over-exploitation of available resources could place the functions of the area at risk. Stressors may occur, not only in the case of the recreational or tourism function, but also as a result of the ecosystem services provided by the greenspace. It is therefore important for management to identify environmental stressors, and to implement appropriate mitigation measures to protect or restore the greenspace in order to adapt to and cope with these stressors. The growing awareness of the benefits of applying the findings of research to the protection of biodiversity and the production of goods and the rendering of services in the context of ecosystems in South Africa underlines the relevance of this research (Department of Environmental Affairs, 2016).

1.3.4 Formulation of aim and objectives

The primary aim of the research was to use a geographical perspective to assess the importance of the Rietvlei Nature Reserve as a critical green infrastructural component of the Tshwane Metropolitan Area, and secondly, to demonstrate the impact of the geographical interplay between urban development, conservation

and sense of place on the Rietvlei Nature Reserve (Tshwane). The aim was guided by four research objectives.

1.3.4.1 Objective 1

To map and assess implications and challenges of urban growth development and the ongoing changes on the surrounding land use and infrastructure for the conservation of the Rietvlei Nature Reserve as a prominent urban greenspace within the Tshwane Metropolitan Area.

1.3.4.2 Objective 2

To analyse and assess the importance of the critical greenspace functions of the Rietvlei Nature Reserve for conservation and sense of place.

1.3.4.3 Objective 3

To develop a Greenspace Stress Model of Urban Impact as a possible management tool to sustain the future of the Rietvlei Nature Reserve as a protected urban greenspace.

1.3.4.4 Objective 4

To develop implementation guidelines for the Greenspace Stress Model of Urban Impact for possible application within other urban and metropolitan areas

The Greenspace Stress Model of Urban Impact developed from this case study should contribute to evaluating similar cases; to identifying critical lessons; and to informing best practices for the conservation of urban greenspace.

1.4 Research Methodology

A mixed-method approach was applied in this case-study research (Birt *et al*, 2016; Torrance, 2012; Creswell & Plano Clark, 2017; Dellinger & Leech, 2007). The unit of analysis was the Rietvlei Nature Reserve in the context of the Tshwane Metropolitan Municipality in the Gauteng province of South Africa. A range of well-researched strategies, methodologies and multiple sources therefore provided information about the Rietvlei Nature Reserve, and these are documented in Chapter 3.

1.4.1 Primary resources

1.4.1.1 Observation

It was important for the researcher to gain first-hand experience of the study area and to make observations in exploring the reality of the situation; to identify issues; to select meaningful focus groups; and to compile appropriate questions for semi-structured interviews. Observations were supported by photographic evidence and field notes of research experiences at the Rietvlei Nature Reserve over a period of five years, commencing in 2014.

1.4.1.2 Interviews

Semi-structured interviews were conducted with key informants representing different types of stakeholders (n=18). Both quantitative and qualitative data obtained from key respondents were used to analyse the respective aspects of environmental benefits and stressors, as being experienced in the study area (Appendices E, F and H).

Face-to-face structured on-site interviews were conducted with visitors (n=181) to different areas of the Rietvlei Nature Reserve and at different time intervals. Questions were directed to specifically evaluate the visitors' responses regarding their sense of place of the Reserve.

1.4.1.3 Electronic surveys

The results of two electronic surveys that were placed on the Facebook Pages of Friends of Rietvlei and Rietvlei Photographers (n = 365) were added to the data collected from interviews with visitors to the Rietvlei Nature Reserve.

1.4.1.4 Group discussions

Results of the literature study and responses issuing from observations, individual semi-structured interviews, and a dedicated survey, were determined through triangulation into groups. Dedicated group interviews with interest groups were held to establish the possibly different perspectives of users of the Rietvlei Nature Reserve with regard to this green space. Discussions were held with Honorary Rangers (n=5), Friends of Rietvlei (n=5), the Pretoria Yacht Club (n=5) and Birders and Photographers (n=5).

1.4.1.5 Focus group session

In an attempt to not only confirm the reliability of the findings, but also quantify the potential benefits and concerns, a final plenary focus group session was conducted on 10 July, 2019. It comprised of participants with an interest in dedicated aspects of urban development, conservation and sense of place in terms of the Rietvlei Nature Reserve. During this focus group session, the potential benefits and risks identified during the previous phases of the research were evaluated through

respondent validation (Torrance, 2012; Birt *et al*, 2016; Dellinger & Leech, 2007). Participants were challenged to rank social, environmental and ecological benefits and risks according to their understanding of their relevance to the Rietvlei Nature Reserve. This turned out to be an important phase in support of the basic components underlying the relevant stressors captured for the Greenspace Stress Model of Urban Impact.

1.4.2 Secondary resources

Various secondary data sources were consulted to obtain relevant data on the history, current multiple-use and environmental benefits, and risks and stressors associated with the study area. Published research reports, marketing collateral, media reports and the internet formed the basis for the identification of benefits, risks and environmental stressors in the case of the Rietvlei Nature Reserve.

Quantitative data were sourced from Statistics South Africa, as well as from management reports of the Rietvlei Nature Reserve and the Tshwane Metropolitan Municipality, to establish the importance and challenges of the Rietvlei Nature Reserve for the growing urban population of Tshwane.

The interpretation of maps and remote sensing images elucidated development trends in the catchment area of the Rietvlei Nature Reserve and clearly unveiled the importance of the location of the Rietvlei Nature Reserve for the dedicated functions of the Reserve.

1.5 Chapter outline

This thesis is presented in eight chapters. Chapter 1 introduces the research problem. It was essential to develop a sound theoretical basis from which the

research could unfold and therefore the literature review in Chapter 2 contextualises the study of greenspace in a changing urban environment. The literature study provides lessons learnt and recommendations from both the global North and South in terms of the conservation of urban greenspace and the provision of water to a growing urban population. Chapter 3 provides a motivation and an explanation for the methodology applied to address the respective objectives of the project. Chapter 4 evaluates some implications of urban development for the Rietvlei Nature Reserve. Chapter 5 focuses on the conservation benefits and risks of greenspace, as well as sense of place, as responses to the functions of the Reserve. Chapter 6 presents a Greenspace Stress Model of Urban Impact based on the research findings in respect of the Rietvlei Nature Reserve, and Chapter 7 provides guidelines for the implementation of the model in other greenspaces. Chapter 8 concludes with a synthesis and conclusions, and offers recommendations for possible follow-up initiatives and future research.

Chapter 2: Greenspace in a changing urban environment

2.1 Introduction

The way in which urban greenspace is valued and utilised demonstrates the interconnectedness of the ecological, social and economic spheres and their influence on sustainability, liveability and the quality of life of urban residents (de Crom & Nealer, 2017; Coutts & Hahn, 2015; Sinnet *et al*, 2015; Beatley, 2011). This is increasingly important, since harm to the natural environment is often unintended and unforeseen, but environmental impacts could be irreversible (Millennium Ecosystem Assessment, 2005).

Ecosystems are threatened by social and economic pressures. However, when the ecosystem functions are protected, their untapped economic potential might not be realised (Potter *et al*, 2017; Boc *et al*, 2015). Globally, sustainable development is the proposed pathway between the needs of development and those of conservation (United Nations, 2015), and theoretical and practical implications and applications of sustainable development remain topics of debate amongst practitioners and academics.

Stressors related to urban environments can be evaluated from an anthropocentric perspective. When evaluated from the perspective of demand, the focus would include social justice, the benefits offered by greenspaces, and the factors that would shape the provisioning of and access of urbanites to greenspaces (Jennings *et al*, 2017; 2016).

Researchers such as Kondo *et al* (2018), Jennings *et al* (2017) and Williams (2017) highlighted the fact that ecosystem services contribute to the quality of life of urban

dwellers, while greenspaces are generally considered to offer important restorative benefits to humans who are experiencing the daily stresses of urban living. On the other hand, environmental stressors are also relevant to the perspective of an actual area of the physical environment that has been subjected to the pressures of development (Freedman, 2015). In the research of Tzoulas *et al* (2007), the concepts related to human health and the health of the ecosystem are combined through the development of a theoretical framework that is used to evaluate the health of the urban greenspace.

Environmental stressors are evident on different levels - from the global to the local. There are increasing concerns that Earth, a finite space within its planetary boundaries, might not be able to support the growing global population and the demand for resources across the world (Cohen, 2020; Miller & Spoolman, 2019; Brown, 2015; Carson, 1962). This chapter therefore focuses on a critical analysis of the reviewed literature that relates to the geographical interplay between urban growth, conservation and sense of place in the context of urban greenspace.

2.2 Framework for the literature review

The challenge of conservation within the context of competing needs in a growing metropolitan area was the focus of this case study. The literature review is structured around this focus, which is reflected in the objectives of this thesis. Each of the objectives formulated in Chapter 1 is linked to the literature and case studies relevant to the topic of this thesis, as presented in Figure 2.1. In order to support the first objective, some of the implications arising from urban development and that impact on the management of the different types of greenspace are identified in the contexts of the global North and the global South respectively.

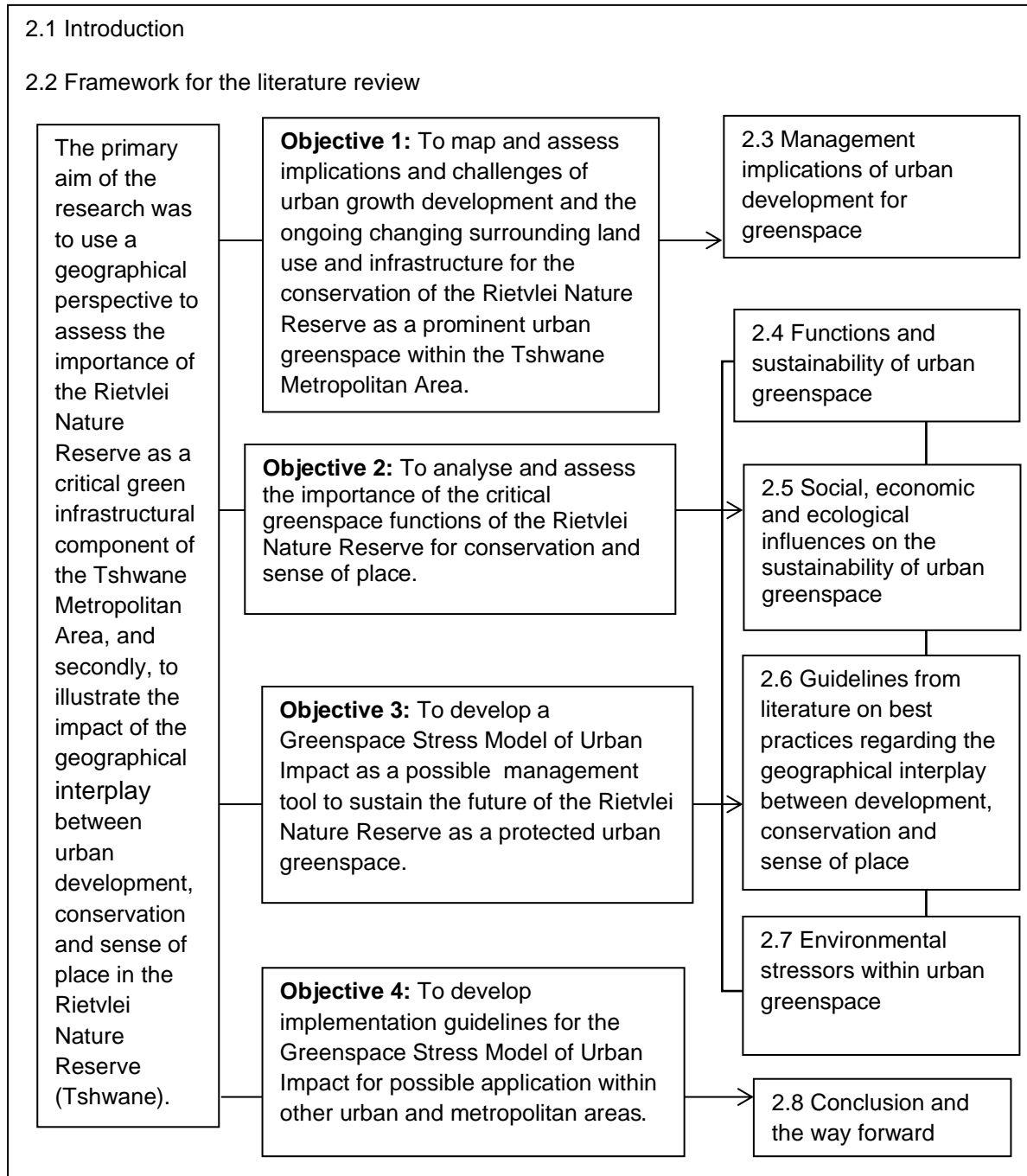


Figure 2.1: The link between the objectives of the thesis and sections of the literature review

The conservation of greenspace is discussed in terms of the influence that the social, economic and ecological components of the metropolitan area have on the sustainability of the urban greenspace. Guidelines and best practices for controlling

the interplay between urban development, conservation, and sense of place were identified through the literature survey. Throughout the following sections of the literature review, potential environmental stressors and benefits which could contribute to the development of the Greenspace Stress Model of Urban Impact (Objective 3) are identified.

2.3 Management implications of urban development for greenspace

Urban development is associated with *inter alia* changes in urban morphology, land use and its utilisation, as well as demographic changes. Greenspace has been an important component in urban growth management strategies and policies, and yet its definition is not simple. Greenspace is often referred to as a soft open space and refers to land that is covered mainly by vegetation, as in the case of parks, sportsgrounds, and land for urban agriculture, ridges, wetlands or areas bordering on rivers (CSIR, 2000). Undeveloped green spaces could be either protected, landscaped or merely yet-to-be-developed areas.

Different frameworks have been suggested to investigate the implications of greenspace for human quality of life. Models adapted from the field of Economics promote efficiency in the use of physical, human, and natural capital (Cilliers & Cilliers, 2015) as useful tools in this respect. Dietz *et al* (2009) applied mathematical models of efficiency and well-being to indicate that human quality of life should not necessarily lead to environmental destruction. On the other hand, Williams (2017) used remote sensing data to evaluate equity in the provision of urban greenspace in Vancouver. Williams (2017) argued that ecologists do not pay sufficient attention to environmental justice and equity in their attempts to access

urban greenspace. Furthermore, there are indications that urbanites in the more affluent areas of the city are in a better position to access urban greenspace (Marahaj, 2020; Jennings *et al*, 2016). However, there are disparities in accessing urban greenspace which are especially evident in the cities of the global South (Rigolon *et al*, 2018).

The Millennium Ecosystem Assessment (2005) provides a framework of four categories to evaluate the functions of ecosystems and the goods and services provided by the natural environment in the form of supportive, provisioning, regulative, and cultural services. There are, however, also ecosystem disservices and negative externalities of proximity to or contact with urban greenspace that should be noted and therefore included in such assessments (Mak & Jim, 2018). Disservices need to be managed in order to prevent them from becoming potential stressors on various geographical levels.

Global environmental challenges such as climate change and the decline in biodiversity provide challenges to good governance and effective management at different levels (Potter *et al*, 2017). On a local level, however, the way in which greenspace is managed influences not only the characteristics of the space, but also the way in which ecosystem services are supported by the authorities. On both the global and local levels, there are concerns that the finite Earth space constrained within the planetary boundaries might not be able to support the growing population and fulfil the huge demand for resources (Cohen, 2020; Heymans *et al*, 2019; Brown, 2015). Thus, it is of critical importance that cognisance should be taken of the environmental stressors in urban areas if a sustainable future is to be a reality for both the global and local populations.

What follows in Sections 2.3.1 and 2.3.2 is a comparison between the global North and the global South of the spatial manifestation and utilisation aspects of urban greenspace. The reason for including this comparison in this thesis was to identify possible lessons to be considered from the case study of the Rietvlei Nature Reserve in Tshwane.

2.3.1 Some implications of urban development and growth management for greenspace in the global North

As illustrated in the cases discussed below, greenspace is an important consideration for the respective generations of urban growth management (Arendt, 2019; Horn, 2018). Growth management strategies play an important role in the spatial patterns of urban development and the protection and management of urban greenspace (Zepp *et al*, 2020; Arendt, 2019; Siedentop *et al*, 2016).

From the beginning of the 20th century, various interventions for urban development were planned in the USA and Europe. In the urban context, the goal of negative strategies, such as green belts, served to limit urban growth in areas used for *inter alia* agriculture, conservation, or the provision of water. On the other hand, positive planning policies identified priority areas for development and made recommendations for acceptable building densities (Siedentop *et al*, 2016).

Using the example of Olmstead and Vaux (a firm tasked with urban development), Sinnet *et al*, (2015) indicated that in the early 19th century open space was not referred to as green infrastructure even though it performed functions similar to those of the latter. In their planning projects, the Olmstead firm attempted to balance human and ecological functions in urban development and to integrate various ecological hubs and links in planning for urban development (Sinnet *et al*,

2015). Urban greenspace therefore provided ecological benefits through flood mitigation, its facilitation of sewage and stormwater outflows, habitat protection, as well as social and health benefits. In accordance with their planning methods, greenspace could be accessed from different parts of the city. Fredric Law Olmstead (senior) also emphasised the importance of re-introducing indigenous vegetation and of protecting watercourses in the planning and layout of famous parks such as Central Park in New York, the Boston Park System, as well as private estates across North America (Sinnott *et al*, 2015; Mitchell, 2005).

Ebenezer Howard (1850-1928) proposed the Garden City Concept in the book, *Garden Cities of Tomorrow*, published in 1902. The “Town-country Magnet” and the “marriage” of town and country were suggested as solutions to problems created by rural-urban migration (Ndubisi, 2014: 54). The Garden City was seen as an ecologically self-sufficient unit, including residential places and places for work within walking distance of one another (Arendt, 2019; Ndubisi, 2014). A central park could provide space for urbanites to socialise in a natural setting, and green belts could provide a buffer between residential and industrial land-use zones. The green belts around the city were intended to limit urban expansion and were left as open space or used for agriculture.

Various cities across the world have been developed or adapted according to the principles of the Garden City Concept. In London, residential and industrial land-use functions were segregated, and greenspace was developed to improve the unhealthy living conditions that developed after the Industrial Revolution (Zepp *et al*, 2020; Grayson, 1990). Letchworth and Welwyn in the United Kingdom (UK) and Radburn in the United States (US) were planned and developed as New Towns

according to the principles of the Garden City Concept (Pacione, 2009). The importance of contact with nature is also acknowledged by planners such as the Scottish botanist, Patrick Geddes, who left a legacy which supported the concept of integrating the natural environment into urban planning initiatives (Maulam, 2017).

Many cities in Europe grew beyond the Green Belt that was supposed to demarcate the limits of growth. Green belts have been efficient in protecting valuable conservation, recreational, agricultural and forest areas, but not necessarily in controlling urban growth (Siedentop *et al*, 2016; Horn, 2018). This is not surprising as Howard, as quoted in Horn (2018), initially envisaged that the Garden City would accommodate no more than 30 000 residents.

Within the growth management discourse, the compact urban form is regarded as ideal as it could counter the social and economic effects of the lower-density, outward spatial expansion of the city (Tappert *et al*, 2018; Horn, 2018). A more compact urban form with high-density developments could potentially lead to savings in terms of service-provisioning networks, traveling time and fuel consumption.

Densification strategies have, however, led to tensions between development, conservation, and sense of place. In Brisbane (Australia), where community organisations have tended to resist densification, development plans were adapted to conserve an anchor zone of greenspace around the Brisbane River. This zone has proved to be important for the tourism destination image of Brisbane, as well

as for the sense of place and quality of life of the urban residents (Byrne & Sipe, 2010).

In the Swiss cities of Basle, Berne, Geneva, and Zürich, as well as in Prague (Czech Republic), traditional urban food-garden allotments have become contested spaces in areas where densification has been planned (Gibas & Boumová, 2020; Tappert *et al*, 2018).

Strong community support for the conservation of greenspace is an important success factor in the protection of urban greenspace (Elmendorf, 2020). In the City of a Thousand Oaks (California), the “multiple core-modified greenbelt community land-use concept” (Towne, 1998:90) was applied in city development plans. It included a ring of natural open space around relatively densely-clustered residential developments. In Thousand Oaks, the effects of community surveys on local government budgets prioritised the protection of the natural beauty of the landscape and its associated quality-of-life benefits (Towne, 1998).

High-density urban development around the Văcărești Wetland in Bucharest (Romania) has led to the emergence of serious environmental stressors. The degraded wetlands area, polluted and unsafe, is a case in point. In the Post-Communist dispensation, however, the use of this degraded area was re-evaluated (Manea *et al*, 2016; Boc *et al*, 2015) through a comparative global analysis in which a SWOT analysis of different scenarios was compared (Boc *et al*, 2014). Several criteria (technical, economic, social, ecological, political, and cultural) were evaluated so that the scenarios could be ranked through a scale ranging from (1) (major negative) to (5) (major positive).

It was realised that industrial or real estate development in this area could hold potential economic benefits for both the developers and the local government through the increased tax income that could be generated. This option, however, posed a high risk for negative environmental impacts. At the other extreme, the option to preserve the natural area could become an economic liability. Both these options would limit accessibility to the resources of the wetland area and also the possibility of social benefits. Owing to the potentially negative ecological impacts, the option of a sport and leisure park was not accepted. Instead, a solution was found by presenting the wetland area as one to be used by a multiplicity of users. Different zones were demarcated for educational facilities, cultural heritage conservation and events, as well as for picnics and active recreation, respectively. Furthermore, only passive recreational activities associated with conservation, such as photography, were allowed in the demarcated conservation areas (Manea, 2016; Boc *et al*, 2015).

Green infrastructure can provide potential ecosystem benefits in the environmental, social and economic spheres (Heymans *et al*, 2019). Haase and Rink (2014) argue that the supporting, provisioning, regulating and cultural ecosystem functions should be consciously identified and restored in order to enhance the quality of life of the associated users.

This model places urban greenspace in the broader context of theoretical debates in the Social Sciences, Human Geography and Urban Planning spheres (Haase *et al*, 2019). In a shrinking city, vacant land and rundown industrial areas, with derelict buildings, are therefore being redeveloped as greenspace. While this model (Figure 2.2) has been unpacked in the context of urban shrinkage, the nexus

between urban change and ecosystem functions is also relevant to other contexts. This model therefore informs the model which was developed to demonstrate the interplay between urban development, conservation and sense of place in the context of urban greenspace (Chapter 6).

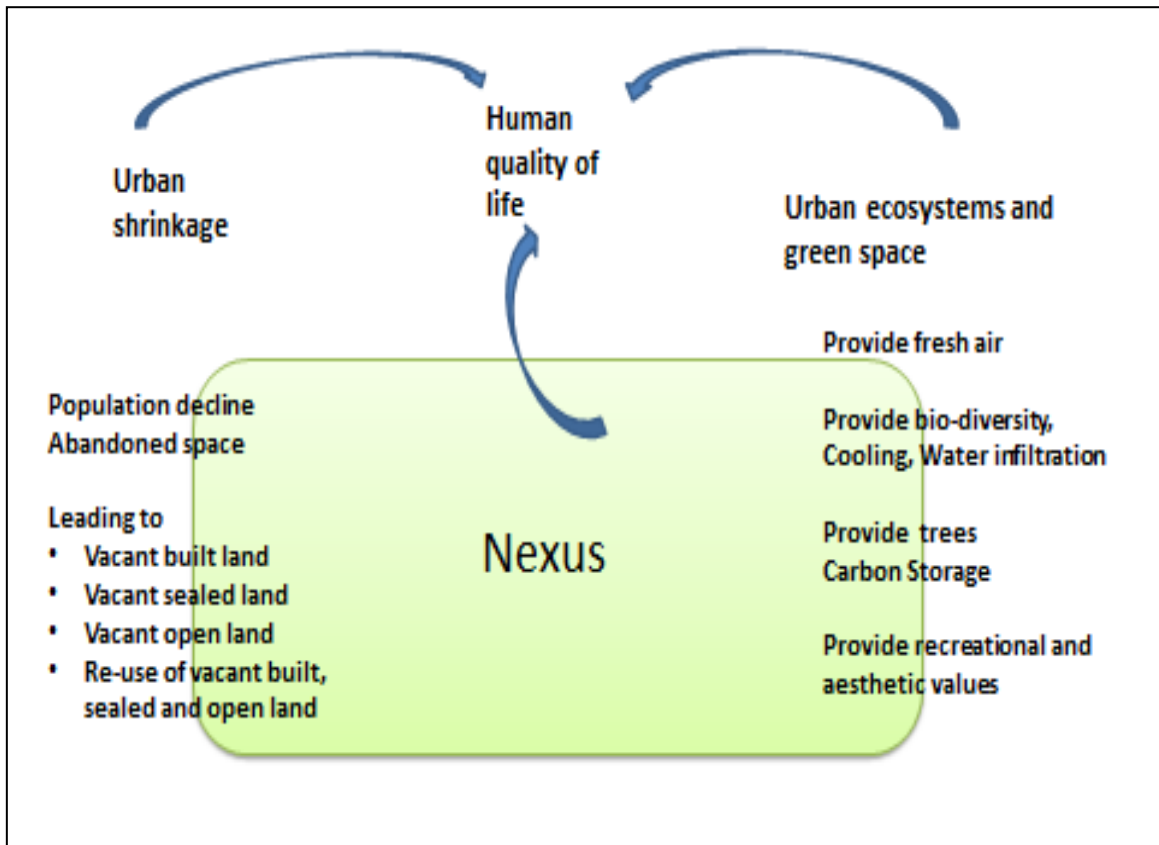


Figure 2.2: The nexus between processes and patterns of urban shrinkage and ecosystem services provisioning in Europe

Source: Adapted from Haase and Rink (2014)

The literature overview indicates that greenspace is important for the quality of life of people living in the global North cities. This is not only in terms of the user behaviour of the visitors to a particular greenspace, but even more so in terms of the role of greenspace in the larger ecological green infrastructural sphere, and including the ecological services (e.g. the provision of water) supported by greenspace.

The following section, focuses on the implications of urban development for the management of greenspace in the global South and is relevant to the study area of the Rietvlei Nature Reserve, Tshwane, South Africa.

2.3.2 Some implications of urban development and growth management for greenspace management in the global South

Issues of balancing human needs concerned with urban development and settlement and with protecting greenspace are providing growing challenges in the global South. The Garden City Model has also been applied in African cities (e.g. Lilongwe (Malawi), Kisumu city (Kenya), Kumasi (Ghana), and Addis Ababa, also known as Finfinne (Ethiopia)) (Toure *et al*, 2020; Girma *et al*, 2019; Mkula, 2015; Mensah, 2014; Oduro-Ofori *et al*, 2014; Owino *et al*, 2014). Greenspace is, however, being threatened in that it must accommodate the increased population numbers arising from the high rate of urbanisation and concomitantly battles to balance the growing demand for housing and services with the protection of natural areas (Girma *et al*, 2019). This provides a stressor for the management and protection of different types of urban greenspace. Even where environmental policies are in place, their implementation is in many cases not effective (Girma *et al*, 2019; Lindley *et al*, 2018; Mensah, 2014).

The quality of life in Asian cities is hampered by challenges related to rapid urbanisation and environmental degradation (Li, 2020; Li *et al*, 2016; Li *et al*, 2015; Atiquil Haq, 2011). According to Li (2020) and Li *et al* (2015), urban planners, policy makers and builders in Nanchang City, decision makers in the capital city of Jiangxi province (China) have underestimated the importance of greenspace. This has led to fragmentation and a reduction in the available greenspace area and in the

ecosystem functions, such as the buffering of noise, the absorption of air pollution, and the mitigation of the urban heat-island effect.

Environmental stressors such as high levels of air and noise pollution and thermal stress are causing health hazards for the population, most of whom are also deprived of the potential health benefits of greenspace recreation. Similar to what happened in Europe (Haase & Rink, 2014), strategies for restoring ecosystem functions in rundown industrial areas, railway corridors and abandoned canals have also been applied in cities in the global South (e.g. China) to improve ecosystem services and quality of life (Song *et al*, 2017).

In Mumbai (India), urban encroachment has eliminated large mangrove swamps that used to protect the city from the adverse effects of flooding (Dholakia *et al*, 2020; Beatley, 2011). Changes in this ecosystem function could potentially have a negative impact on the quality of life of communities living downstream of the mangroves. According to Beatley (2011), this might require investments in grey infrastructure to control the stormwater drainage.

The sustainability agenda of Curitiba (Brazil) puts a high priority on the ecological functions of urban greenspace (Osorio Guzmán *et al*, 2020; Soltani & Sharifi, 2012). Integrated planning includes an integrated network of greenspace, which supports service provision, public transport systems, water provisioning; wastewater and waste management.

Political decision-making, as well as the dualistic social structure of the South African society, has influenced the spatial development of South African cities (Anderson *et al*, 2020; Horn, 2018; du Plessis, 2015; CSIR, 2000; Hattingh & Horn,

1991; Marais & Visser, 2008). Since 1994, there have been major changes in the South African spatial development policies and instruments aimed at the restructuring of cities toward a compact, high-density urban form with mixed uses (Maharaj, 2020; Horn *et al*, 2018; du Plessis, 2015).

The Development Facilitation Act (Republic of South Africa, 1995), as well as the National Development Plan - Vision 2030 (National Planning Commission, 2012), and the National Spatial Planning and Land-use Management Act of 2013, collectively aimed to restructure South African cities and improve access to services for all. The paper, Guidelines of Spatial Development Frameworks (Republic of South Africa, 2011), suggests functional integration as one of the guiding principles for spatial planning. On the provincial level, the Gauteng Spatial Development Framework 2030 (Gauteng Province, 2011) and the Gauteng Integrated Infrastructure Master Plan serve to direct the spatial and economic transformation of the urban areas.

According to the City of Cape Town's Spatial Development Framework, the city needs to "balance competing agendas for the provision of basic needs, social services and utilities against the stimulation of economic development and employment, the management of city growth, and the protection of environmental resources and systems" (City of Cape Town, 2012: 29).

South African cities and towns are experiencing major challenges in respect of the limited water sources for the demands of a growing population (Lombard, 2020; Knuppe, 2011). Not only is the quality of water a problem; pollution and catchment destruction are contributing to the decline in its quality (Baker & Greenfield, 2019;

van Ginkel, 2011; Oberholser *et al*, 2008; Wepener *et al*, 2008). This situation is exacerbated by the inadequate and inefficient maintenance and renewal of infrastructures for water and sanitation (Loubser *et al*, 2020; van Vuuren, 2017). Service provision to a growing population remains challenging, and this is especially true in respect of the formalisation of spontaneous informal urban development sprawl (City of Tshwane, 2018/19; Chauke, 2017). According to the South African Statistical Service Household Survey, the City of Tshwane experienced an 18% backlog in terms of its sanitation services (Lehola, 2017). However, according to the South African Census of 2011, 80% of the households in Tshwane were living in formal dwellings, and 64% of them had piped water inside their dwellings (City of Tshwane, 2017).

The South African Water Research Commission suggests a systems approach, with multiple objectives to address the challenges of the quantity and quality of water. This implies that the community values and aspirations in terms of urban greenspace need to be carefully considered when planning water-sensitive settlements (Armitage *et al*, 2014).

From the preceding review it became clear that greenspace has been prominent in the planning of urban development in the global North. The application of global North planning principles for greenspace planning in the global South has not, however, been maintained to the same standards (Girma, 2019; Chishaleshale *et al*, 2015). However, there is evidence of an increasing awareness of the importance of conservation in respect of urban greenspace in what is called a quest for “naturbanity” (Landy, 2018).

It is clear that decision-making in respect of the balance between human needs and the protection of urban greenspace is increasingly being influenced by the characteristics and functions of a particular greenspace, as well as by the context in which it is viewed. This was the motivation, therefore, for considering greenspace to be important enough and of value, and thus to explore the functions of greenspace, as well as its benefits and risks, in the next section.

2.4 Functions and sustainability of urban greenspace

Land-use and functional changes in particular areas are virtually continuous processes that epitomise urban development. Rapid urban development could render particular places useless should they lose their past identity and alter their functions (Haase & Rink, 2014). This is not only relevant to places of historic and cultural significance such as historic mansions in Iran (Molavi *et al*, 2016), but also to urban greenspace (Mohammad *et al*, 2013).

Within the context of growing human needs, the pressure of development and the densification strategies adopted by the metropolitan authorities, as well as the strong sense of place that develops in urbanites, could potentially play important roles in the maintenance and conservation of urban greenspace (Sabyrbekov *et al*, 2020; Hausmann *et al*, 2015). The protection of the green infrastructure could also contribute to the distinctiveness of and sense of place in cities that are changing in the face of rapid population increase and spatial development (Fisher, 2017). An evaluation of the functions of greenspace in the city and of the reasons for protecting it (Anderson *et al*, 2020) was therefore regarded as important in the context of this study.

The intrinsic suitability of a particular place for development (e.g. the geological structure, soil type, surface gradient, water table and presence of sensitive wildlife habitats) might influence the decision as to whether a particular place would remain as a greenspace or whether it would be transformed into an urban land-use zone. Apart from these influences, greenspaces in cities also have social and economic functions that could influence their sustainability (Mangara, 2016).

Parks are valuable assets in the context of greenspaces, and their landscaped gardens and deer trails, features that date back to the eras of Ancient Greece and Medieval Europe, could be considered the forerunners of the contemporary public parks of Europe and the United States.

The respective parks forums of Britain and Australia focus on the benefits of parks for people in terms of their culture, level of education, health and well-being, and leisure-time interests. These forums also emphasise the potential of parks for tourism, for offering environmental goods and services and for generating benefits in the economic sphere (Parks Forum, 2011). The physical and mental health benefits of urban greenspace are also well established in the relevant literature sources (Chen *et al*, 2020; Kondo *et al*, 2018; Bernstein, 2017; de Crom & Nealer, 2017; Coutts & Hahn, 2015; de Young, 2013).

Urban greenspace provides social benefits in that it provides opportunities for social interaction and platforms for events. Environmental goods and services provided by urban greenspaces include, *inter alia*, improvements to the air quality; the recycling of water and oxygen; the benefits emanating from their role as carbon

sinks; and their cooling effect on the urban heat island (Gomez-Baggethun & Barton, 2013; Millennium Ecosystem Assessment, 2005).

Section 2.5 focuses on the influences of these components on urban greenspace since collectively they are linked to the conservation and water-provisioning functions of urban greenspace.

2.5 Social, economic and ecological influences on the sustainability of urban greenspace

One of the original definitions of sustainable development established by the World Commission on the Environment and Development (1987:8), namely “development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs”, certainly is still relevant to greenspace in the city today. The concept of sustainable development is based on the social, economic and environmental dimensions of the interplay between development, conservation and sense of place.

It deserves mention that in reality, the pro-development and pro-conservation approaches to the greenspace issue are not necessarily in balance. One of the reasons for this imbalance is that in contrast to developed urban areas, the functions of greenspace are not adequately measured in terms of monetary value (Sabyrbekov *et al*, 2020; Cilliers & Cilliers, 2015).

The integration of nature-based conservation objectives into socio-economic development policies is a conservation strategy that could be relevant to urban greenspace. The social, economic and environmental benefits of greenspace are included in the action plan for greenspace devised by the World Health

Organisation (World Health Organisation, 2017). As biodiversity is declining on the global level, new emphasis is now being placed on conservation. There are various motives for the conservation of species and landscapes (Pearson, 2016; Gaudie, 2013), while sense of place could also potentially play an important role in this regard (Žlender & Gemin, 2020; Williams & Stewart, 1998). Measures to promote the sustainability of urban greenspaces could have social, cultural, economic and environmental implications, some of which are unpacked in the following section.

2.5.1 Social and cultural influences on the sustainability of urban greenspace

Urban development leads to changes in the natural landscape in terms of land use, viewsheds, sites, watersheds, and functions (Riechers *et al*, 2019; Mohammad *et al*, 2013; Stedman, 2003). Greenspace is not always linked to conservation or associated with a sense of place. Sometimes it is only when the known characteristics of a landscape are threatened that sense of place becomes evident through the resistance presented by individuals or communities (Stedman, 2003). The use of and perceptions about a particular urban greenspace might also change over time as was evident in the case of the Rondebosch Common in Cape Town (South Africa) (Woelk, 2017).

Through the various definitions of sense of place, it is apparent that perceptions and interpretations of the environment have the potential to link social and ecological issues (Sebastien, 2020; Hausmann *et al*, 2015). Sense of place is value-based and is one of the benefits of cultural ecosystem services (Riechers *et al*, 2019; Dickenson & Hobbs, 2017). The characteristics and place identity of a greenspace, as well as the dependence of people on the resources of the place,

influence the sense of place (Masterson *et al*, 2017; Puren *et al*, 2006). The significance of sense of place is linked to the local context, the character and physical setting of the place, the identity of the place, the names of the people involved, and their experiences in the place in question (Woelk, 2017; McLain *et al*, 2013).

An attachment to place is an indication of feelings of belonging in a particular place (Jennings *et al*, 2016) and even affection and love for that place (Tuan, 1977). Individuals or groups may identify strongly with places associated with a significant cultural heritage or unique natural features (Farahani & Maller, 2018). There are indications that strong connections to a particular place could support motivations for conservation and environmentally-responsible behaviour (Colley & Craig, 2019; Lee, 2011).

Sense of place is not only associated with positive experiences but could also be applied to the identification of dangerous areas, the fear of gang-threatened neighbourhoods (Curtis & Shiau, 2014) or crime (Maruthaveeran & van den Bosch, 2014; Pacione, 2003). Negative externalities such as crime, vandalism, the nuisance element, and associated health and safety risks, could negatively influence the sustainability of urban greenspace and quality of life in the city.

The concept, urban greenspace, does not have the same meaning for everyone (Farahani & Maller, 2018). It leads to different motivations for conserving urban greenspace or to decisions to change the land-use function. The diversity of needs and demands in terms of greenspace can therefore act as stressors for the protection and maintenance of urban greenspace (Girma *et al*, 2019;

Chishaleshale *et al*, 2015; Raymond *et al*, 2009). In a context where basic needs are recognised as not being met, the sense of place in respect of urban greenspace could be that it represents a space for development. Thus, it is important to consider the needs and aspirations of the different stakeholders in the interplay between development, conservation and sense of place.

Sense of place has featured prominently in the research conducted by critical geographers, such as Soja, Harvey, and Massey, who, from a Marxist perspective, analyse cities as the material consequence of capitalism (Adams *et al*, 2016; Massey, 1994). Soja based his spatial theory on that of Lefebvre, by stating that spaces are both real and imagined.

The critical perspective focusing on societal struggles and the globalisation of the economy argue that unique spaces are represented and that they are reflected in the complexity of the various perceptions of sense of place and the contested significance and meanings attached to the place (Adams *et al*, 2016; Massey, 1994). From this perspective, conservation areas are spaces of resistance against the new liberal agenda for urban growth. On the other hand, sense of place is also evaluated from a positivist perspective, where analysis is based on the individual conceptual systems associated with particular locations (Bush *et al*, 2020; Tauotsoala *et al*, 2017; Molavi *et al*, 2016; Ghoomi *et al*, 2015; Canter, 1977).

The theoretical framework for sense of place developed by Canter (1977) includes form, activities, and imagination (Sebastien, 2020). Montgomery (1998) argued that the frameworks for sense of place are of limited practical application in creating successful cities. He therefore applied policy directions to the basic components

identified by Canter. Thus, the focus shifted from sense of place to place making (Figure 2.3). Based on this framework, policies were implemented to improve each of the identified aspects and to contribute to the form, activity, and image of the place in question.

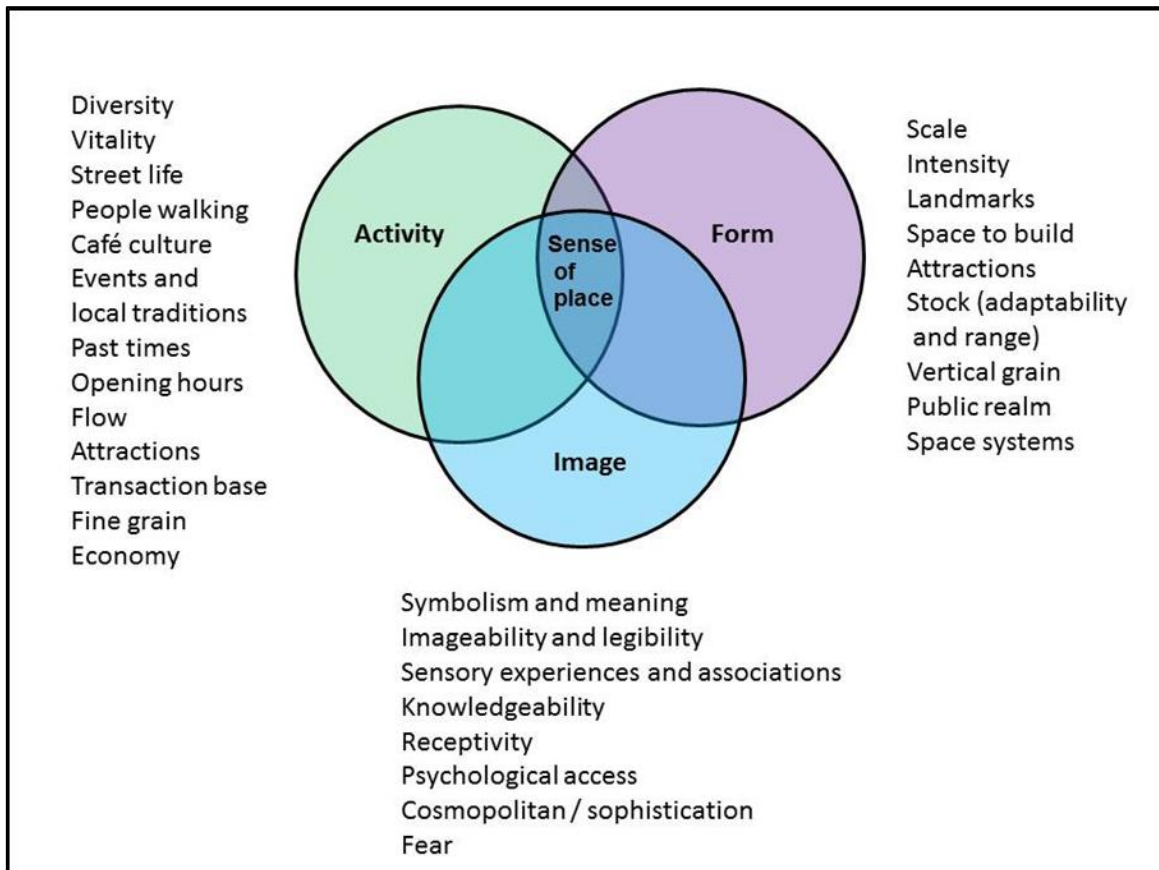


Figure 2.3: Montgomery's adaptation of Canter's model for sense of place to include specific aspects linked to policy directions for improving places in the city
 Source: Adapted from Montgomery, 1998:98

This framework for analysing sense of place has, however, been re-interpreted by different scholars, including Punter in 1991 and Golkar in 2000 (Ghoomi *et al*, 2015). They used the concept, *meaning*, rather than the concept, *imagination* or *conception*, and unpacked the three components, namely form, activities and meaning, in greater detail (Ghoomi *et al*, 2015). In later adaptations of the model, an environmental component was also included. *Activities* and *Imagination* were

grouped to become the *Aesthetic and Experiential Component*, while *Activities* and *Form* constituted the *Functional Component*. On the other hand, *Form* and *Ecosystem* were combined in the *Environmental Component* of the Permanent Place. The form, image and activity components will be applied to sense of place in the Rietvlei Nature Reserve.

The intentional legibility of a place, as created in the constructed environment, is especially important to architects and planners (Landman, 2016; 2015; Blom, 2012). In the field of tourism, sense of place is linked to the destination images and place making (Hall & Page, 2014; de Jager, 2010). The names, symbols, language register, images, as well as the representations on maps and marketing collateral, contribute to the sense-of-place perspective of destinations or sites.

The duality of the South African society, with its contrasting worldviews and understanding of space, poses major challenges in the utilisation of public space (Woelk, 2017; Landman, 2015). The Green Agenda, with a clear focus on the impact of urbanisation on natural ecosystems and the mitigation of human impacts on the natural environment, seems to be a priority in the more affluent neighbourhoods, while the poorer neighbourhoods tend to emphasise the Brown Agenda. The Brown Agenda focuses on the provision of water, a reduction in pollution, and the mitigation of environmental constraints impinging on health and well-being (Cilliers *et al*, 2014; Schäffler & Swilling, 2013).

Different perceptions of greenspace need to be understood to improve attempts to protect it (Woelk, 2017; Landman, 2016; Miller *et al*, 2015). The significance that a place has for an individual or group does in fact influence place-based behaviour

(Armstrong & Stedman, 2019; Masterson *et al*, 2017; Vaske & Kobrin, 2011). Conservation-minded individuals would most probably have a stronger attachment to a conservation area and become more involved in conservation activities than individuals with no knowledge or concern about conservation (Armstrong & Stedman, 2019; Chiu *et al*, 2013; Vaske & Kobrin, 2011; Boc *et al*, 2014; 2015).

From the literature review, it became clear that formal, as well as informal social and cultural developments could influence the continued existence of urban greenspace. The balance between urban development and the maintenance or conservation of urban greenspace is influenced by the perceptions of communities and local government, as well as by economic factors (Sebastien, 2020).

2.5.2 Economic influences on the sustainability of urban greenspace

Urban development and the associated changes in land use present potential economic benefits, which in turn increase the pressure of development on the urban greenspace. The costs of environmental management, maintenance and conservation activities have implications for limited budgets. In the global South, it remains a continual challenge to balance social provision with the costs associated with protecting and maintaining the greenspace (Girma *et al*, 2019; Chishaleshale *et al*, 2015). This is complicated by the socio-economic structure of the area surrounding the urban greenspace. Poorer areas with higher housing-densities often also have limited access to greenspace (Girma *et al*, 2019).

Development corridors aim at linking residential areas to areas of economic opportunity. The economic value of greenspace within a spatial development corridor could therefore outweigh its conservation value. Large green spaces,

which are located in a development corridor between growth nodes, could be evaluated as barriers to development. On the other hand, linear green areas, which are servitudes for infrastructural networks, could have a positive economic effect on future developments. It is more cost-effective to develop infrastructures, such as electricity networks, through large greenspace areas than through developed areas accommodating numerous property owners.

Even though all human activity impacts on the natural environment, it is not easy to incorporate environmental costs or externalities into an equation representing the environmental value of an urban greenspace. Owing to the destruction of biodiversity, it is possible for some of the undiscovered elements to be lost to future scientific use, cosmetic or medicinal applications. The short-term economic benefits could therefore lead to long-term environmental and economic losses. The conservation of grasslands not only protects habitats and species, but also supports water quality in a catchment area (Zhao *et al*, 2020; SANBI, 2013). There are long-term monetary savings for water utilities when water is filtered through grasslands and wetlands (Carbutt & Martindale, 2014).

2.5.3 Ecological influences on the sustainability of urban greenspace

Urban development leads to the fragmentation of the natural environment. The argument that biodiversity enhances the resilience of an environment is an important motivation for protecting urban greenspace (Fisher, 2017). There is a range in the type of greenspace and the size of the area it occupies that is needed to provide habitats and adequate gene pools for the sustainable reproduction of a variety of species. The relative location and characteristics of the surrounding urban landscape, and the size and quality of the greenspace patch influence the

habitat and its potential for the conservation of biodiversity (Lepczyk *et al*, 2017). Each urban greenspace related to water provisioning naturally forms part of a bigger picture at the catchment level (Baker & Greenfield, 2019).

The benefits associated with and the value attached to an ecosystem are relevant on different scales or resolution levels, ranging from the global level to the regional (ecosystems) level, to the local or site level (Sutherland, 2019; Pearson, 2016; Mitch & Gosselink, 2011). The significance of a greenspace may be evaluated differently at the site level as opposed to the value attached to a larger ecosystem on the regional level (Cilliers & Cilliers, 2015). A particular wetland can, for example have benefits for users on site level, but also provide a habitat for migratory birds (Callaghan *et al*, 2018). Thus, the role that urban greenspaces could play in providing water sources for growing urban populations as well as in protecting biodiversity should therefore not be under-estimated (Baker & Greenfield, 2019; United Nations, 2018).

When land-use changes transform landscapes, the effects are not only apparent on the local ecosystem, but also on a regional or global scale. In fact, the destruction of habitats, as in the latter case, could lead to the extinction of an entire migratory species (Sutherland *et al*, 2019; Millennium Ecosystem Assessment, 2005). The selected scale or resolution on which a greenspace is evaluated influences the management approaches and the data requirements. The management of a watershed on a regional scale, for instance, is not equivalent to the management of a greenbelt or the protection of a recreational area on a local scale (Sutherland *et al*, 2019; Boulton *et al*, 2018; van der Wateren, 2012; Wei, 2008).

The resolution at which a study is conducted influences the geographical tools required to detect ecological problems. Remote sensing images and geographical information systems (GIS) are effectively applied to identify possible sources of pollution in catchment areas (Petersen *et al*, 2017; Gründling, 2004) because land-use functions and human activities in a catchment could contribute to the risk of cultural eutrophication in particular water bodies (Baker & Greenfield, 2019).

Land-use functions and human activities on a regional scale (e.g. in a catchment area) could seriously impact upon the environment in that they might contribute to the risk of cultural eutrophication in particular water bodies (Baker & Greenfield, 2019).

The quality of water entering a greenspace from an external source also affects the functioning of that particular site. It is therefore important to consider greenspaces in terms of their functional systems and their connecting corridors on different resolution levels (Baker & Greenfield, 2019; Sutherland *et al*, 2019; Wolhitz, 2016; Schäffler & Swilling, 2013; Gauteng Province, 2011; Byrne & Sipe, 2010). The green infrastructural approach therefore places a particular site within the broader context of its ecosystem functions and linkages and in the context of a typology of greenspace components (Wolhitz, 2016; Atiquil Haq, 2011; Byrne & Sipe, 2010). In order to protect wildlife populations, regional green corridors should allow for the migrations of wildlife between the larger protected areas.

Hydrological systems are interlinked. This means that degraded wetlands increase the vulnerability of water sources to silting (United Nations, 2018; Sieben *et al*, 2017). It is therefore important to consider the implications of surrounding

developments for increased runoff and urban return flows (Mitch & Gosselink, 2011). One such example is the Kaalspruit, which flows from Ekurhuleni Metropolitan Area in the Gauteng province into the Hennops River. Because the degraded wetlands could not support the water purification function, they contributed to increased particle download into the Kaalspruit (Fisher, 2017, Tleane, 2011) and, as such, to the silting and eventual degradation of the Centurion Lake lower in the catchment. The continuous monitoring of the wetland functions therefore remains important (McKay *et al*, 2018) as it would prevent a situation from arising where the wetland functions can no longer be sustained.

Different components of green infrastructure are interlinked, and the environmental health of each component may have wider implications. Wetlands can play an important role in controlling stormwater drainage by reducing the speed of the floodwater currents, the circulation and spreading of the water, the recharging of the groundwater supply, and the water purification process through filtration (Gründling *et al*, 2017; SANBI, 2013; Mitch & Gosselink, 2011). Unfortunately, the ecological function of wetlands in the water purification process is often taken for granted (United Nations, 2018; Millennium Ecosystem Assessment, 2005). Wetlands should be managed to mitigate the risk of degradation as the removal of vegetation for development and the loss of topsoil could interfere with the ecosystem functions and also increase the risk of flooding and landslides (Kuldna *et al*, 2020; Oberholser *et al*, 2014; Venter *et al*, 2003).

Water provision and sanitation remain huge challenges. Their inclusion in the United Nations Sustainable Development Goals (United Nations, 2015) bears

testimony to the importance of water as a vital resource. Untreated sewage and domestic wastewater give rise to cultural eutrophication (Baker & Greenfield, 2019), the implications of which are experienced in cities all over the world. A case in point is the city of Bhopal, India, also known as the City of Lakes, on account of the various natural water bodies in the low-lying areas between the hills where the city is located. Most of the available water here is in fact unfit for human consumption (Rishi & Khuntia, 2012). Cultural eutrophication is therefore an important stressor for water quality.

Eutrophication has also been experienced as an environmental stressor in various African water bodies, as in the cases of Lake Victoria (Uganda), Yaounde Municipal Lake (Cameroon), Lake Chivero (Zimbabwe), the Hartebeespoort Dam (South Africa) (Hart & Matthews, 2018; Foppen & Kansime, 2009). As detailed in chapter 6 (Section 6.7.5.2), eutrophication in the Rietvlei Dam is also a matter for concern (Harding & Hart, 2013; van Ginkel, 2011; Oberholser *et al*, 2008; Toerien & Walmsley; 1979).

2.6 Guidelines from literature on best practices regarding the geographical interplay between development, conservation and sense of place

The geographical interplay between development, conservation and sense of place is evident in the way human perceptions, needs and the consumption of resources are balanced with the ecological requirements for preserving and enhancing biodiversity. However, the conservation of urban greenspaces within the context of a growing city remains a challenge (Boulton *et al*, 2018; Derkzen *et al* , 2017; Lepczyk, 2017).

The following aspects are not the only best practices for the conservation of urban greenspaces, but they could be useful when it comes to prioritising the greeninfrastructure in urban management plans.

2.6.1 Integrated spatial planning

The focus of urban planning in South Africa has generally shifted from master planning prior to 1994 to the implementation of strategic frameworks for sustainable development (Maharaj, 2020; Horn *et al*, 2018; Satgé & Watson, 2018; Sihlongonyane, 2018; du Plessis, 2015), Integrated development, strategic environmental management, environmental impact assessments and community participation were important components of legislation such as the National Environmental Management Act of 1998 as well as the National Water Act of 1998, and later amendments thereof. Integrated spatial planning can be seen in the guidelines for human settlement, planning and design (CSIR, 2000), as well as the planning frameworks on different resolution levels, which aim at promoting sustainable human settlements that are economically, physically and socially integrated (Department of Human Settlements, 2019; Horn *et al*, 2018; Cilliers *et al*, 2014).

The guidelines and legislation for South Africa on the national and provincial levels provide a basis for the planning of Metropolitan Open Space Systems, and for green infrastructures on the local level (Culwick & Bobbinsk, 2016, Schäffler *et al*, 2013). When it comes to the delimitation of boundaries between an urban greenspace and the surrounding urban area, there are certain boundary strategies relating to urban growth that are applied, and lessons can be learnt from the urban planning departments in various cities of the USA, Europe, the UK and Australia.

In terms of local land-use planning and the associated regulations, new developments are only permitted once the supporting infrastructure has been put in place. Furthermore, developers are incentivised to develop within the existing urban core region rather than on the urban fringe. This approach is also relevant in the Tshwane Metropolitan Municipality.

In the context of the Rietvlei greenspace, the plans for the development of the Gauteng urban edge delimited by the Gauteng Spatial Development Framework support such issues. This development framework aims to curb urban sprawl and protect areas of natural beauty and of cultural heritage (Gauteng Department of Agriculture and Rural Development, 2014).

Furthermore, both the Green Infrastructure Plan for the Greater Gauteng City Region (Schäffler *et al*, 2013) and the Gauteng Conservation Plan (Gauteng Department of Agriculture and Rural Development, 2014) emphasise the importance of conservation practices in the different types of urban greenspace. On the local level, the Tshwane Integrated Environmental Policy (TIEP) includes open space frameworks, bioregional plans and policies for urban forestry (City of Tshwane, 2005).

The main objective of plans for urban development is generally to increase the service delivery footprint and quality of life of the urban residents (Li, 2020; de Crom & Nealer, 2017; Cilliers & Cilliers, 2016; Haase & Rink, 2014; Schäffler *et al*, 2013). When it comes to assessing the urban residents' reactions to plans for urban green spaces, however, there is evidence of increased awareness among them and the private decision makers of the importance of recognising the beneficial ecosystem services that emanate from the greenspace.

From the literature review, it became apparent that landscape conservation and ecosystem services need to be integrated into urban-planning practices in order to protect greenspace. Areas that need to be protected should, therefore, be timeously identified and the impact of rehabilitation measures evaluated. The spatial plans should also include the zones where development is prohibited. Examples of such limitations are the 1:50 year floodline, below which development is prohibited, in order to protect urban developments from flooding and also to protect the functioning of the green infrastructure (Department of Human Settlements, 2019). A buffer of vegetation should be allowed along the water courses to protect them from pollutants and to mitigate bank erosion.

These zones along rivers and around wetlands also secure the habitats for birds and other forms of wildlife. Comprehensive management plans for the greenspaces along waterways and adjacent to the wetlands also need to be in place in order to protect the watersheds. This is important because of the water purification function performed by wetlands (Sieben *et al*, 2017; Dickens *et al*, 2003). The provision of water, as well as the treatment of wastewater, should be an integral part of the integrated sanitation system (Foppen & Kansiime, 2009).

Reliable information on land cover and land use is important for knowledge-based decision making regarding urban greenspace (Siedentop *et al*, 2016). It is therefore necessary to gather baseline information for monitoring and evaluation from comprehensive and detailed mapping inventories of land use and land cover (Estoquea & Murayama, 2013). Population and economic forecasts can also be used to inform trends of urban development (Siedentop *et al*, 2016).

2.6.2 Management of urban greenspace

Ecosystem-based management is becoming increasingly important in high-density urban developments (Heymans *et al*, 2019; Steenberg *et al*, 2017) since effective management and maintenance of greenspace contribute to resilient ecosystems (Chishaleshale *et al*, 2015). Vegetation and veld management are not only important for lawns and landscaped gardens, but also for greenspaces with their indigenous vegetational cover. Periodically, the vegetation in ecological hubs needs to be rehabilitated by removing alien species and restoring the wetland functions (Venter *et al*, 2003). In order to improve the overall greening of the city, private home-owners, developers, and educational institutions should be encouraged or incentivised to maintain their gardens (Oduro-Ofori *et al*, 2014).

Management decisions and the implementation of mitigation strategies play an important role in the life-cycle evolution of a greenspace since the management interventions applied at particular critical points could influence the rejuvenation or decline of an urban area. This issue could be aligned to the principles of the model developed by Butler (1980).

Although the Tourist Area Life Cycle (TALC) model (Butler, 1980) was developed within the context of tourist destinations specifically (Liu *et al*, 2019), the management principles included in this model could possibly have wider applications. The researcher accepts that not all urban greenspaces are utilised as tourist destinations; however, the concept of an evolutionary life cycle that is posed in this model (Butler, 1980) could be relevant to the changing levels of robustness for the purpose of urban greenspaces. Thus, although the model was specifically developed as a management guideline for tourist destinations (Figure 2.4), the

relevance of the Butler (1980) model in managing urban greenspaces could be of value in the development of a model for the Rietvlei Reserve (Objective 3), and for this reason, a brief evaluation of Butler's model (1980) is included in this chapter.

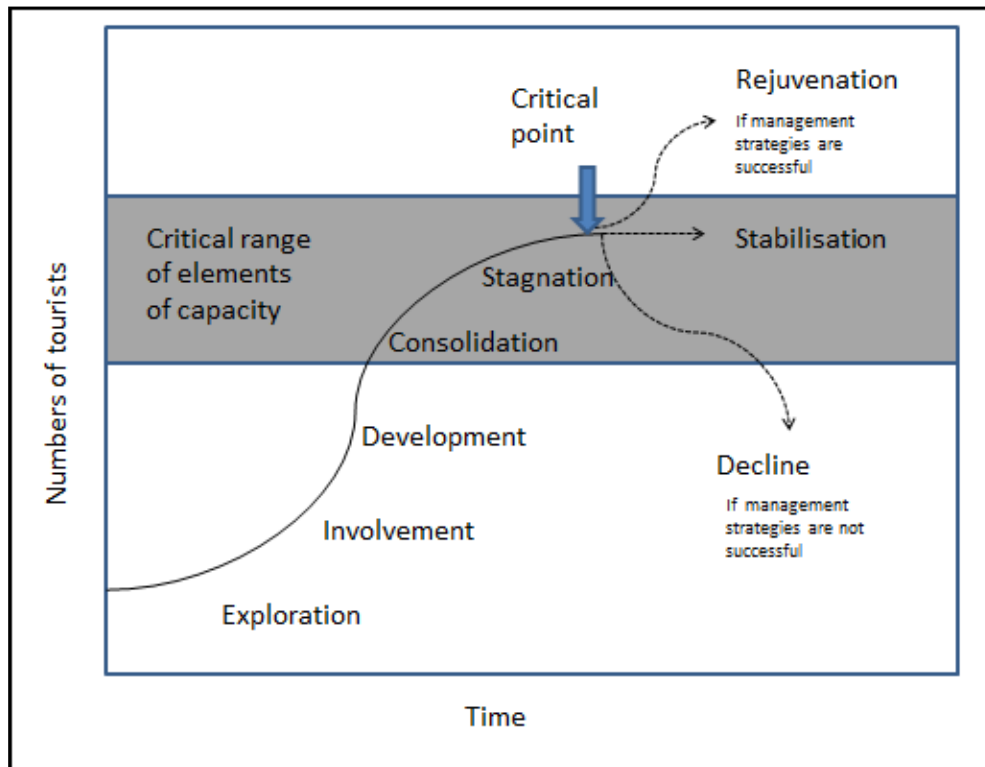


Figure 2.4: The Tourist Area Life Cycle (TALC) model
Adapted from Butler (1980)

Through the respective phases of the destination cycle, the characteristics that initially made a place attractive could be destroyed by over-tourism when the limits of acceptable change are exceeded and the carrying capacity can no longer support its beneficial role at the specific place (destination). Environmental awareness and sense of place potentially play an important role in management decisions at particular critical points in the life cycle of a specific urban greenspace. When a destination reaches the stagnation phase in terms of visitor numbers, it

can either decline until it collapses, or rejuvenation can take place. Within the context of urban greenspace, it is therefore essential for managers to understand the expectations and purpose of a particular geographical area. This could be in terms of the needs of the visitors or the ecosystem services provided by an urban greenspace site. In order to rejuvenate a tourist destination, Butler (1980) recommends the human generation of attractions or the exploration of previously untapped natural resources.

Applied beyond the tourist destination context, the rejuvenation of an urban greenspace requires management decisions and the implementation of relevant strategies that could influence the provision of sustainable ecosystem services by urban greenspaces (Rapport *et al*, 2018).

2.6.3 Multiple use of greenspace

Because of the scarcity of land in the city, mixed but compatible land-use functions could be combined (CSIR, 2000). Multifunctional greenspace, for example, provides space for bulk electrical and water infrastructural networks, recreational spaces, as well as healthy ecosystems that can support natural processes (van der Wateren, 2012). A multiplicity of uses should, however, not lead to a point where the functioning of an ecosystem is compromised (Department of Human Settlements, 2019). The carrying capacity in terms of the recreational function of an urban greenspace also needs to be monitored and managed for the purpose of a sustained recreational experience (Kuldna *et al*, 2020; Arnberger, 2012).

As South African cities and towns are experiencing major challenges with their limited water resources to satisfy the demands of a growing population (du Plessis,

2019; Knuppe, 2011), it is becoming increasingly important to protect systems that support the provisioning of water. Not only is the quality of water a problem; the destruction and pollution of the catchment area also contribute to a decline in the quality of the water (van Ginkel, 2011; Oberholser *et al*, 2008; Wepener *et al*, 2008). Thus, it is vital to protect greenspace areas that support the provisioning of water.

2.6.4 Agreements and collaborations

Cooperation and agreements for participation among the different agencies are important for the coordination of spatial urban development frameworks, as well as for governance, conservation initiatives, and sense of place (Gauteng Department of Agriculture and Rural Development, 2011; Gauteng Province, 2011; Horn, 2010).

The public, in association with private participation, could provide valuable support for conservation efforts and the protection of urban greenspace. Examples of this strategy are evident in the global North and also in the global South. In Thousand Oaks (California), a coalition of business people, government representatives, educators and citizens recommended strategies for the preservation of land for open space, the protection of wildlife and ecosystems, and the establishment of a regional trail system (Towne, 1998). On the other hand, the private sector, in association with public partnerships, played an enabling role to re-establish greenspace in Eden Park in Malawi (Mkula, 2015). On the international level, the Wildlife and Environment Society of South Africa's (WESSA) Environmental Governance Programme promotes partnerships with wildlife stakeholders and authorities (Wildlife and Environment Society of South Africa, 2018).

2.6.5 Community initiatives and public participation in support of the protection of greenspace

Early and sustained support from the community is an important success factor in the protection of urban greenspace (Elmendorf, 2020). Community support is important in the context of the global North where greenspace is identified for conservation in formal urban planning processes and through budgeting for conservation thereof (Towne, 1998), as well as in the global South where competing needs and informal developments place stressors on urban greenspace (Yang *et al*, 2015; Mensah, 2014; Takon *et al*, 2013). Non-governmental organisations, such as the Friends of Rietvlei group, that consists of volunteers who support the functions of conservation areas, has played an important role in protecting urban greenspaces (Wolhitz, 2016).

Community initiatives and support from the early stages in the planning process were important success factors in the protection of greenspace in the City and Park District of Thousand Oaks (California). Regular community surveys reflected very strong support and a high budget priority for the protection of greenspace (Towne, 1998). The natural beauty of the valleys and the semi-rural atmosphere created by greenspace, as well as the utilisation of greenspace for recreational purposes, was valued by the local community.

In the global South, competing needs influence the prioritisation of the protection of greenspace. It is important to acknowledge the needs and perceptions of the local residents in decisions on the conservation of greenspace because their support - or lack thereof – could have serious implications for the long-term

sustainability of conservation practices (Yang *et al*, 2015; Mensah, 2014; Takon *et al*, 2013).

Sense of place and culture could potentially play important roles in motivations for conservation and specific conservation practices (Lee, 2011; Verschuuren *et al*, 2010). Urban greenspace could also provide opportunities for the harvesting of indigenous plants and for conducting religious ceremonies (e.g. the Shembe in South Africa who gather under trees for religious ceremonies). The Franklin Nature Reserve in Bloemfontein and the Dlinza Forest in Eshowe (a town in KwaZulu-Natal, South Africa) are examples of urban nature reserves that are used in a quest to preserve the cultural heritage (Mthembu, 2009).

The community of iNanda in the peri-urban area of eThekweni (South Africa) uses a protected patch of grassland in the KwaZulu-Natal Sandstone Sourveld for livestock grazing, crop production, religious and cultural practices, and to gather resources for the crafting of baskets and brooms as well as thatched roof installations and maintenance (Nkambule *et al*, 2016). The local community do not regard recreation and leisure-time activities as a significant way in which to use this urban greenspace. Instead, they apply community-based conservation principles and create products from local resources for the tourism market (Nkambule *et al*, 2016).

Ferreira (2011) illustrated the sensitivity of the relationship between conservation areas in the city and the local population in the context of the global South, where societal pressures and criminal activity often threaten the conservation of open spaces. The Table Mountain National Park is a major asset for tourism in South

Africa, the Western Cape, and the City of Cape Town, and yet many challenges are experienced to reconcile biodiversity conservation priorities with the needs and aspirations of the local people. The City of Cape Town increasingly depends on the cooperation of communities and NGOs to assist in the maintenance and protection of the park.

Ferreira (2011) appealed to decision makers and planners in the global South to manage and nurture a healthy relationship between local communities and conservation areas by integrating socio-economic development and resource-management practices. This should be considered to be an important appeal since there are many threats and challenges to the conservation of open areas in cities, especially in the light of the increasing population migration into the cities and the issues related to the maintenance and safety of conservation areas.

2.6.6 Environmental communication, education and improved environmental awareness

A lack of awareness of environmental issues and limited responsibility for conservation are evident in both the global North (e.g. Toronto (Canada)) (Olive, 2014) and the global South (Oduro-Ofori *et al*, 2014). Despite the environmental awareness programmes presented at the Tonga Environmental Centre in Masibekela (Mpumalanga, South Africa), destruction of the habitat, dumping, littering, and the contamination of water sources in the surrounding area have persisted (Nkalanga, 2013). In this case, environmental education did not change environmental behaviour. For environmental education and awareness programmes to be successful, their linkage to sense of place is important (Russ & Krasny, 2017).

Environmental awareness programmes should not be regarded as special events for school learners but should also include adult environmental-awareness initiatives (Lauer *et al*, 2019; Nkalanga, 2013). Thus, place-based knowledge sharing, eco-literacy programmes, and greenspace awareness campaigns about the importance of urban greenspace, are important for educating the public and stakeholders on the greening of cities (Lauer *et al*, 2019; Nkalanga, 2013). Environmental communication strategies should present urban environmental data in a format that is convincing and useful to decision makers. (Lauer *et al*, 2019). Community radio stations and educational institutions, together with other stakeholders, could participate in such campaigns.

2.6.7 Integrating the landscape narrative and place-based values into the management of a conservation area

The landscape narrative can be a powerful tool to emphasise the importance of a greenspace and to understand its uniqueness. In order to avoid the perception that greenspace is wasted space that could just as well be developed, it is important to understand the processes of the physical landscape, as well as the cultural realms of history, culture, and perception and experience (Armitage *et al*, 2014; French, 2010). Landscape architects use this approach to create memorable spaces from which the environment can be appreciated (Blom, 2012). Faerie Glen Nature Reserve in Tshwane is an example of a greenspace for which a programme was developed to integrate sustainable ecological design principles with landscape narrative principles (French, 2010).

According to French (2010), when greenspace is transformed through landscape design into socially-, economically- and environmentally-sustainable open space,

it has the potential to be appreciated, more so than when it is fenced off from the surrounding communities. In the case of conservation areas, however, it might be necessary to fence off the area in order to keep dangerous animals within, and to protect the carrying capacity of the reserve by limiting the number of visitors entering the reserve and the type of activities permitted. Public awareness as to the importance of the ecosystem functions of greenspace is important in the long-term protection of this valuable type of land-use function (Hove & Osunkule, 2019; Culwick & Bobbinsk, 2016).

There are strong indications of a positive correlation between attachment to place and concern about its ecological well-being (Sebastien, 2020; Farnum *et al*, 2005). Furthermore, visitors or locals with an attachment or affective orientation towards a place are more inclined to be concerned about environmental impacts and to have feelings of stewardship that would motivate them to participate in maintenance-type activities, rather than in recreational-type activities only.

There are indications, especially in the global North, that the perception of wilderness could contribute to attachments by such users to local greenspace and encourage them to contribute to conservation programmes (Colley & Craig, 2019; McKinney *et al*, 2018). There is, therefore, a need for place-based management to consider the specific characteristics of greenspace and sense of place (Sebastien, 2020).

In the case of the National City Park in Stockholm (Sweden), Ugglå (2014) found that sense of place plays an important role in the establishment of formal parks and has thereby contributed to a conservation status award to this urban greenspace

category in order to protect it from the ravages of urban development. Narratives of cultural and historical heritage, together with sustainable place-making initiatives to motivate conservation of the greenspace, were used in this case.

The role of sense of place should not be under-estimated in the development and implementation of local response plans to environmental stressors (Sebastien, 2020; Masterson, 2017; Russ & Krasny, 2017; Uggla, 2014). Public awareness of the importance of the ecosystem functions of greenspaces is important for their long-term protection (Culwick & Bobbinsk, 2016). Thus, a communication strategy should be developed to disseminate information on the ecosystem services provided by the conservation area (Elmendorf, 2020; Uggla, 2014). It should acknowledge the diversity of the significance that people associate with places and their attachment to such places (Farnum *et al*, 2005).

It is common practice at tourist or recreational destinations to provide information about the rules or guidelines for expected behaviour. Destination managers also spend a lot of time on managing and maintaining the conditions of the setting. Over and above these practices, managers should also consider that the type of information disseminated could enhance the motivations and experiences of the users at the site in question and influence the sense of place (Farnum *et al*, 2005). As best practice, managers need to acknowledge the diversity of the significance that people associate with such places and their attachment to them. Thus, place-specific terms need to be included so that local communities can understand and identify with the relevant management plans (Farnum *et al*, 2005). Managers also need to take note of the sense of place in decision making, as it could be a powerful influence on human actions.

2.7 Environmental stressors within urban greenspace

Where the balance between urban development, conservation and sense of place is disturbed, environmental stressors could put urban greenspace at risk. Urban greenspaces are vulnerable, because of not only the stressors that they expose the greenspace users to, but also their own sensitivity and adaptational capacity (Steenberg *et al*, 2017; Govender-Ragubeer *et al*, 2014). The diversity in the types of urban greenspace, the way they are managed, the changing settings, and conflicts over land use could also contribute to the vulnerability of urban greenspaces (Osorio Guzmán *et al*, 2020; Konijnendijk, 2018; Steenberg *et al*, 2017).

Environmental stressors refer to the environmental factors issuing from the biophysical environment, as well as the context of the setting, that both cause stress. Stressors could be in terms of unpredictable or uncontrollable environmental changes or a compromised suitability to meet the functional requirements of the ecosystem in question (Schulte *et al*, 2014). It is, therefore, important to identify the environmental stressors and the effects that they are having on the functioning of a particular greenspace. Environmental stressors could originate from both the physical and the socio-cultural environments (Steenberg *et al*, 2017; Pacione, 2009; Tzoulas *et al*, 2007).

Environmental stressors could affect the supporting ecosystem services, as well as the provisioning, regulatory and cultural services that ecosystems perform in urban greenspace (Steenberg *et al*, 2017; Millennium Ecosystem Assessment, 2005). Should the stressors intensify, the structure and functions of an ecosystem could be degraded. On the other hand, if the environmental stressors are released,

there would be the possibility of restoring that ecosystem. Expert analysis of ecosystem functioning is therefore important in evaluating ecosystem services (von Schiller *et al*, 2017). It might be necessary too to make dynamic changes in order to maintain functional homeostasis (Schulte *et al*, 2014). A thorough understanding of how people are using greenspace and their perceptions of its value could provide valuable insights into the quality of life of urbanites and the future sustainability of greenspace.

2.7.1 Source of stressors

As already mentioned, environmental stressors could originate from both the physical and socio-cultural environments (Pacione, 2009; Tzoulas *et al*, 2007). Biological stressors are based on interactions between different organisms (Freedman, 2015). In the context of urban greenspace, biological stressors are also relevant to human-animal interactions (e.g. when animals escape from a conservation area or when humans destroy habitats, over-fish or poach game).

2.7.2 Intensity and severity of stressors

The term, ambient stressors, refers to the prevailing background conditions of a place, but they become stressors only when they block the attainment of goals or when they are perceived in a negative way (Nagar, 2006). This is also the case when their risks are understood. Many environmental stressors experienced in urban greenspace are ambient (Wepener, 2008). Air and water pollution; wetland degradation; the presence of invasive plants; extremes in temperature; and wind or moisture, for example, could become stressors only when conditions are unsatisfactory or extreme, or when their implications are understood.

Daily hassles are smaller disturbances in personal and social life. Even though a nuisance, such as an odour caused by pollution, might appear to be of short duration, the cumulative effects could, however, be major (Prescott & Bland, 2020; Nagar, 2006).

Eutrophication is an example of an environmental stressor that occurs on different levels of intensity that range from a daily hassle to a cataclysmic event. An aspect such as artificial light could also be an ambient environmental stressor. Light pollution could influence breeding patterns and developmental irregularities, such as retinal damage, reduced sperm production, and genetic mutations in amphibians and reptiles (Perry *et al*, 2008).

Cataclysmic events are sudden, traumatic and violently destructive single events that affect large numbers of people and require major adaptive responses (Nagar, 2006). They could be compared to severe events or disturbances in the environment (Freedman, 2015). The psychological consequences of cataclysmic events could be similar and severe for both survivors and workers at the scene (Nagar, 2006). Geophysical events such as earthquakes, droughts, floods, landslides, and global warming, could lead to cataclysmic events.

2.7.3 An environmental stress model of urban impact

The study by Pacione (2001; 2003) follows a social geographical perspective in investigating the influence of urban environmental quality on human wellbeing. This study found that social conditions, especially in the lower-income areas, constitute an important aspect of environmental quality. Figure 2.5 presents the Stress Model of Urban Impact (Pacione 2001).

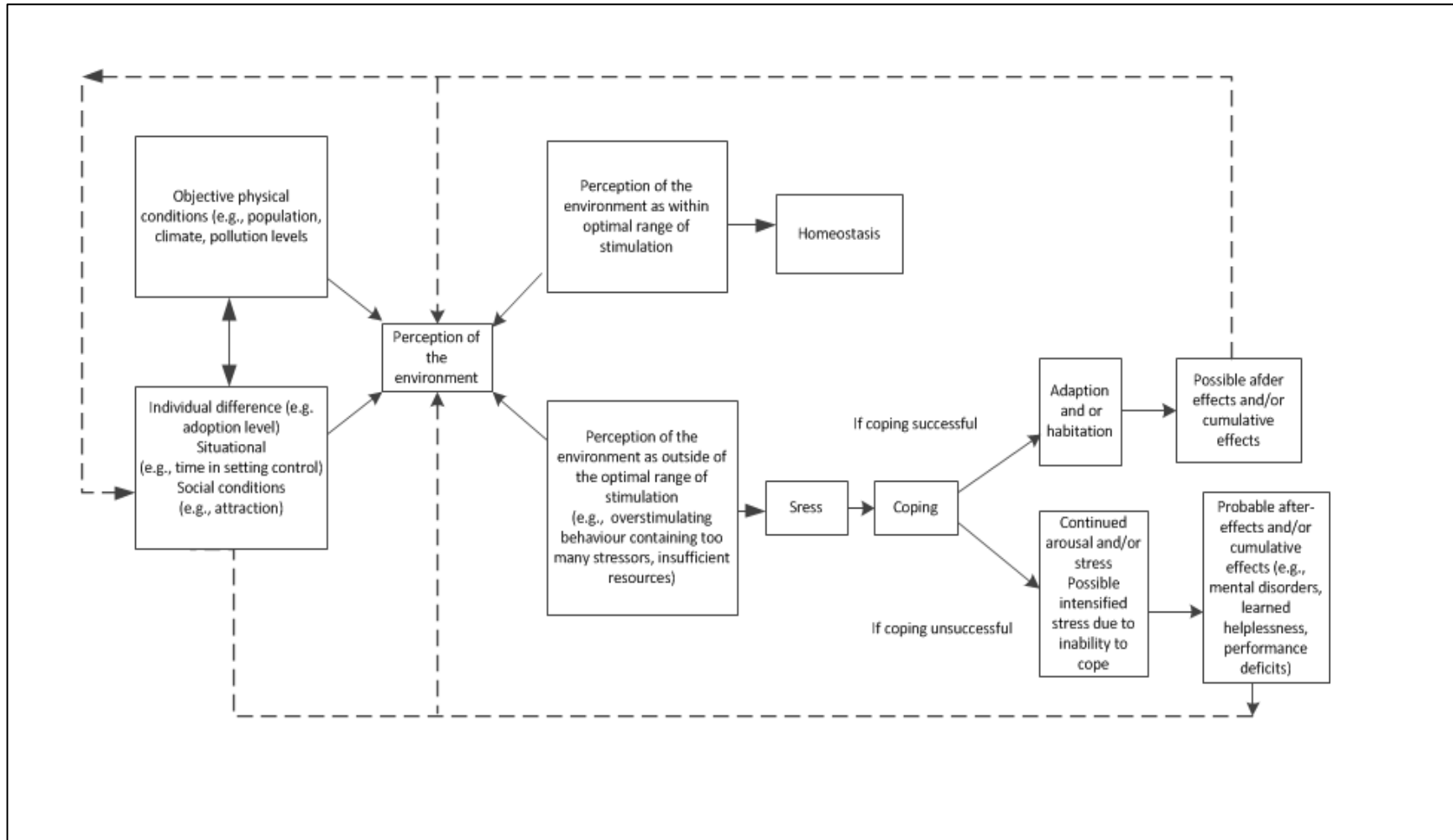


Figure 2.5: The Stress Model of Urban Impact by Pacione

Source: Pacione (2001)

According to the Environmental Stress Model of Urban Impact by Pacione (2001; 2003), as well as later applications of the model, the experience or perceptions of the city represent a joint function of the environmental conditions and the subjective experience of the individual. In fact, person-environment relationships seem to be at the core of quality of life in the city (Figure 2.5).

Pacione integrated five theoretical approaches, namely: the human-ecology approach; the subcultural approach; the environmental-load approach (e.g. how much environmental stimulation is acceptable); the behavioural-constraint approach; and the behaviour-setting approach. These theories of human-environment interaction, not mutually exclusive, have been combined in a stress model of urban impact (Figure 2.5).

Should the environmental conditions be perceived within the optimal range of stimulation, the individual would be inclined to experience a sense of homeostasis. However, should conditions of overstimulation, insufficient resources, or too many environmental stressors prevail, the individual might need to apply relevant coping mechanisms.

Individuals experience stress when they cannot cope well with environmental stressors, and their side effects (e.g. mental disorders, learned helplessness, and performance deficit) might occur (Pacione, 2009; Nagar, 2006).

However, should the individual cope successfully with environmental stressors, a positive learning experience as to how to deal with environmental stressors would prevail. Both positive and negative experiences feed back into perceptions of the

environment and could potentially influence the way in which the individual deals with future events (Figure 2.5).

According to Pacione (2001), homeostasis is achieved in an individual when the environment is in a mode of optimal stimulation, while stress is experienced when the environment is in a mode that is beyond the confines of the optimal range of stimulation (Figure 2.5).

Should the individual experience the environment to be beyond the confines of the optimal range of stimulation, environmental stress would be experienced and the individual's coping mechanisms would have to be applied. Overcrowding, noise, heat, pollution, architectural dysfunction and environmental disasters are examples of environmental stressors. As long as the individual is able to cope with the situation, the possible after-effects would be mitigated (Pacione, 2003). On the other hand, though, if the individual is unable to cope successfully, the cumulative effects of stress could lead to the manifestation of the above-mentioned side effects (viz. mental disorders, learned helplessness and performance deficits).

Pacione (2001) theorised that the physical characteristics of the urban environment, as well as individual differences, situational and social conditions, tend to feed into environmental perceptions, and that environmental perceptions do in fact influence the way in which stressors are identified and dealt with. The experiences, knowledge and skills, as well as the necessary resources available to the individual, would influence the selection of coping mechanisms dealing with environmental stressors. This implies that if the individual is able to cope successfully, the balance is restored; but if not, various types of stress-related

behaviour could manifest (Rishi & Khuntia, 2012; Pacione, 2001). The aftereffects of stress experienced in the urban greenspace would then influence the individual in terms of future perceptions and experiences of the environment.

Despite the criticisms levelled against the environmental-determinism premise of human ecology, there is evidence that urban greenspace does in fact contribute to quality of life in cities and provides an escape from high-density urban living (Chiesura, 2004). This is especially relevant to cities in the global North, for example, Vondel Park in Amsterdam (Netherlands), the Bois de Boulogne in the peri-urban area west of Paris (France), and the Parque de Maria Luisa, along the Guadalquivir river in Seville (Spain) (Mayer-Grandbastien *et al*, 2020; Chiesura, 2004).

In the global South, the relationship between urban quality of life and access to greenspace is more complex and the value of urban greenspace is not necessarily acknowledged, as in the case of Kumasi City, Ghana (Osorio Guzmán *et al*, 2020; Mensah, 2014).

2.8 Conclusions and the way forward

Based on the literature consulted, it can be concluded that urban greenspace is especially important in urban planning and growth management in the global North. However, there are indications that it is difficult to achieve a balance between urban development and conservation within a context of competing human needs and limited resources. This is especially evident in the context of the global South. In the next chapters knowledge gained from the literature review was integrated into

a Greenspace Stress Model of Urban Impact based on the case study of the Rietvlei Nature Reserve.

Different types of urban greenspace have different functions and services directed at supporting human quality of life. These range from urban gardens and sportsfields to conservation areas, where biodiversity and ecological systems and pristine natural environments are protected. Owing to the competition to access various land-use zones for the resources and services that they provide, urban greenspaces are often multi-functional.

Since the publication of the Millennium Ecosystem Assessment (2005), the ecosystem services provided by urban greenspace have been awarded increasing prominence in the literature. This perspective acknowledges the interdependence of ecological wellbeing and human quality of life (Haase & Rink 2014). Therefore, the relative location of urban greenspace is not only significant in terms of its accessibility for use, but also significant in terms of its support of ecosystem processes, the provisioning of resources, its regulatory effect in mitigating climate change, in cleaning the air, and in terms of its cultural ecosystem services, such as recreation, cultural identity, and aesthetic and spiritual values (Bernstein, 2017). Urban greenspace is especially important in terms of its water-provisioning functions in the case of urban wetlands. In the global South, harvesting for a livelihood is also an important function of urban greenspace.

Sense of place is generally acknowledged as an important component of cultural ecosystem services and does indeed influence decision making regarding the conservation and utilisation of urban greenspace. The literature on greenspace in

the global South explores the sense of place of urban greenspace in terms of cultural rituals and the historical value of particular urban greenspaces. In this context, this is then a case of awarding sense of place an important role in the management of urban greenspace.

The environmental stressors emanating from both the physical and cultural environments that negatively influence the functions of urban greenspace have been reviewed. There is sufficient evidence to conclude that the characteristics of a particular urban greenspace, as well as the context in which it is placed, influence the vulnerability of the greenspace to environmental stressors.

Various studies have indicated that community participation and public and private participatory initiatives are important in protecting the functions of an urban greenspace (Colley & Craig, 2019; Grunewald *et al*, 2018; Hassan & Mombo, 2017). In order to enhance participation for supporting the functions of urban greenspace, the landscape narrative and place-based values have for the most part been successfully applied in management practices. The levels of environmental awareness and of participation of local communities have been improved through environmental education. This is relevant not only to the environmental stressors experienced in a particular urban greenspace, but also to a broader awareness of environmental concerns on a global level (Sutherland *et al*, 2019; Baker & Greenfield, 2019; Masterson *et al*, 2017).

Chapter 3: Research approach and methodology

3.1 Introduction

A mixed-method case-study approach was followed to obtain an in-depth understanding of the Rietvlei Nature Reserve, Tshwane (South Africa) in the context of a growing metropolitan area. This approach was well suited to the aim of the study. A geographical perspective was applied to assess the importance of the Rietvlei Nature Reserve as a critical green infrastructural component of the Tshwane Metropolitan Area, and to illustrate the impact of the interplay between urban development, conservation and sense of place in the Rietvlei Nature Reserve.

The objectives of the study required a mixed methodology as multiple types of sources and methods were used to meet the objectives. In order to attain the first objective of the study, namely to map and assess the implications and challenges of urban growth and the changing surrounding land-use mosaic for the Rietvlei Nature Reserve, the researcher used maps and satellite images. The relative location of the Rietvlei Nature Reserves was then analysed in terms of published sources, including regional development frameworks.

The second objective was to explore and analyse the prominent functions of the Rietvlei Nature Reserve in the Tshwane Metropolitan Area. The results emanating from a study of the literature, observations made and semi-structured interviews conducted were then applied to achieve this objective. The data collected from this geographical area necessitated the adoption of a Greenspace Stress Model of

Urban Impact that could eventually contribute to supporting decision making in other cases showing evidence of similar interplays.

The third objective was to develop a Greenspace Stress Model of Urban Impact in a South African context, illustrating the interplay between human needs and urban growth on the one hand, and nature conservation and sense of place on the other. The methods applied to attain this objective were to conduct semi-structured interviews with key informants, as well as group interviews with representative user groups. Objective 4 was to develop implementation guidelines for the Greenspace Stress Model of Urban Impact.

3.2 Research approach and structure of the chapter

A case-study approach, using a mixed-methods methodology dominated by qualitative data and supplemented by quantitative data, was followed in this thesis. The geographical perspective applied in this study emphasised place on a variety of scales. The Rietvlei Nature Reserve, which falls under the municipal jurisdiction of the Tshwane Metropolitan Municipality in the Gauteng province of South Africa, was the area selected for the case study for this research.

This chapter focuses on the research methodology applied to achieve the four objectives formulated for this research. Figure 3.1 provides a schematic description of the structure of this chapter. This chapter presents the research approach followed, the type of data collected to address the objectives, and an explanation of how the reliability of the data collected was established, and finally, the ethical considerations that were taken into account during the collection phase of this research.

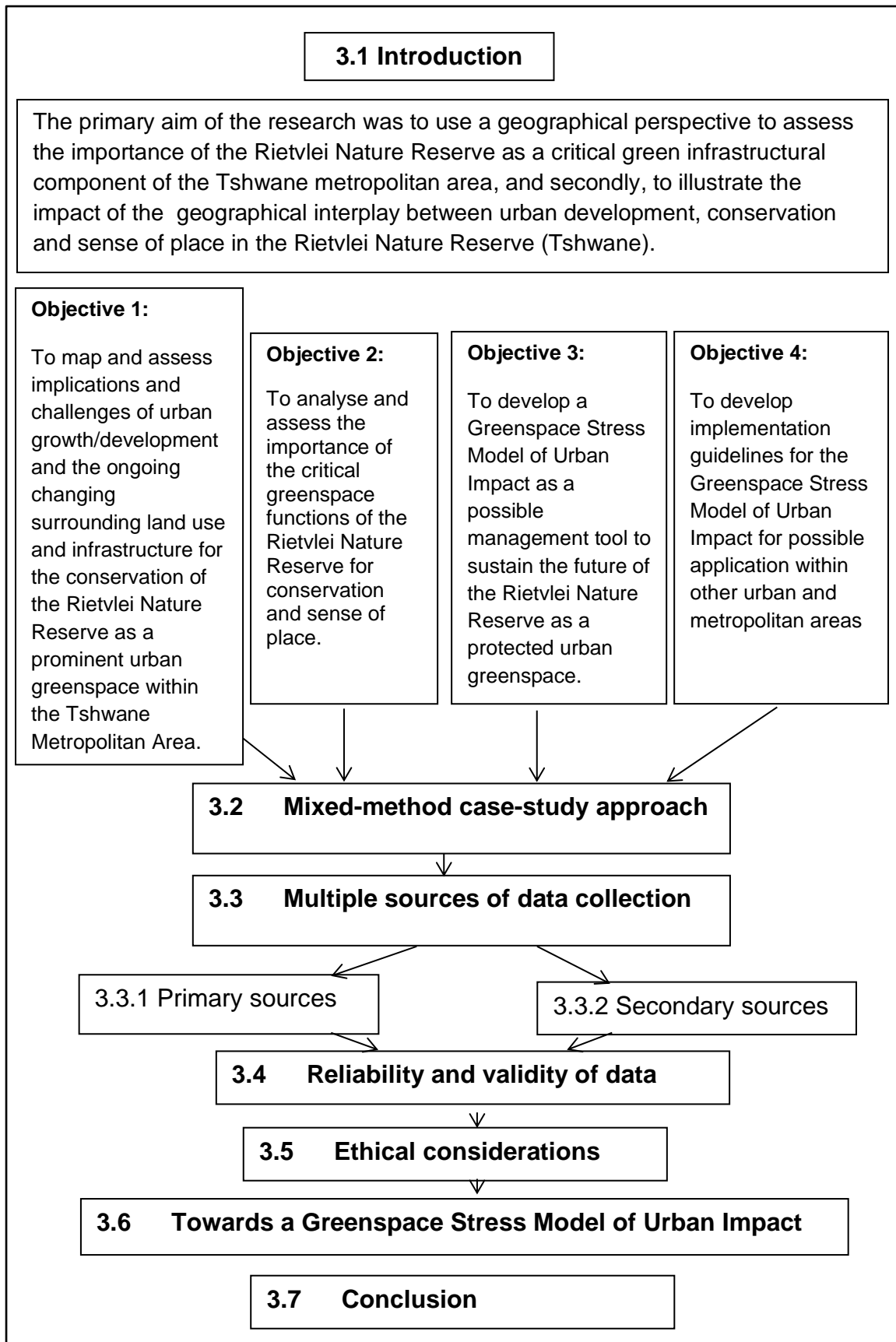


Figure 3.1: The structure of Chapter 3

3.3 Multiple sources of data collection

Generally, multiple sources of evidence are used to explore themes and patterns in case-study research (Figure 3.2). This allows for triangulation whereby information can be confirmed, thus to enhance the reliability of the results (Bolderston, 2012). The data collected in this study were linked to existing models in order to build a Greenspace Stress Model of Urban Impact.

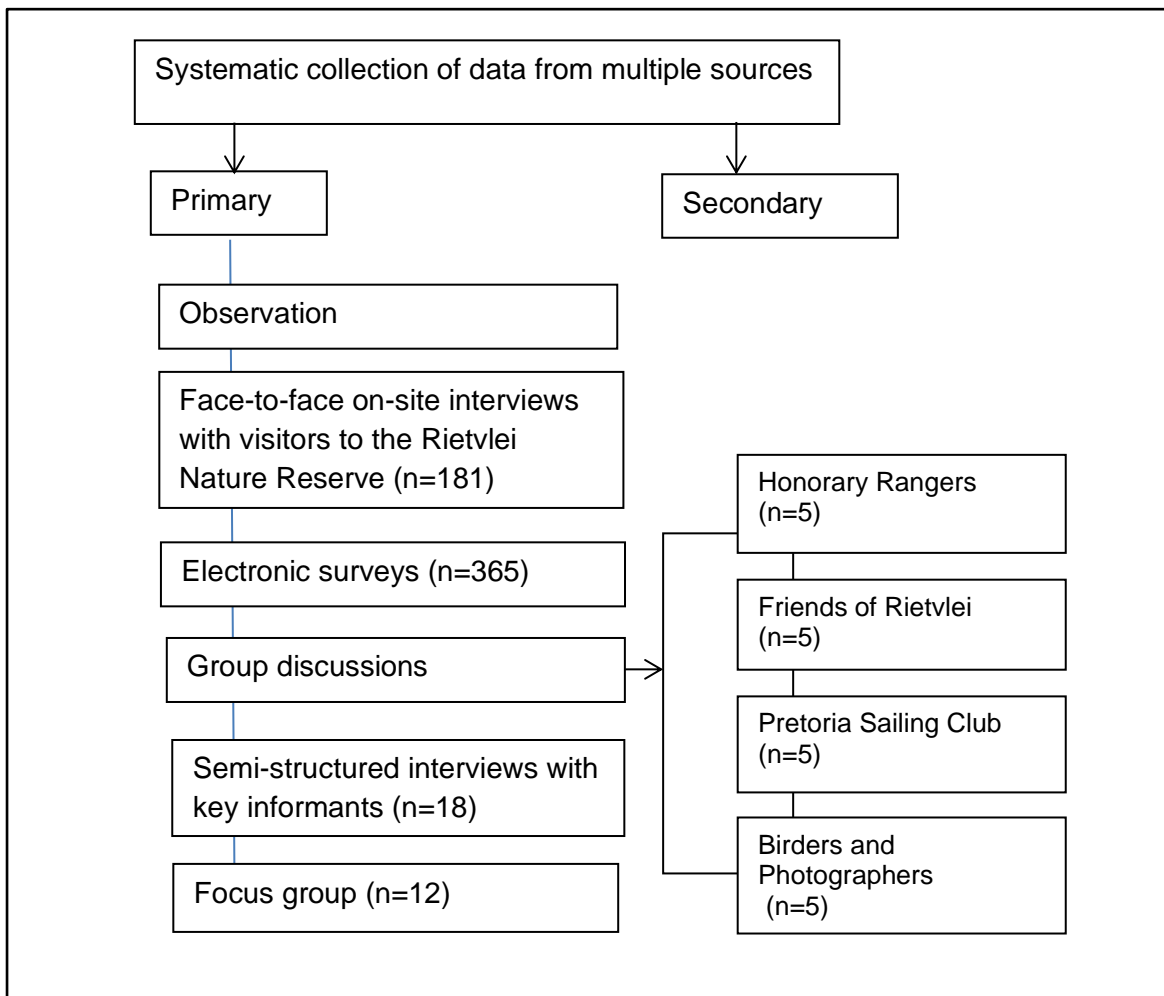


Figure 3.2: Systematic collection of data from multiple sources

The reliability of data was ensured through the application of the triangulation method and by collecting data from a variety of sources (Figure 3.2).

3.3.1 Primary resources

3.3.1.1 Observation

It was important to experience the study area and to make multiple observations to explore the reality of the situation, identify issues, select focus groups, and to compile appropriate questions for semi-structured interviews. The researcher therefore visited the study area at various times and on various occasions during the day and week to experience the ways in which the Reserve is used. Initial unobtrusive observations enabled the researcher to explore and get to know the study area and to obtain a better understanding of the interplay between the dominant components before the formal data collection process for the research commenced. Observations were supported by photographic evidence and field notes of research experiences at the Rietvlei Nature Reserve over a period of five years, starting in 2014.

The observation process enabled the researcher to verify the data obtained from informants and not only to contextualise the information obtained from the interviews, but also to obtain a sound understanding of comments made by the respondents, thereby enabling her to come to informed conclusions from the responses given in the semi-structured interviews.

An adapted version of a Quality of Public Open Space Audit Tool (POST) developed by Broomhall *et al* (2004) was applied to structure the observations made. The POST was initially developed to evaluate the physical attributes that might either encourage or discourage the use of parks or ovals for physical activity, and to collect data on activities, the quality of the environment, the amenities offered by the Reserve and the safety of park users. As the Rietvlei Nature

Reserve is not an urban park, but rather a conservation area that is used mainly for passive recreation, the tool had to be adapted for local conditions.

The strategies used for making observations included the following:

- using available maps to navigate through the Rietvlei Nature Reserve (30 January 2016);
- visiting features represented on the map and using the picnic facilities at the Marais Dam picnic site and the angling area (30 January 2016);
- accompanying a qualified guide on a game drive to the lion camp (27 July 2016);
- participating in guided walks organised by Friends of Rietvlei (15 October 2016; 20 May 2017);
- accompanying a field guide and group of school learners on an environmental education excursion (31 October 2016);
- attending a working session of Friends of Rietvlei for the eradication of invasive species at the Finfoot Hide (19 November 2016)²;
- attending two meetings of the Hennops Catchment Management Forum in order to collect data on issues related to the larger catchment area (30 May 2017; 26 July 2017);
- attending the annual meeting in 2016 of Friends of Rietvlei , as well as a meeting on 8 April 2017 of the committee of the Friends of Rietvlei group;

² This experience clarified the severity of the problem of invasive species and the important role that volunteers play in the maintenance of the Reserve.

- collecting photographic evidence covering various visits over a period of five years and the taking of field notes based on the researcher's own experiences in support of the validity of her observations.

In the broader scheme of the research plan, the observation phase (and the informal discussion phase) preceded the semi-structured interview phase of the research. This facilitated the refinement of the questions for guiding the discussions in the formal interviews.

3.3.1.2 Face-to-face on-site interviews with visitors to the Rietvlei Nature Reserve

The questionnaire survey is an indispensable tool for collecting primary data concerning behaviour, attitudes and opinions, as well as awareness about particular issues (Phillips & Johns, 2012). Owing to the potential risk of a low response rate, it was decided that the questionnaires for completion would not be left at the entrance gate, but rather for on-site face-to-face interviews to be conducted.

The aim of the on-site structured interviews with visitors was to make observations about and investigate the reasons for their visit; to evaluate their connection with the Rietvlei Nature Reserve; and to identify favourite areas, experiences and concerns. The on-site interviews provided an additional advantage of allowing in-depth discussions with some of the visitors who were more involved and knowledgeable about particular issues. Based on the face-to-face interviews, potential informants were also identified and invited to the focus group meetings.

On-site, face-to-face structured interviews were conducted with visitors at the locations indicated by means of star-point symbols on the map (Figure 3.3).

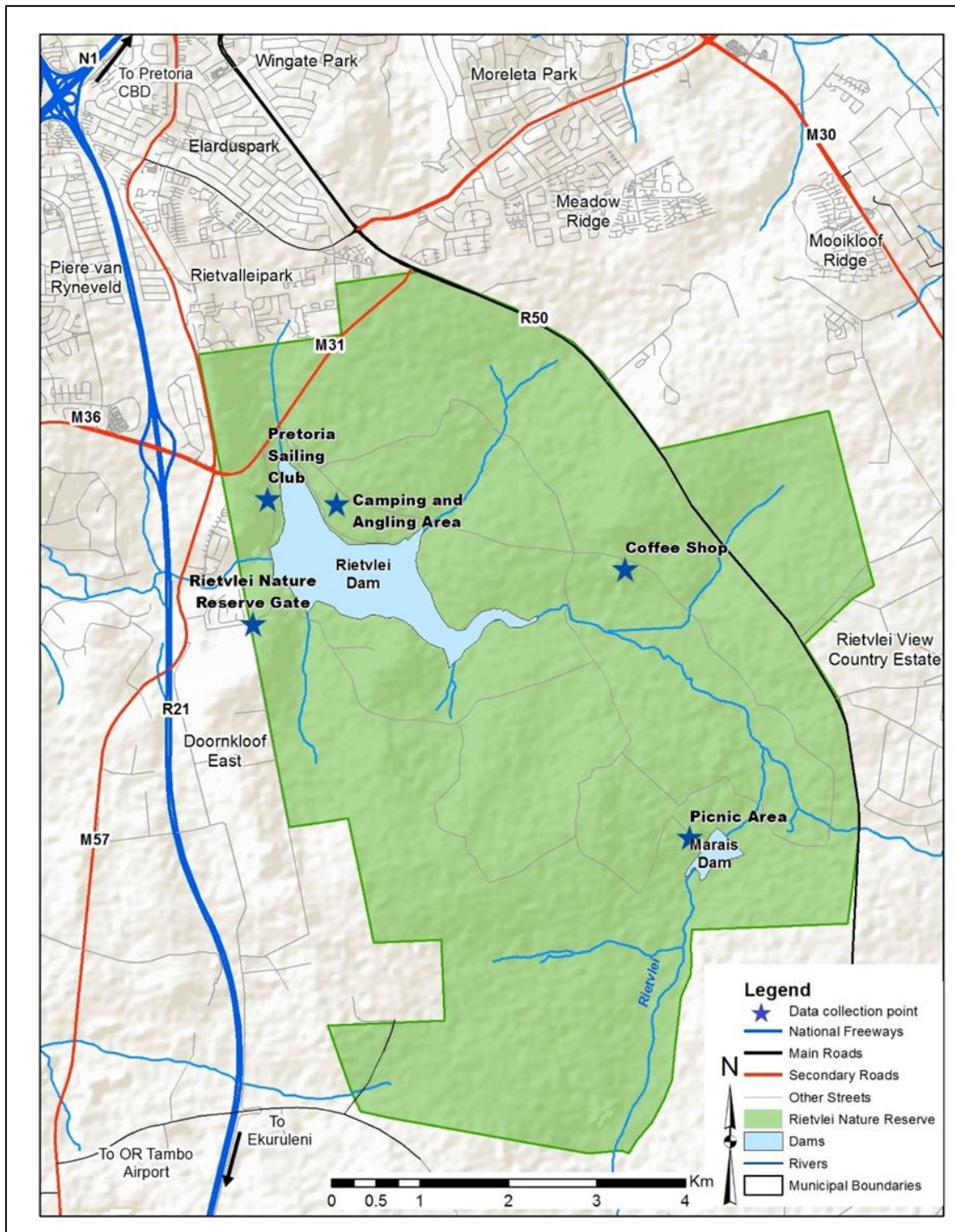


Figure 3.3: Location of the observation points for structured interviews with visitors to the Rietvlei Nature Reserve

Source: Compiled by S. Carow Data: ESRI data in a box (2018)

It was important to select appropriate locations for the completion of the questionnaires (Figure 3.3). The birding hides or lookout points were not suitable settings as conducting interviews would potentially ruin a recreational experience. This proved to be especially true for visitors who intended to visit the Reserve for only a short period. Three observation points, namely the Rietvlei Coffee Shop, the Marais Dam picnic area, and the camping and angling areas, where visitors could take a break in their recreational activities, were identified. No interviews were conducted at the chalets, as they were not occupied at the time when the fieldwork was conducted.

A purposeful stratified sample of respondents was interviewed by selecting observation points across the Reserve (Table 3.1). Owing to their specific recreational needs, visitors to the fishing and camping areas would not necessarily stop at the Marais Dam picnic spot or the Rietvlei Coffee Shop. It was therefore important to conduct face-to-face interviews at the angling and camping sites. The Rietvlei Coffee Shop proved to be the most productive interview site as it constitutes a natural relaxation point amidst the recreational facilities. Thus, more respondents were selected from the Rietvlei Coffee Shop site as this is a popular point for purchasing food and drink and is also the departure point for game drives to the Lion Camp.

Table 3.1: Observation points for collecting data from questionnaires

Observation points for questionnaires	Number of questionnaires
Rietvlei Nature Reserve Gate	18
Picnic area at the Marais Dam	30
Coffee shop	84
Camping and angling areas	49
Total	181

As the researcher was sensitive to the time constraints when interviewing visitors to the Reserve, only verbal consent was obtained for the completion of the questionnaires via face-to-face interviews. The questionnaire was shortened after a pilot survey in order to further limit the time required to complete the interviews (The questionnaire used in the research is included in Appendix F).

The size of the sample was calculated by basing it on the primary data on visitors to the Reserve during the period 2013-2014. This was the latest available data at the time when the fieldwork commenced. According to the Reserve Manager, the total number of visitors to the Reserve in 2013-2014 was $N=52\ 684$. More visitors entered the Reserve through the angling area ($n=32\ 432$) than through the main gate ($n=20\ 252$) (Reserve Manager. Personal communication. 15 May 2015). The relatively large number of visitors passing through the gate to the angling site could be explained in terms of the specific niche market for the facilities and organised events in this zone of the Reserve. This is also the gate to the overnight chalets and the Pretoria Sailing Club.

The average number of visitors per month to the Rietvlei Nature Reserve for this period was $N = 52\ 684/12 = 4\ 390$. In quantitative research, a five percent (5%) sample would be regarded as acceptable for a representative sample. Thus, $n = 4\ 390 \times 0,05 = 220$. A limitation of this study is that the sample interviewed amounted to less than five percent (5%) of the total number of visitors to the Reserve and the data could not therefore be generalised, as would be the case in a quantitative study.

During the fieldwork phase, a point of saturation was reached after 49 interviews had been conducted in the camping and angling areas, as it soon became apparent that the visitor cohort to this area was more homogeneous than that to the conservation area of the Nature Reserve. Furthermore, the chalets at the camping and fishing areas were not available for bookings at the time of the research. A decision to conduct a research discussion with representatives of the Pretoria Sailing Club rather than through individual interviews with members or participants in organised events in this demarcated part of the Reserve implied that on-site face-to-face interviews were therefore conducted with only 181 rather than with the theoretical 220 respondents (Table 3.1).

The data collection points for on-site face-to-face visitor interviews were spread throughout the Reserve. It is important to note that there could be some bias in the data as most of the interviews were conducted at the Coffee Shop and not all visitors were inclined to stop there for refreshments. However, the purpose of the survey was not to analyse a profile of visitors to the Rietvlei Nature Reserve, but rather to obtain information regarding their activities and experiences, as well as their perceptions and concerns about the Reserve.

A number of specific interest groups that could provide a wealth of information regarding the Rietvlei Nature Reserve were identified. Rather than opting for a representative sample, a discussion was arranged with key informants at the Pretoria Sailing Club and the data thus collected were supplemented with data from the electronic survey responses, which were elicited from respondents who were interested or involved in activities at the Reserve.

3.3.1.3 Electronic surveys

In order to obtain information from interest groups, electronic surveys were presented on Facebook to allow members of the Friends of Rietvlei group and Rietvlei Photographers to participate. The surveys were voluntary, allowed the respondents to remain anonymous and elicited responses from members of the closed Facebook groups. The survey of 6 January, 2018 (n=229) had a higher response rate than the questionnaire of 25 October, 2017 (n=136). (The questions included in the electronic survey are provided in Appendix F). These surveys were analysed using Survey Monkey software.

3.3.1.4 Group discussions

Group interviews were conducted with specific interest groups and were based on their involvement in the Rietvlei Nature Reserve (Table 3.2). In line with the rules of ethical conduct, participants signed consent forms and agreed to the time commitment before the start of the interview. The duration of the group discussions ranged from one-and-a-half to two hours.

A pre-determined set of questions (Appendix D) formed the basis of the group interviews and the researcher allowed participants to make comments on the areas that they regarded as most important. Group interviews were recorded with prior permission to provide a trail of evidence. Immediately after the interviews, reflective notes were made on the context of and the non-verbal communications by participants. These notes added value to the interpretation of the interviews and the responses of the focus groups. Reflection was, therefore, an integral part of the phase of collecting the raw data and of analysing and interpreting the material. The

researcher developed diagrams and data matrixes to illustrate the internal consistency of the information collected and linked it to the theory in the literature review.

Table 3.2: Group discussions with purposefully-selected informants

Interest	Date	Location	Number
Pretoria Sailing Club (Yacht and Canoe Club)	5 November 2016.	Pretoria Yacht and Canoe Club Hall	5
Honorary Rangers	17 November 2016	Rietvlei Coffee Shop	5
Friends of Rietvlei	4 May 2017	Lecture Hall in the Rietvlei Nature Reserve	5
Birders and Photographers	11 May 2017	Rietvlei Coffee Shop	5

A purposeful selection technique was applied as the people who were actively involved in various activities in Rietvlei Nature Reserve were invited to attend the meetings. Invitations were sent by email or verbally through the network of volunteers. The composition of each group was based on people who had responded to the invitations.

The venues for the on-site face-to-face group discussions were all within the Rietvlei Nature Reserve, which made it safe for and accessible to the participants. The duration of each discussion was around two hours. Observations made by the researcher of the Rietvlei Nature Reserve and findings from the on-site interviews with the visitors were confirmed in the group discussions.

3.3.1.5 Semi-structured interviews

Face-to-face semi-structured interviews were conducted with key informants to obtain information about the main components of the study, namely urban development, conservation, and sense of place.

A draft of the semi-structured questionnaire was first tested with a limited number of visitors and organisations, and further refined before the official semi-structured interviews were conducted. Five pilot interviews were conducted in order to first test and discuss the clarity and validity of the questions. The researcher was acquainted with the first two respondents, and made contact with the third respondent, who, like the researcher, was a participant in the Rietvlei Nature Reserve Facebook group. Based on the feedback of respondents, improvements were made to the draft questionnaire after each pilot interview. The questionnaire was professionally language-edited before the fieldwork commenced.

A snowballing methodology was used to build a purposive, stratified selection (n=18). This non-probability sampling technique is often used in social research, where stakeholders are requested to recommend other possible informants for interviews. In order to ensure a balanced perspective, including information on different aspects, informants were selected on the basis of their involvement in urban development, conservation or activities at the Rietvlei Nature Reserve. As a major part of the catchment area of the Rietvlei Dam falls outside the municipal boundaries of Tshwane, interviews were not confined to the town planners and environmental managers of Tshwane Metropolitan Municipality, but also included two representatives from the Ekurhuleni Metropolitan Municipality. Elements of a convenience sample were evident as only knowledgeable informants who were available and willing to participate were interviewed.

The duration of the face-to-face semi-structured interviews ranged from 45 minutes to two hours. The first in-depth face-to-face semi-structured interview was conducted on site with the chairperson of the Friends of Rietvlei group on 8 August,

2016. The interview was conducted while the parties were driving through the Reserve. This provided an opportunity for observations and interpretations to be made of the features of the landscape, its biodiversity, and the human activities in the Reserve.

At the time of confirming the appointments for the interviews, the researcher provided an upfront list of themes for discussion and gave an indication of the expected time duration. In preparation for the interview, she also explained the aim and objectives of the research project. A consent form, indicating the respondent's acceptance of and compliance with the conditions of participation in this project, and also including a confidentiality clause, was presented for signature (Appendix D). An opportunity for wider discussion for the sharing of information on experiences was also offered.

Probing questions included in the interview schedule (Appendix E) formed the basis for data collection. The questions were posed in a flexible manner in order to accommodate the expertise of the different respondents and in line with the time limitations (Elmendorf & Luloff, 2006). Evidence gathered from the semi-structured interviews was used to refine the questions for consecutive interviews. Interview notes, recordings, and transcriptions of semi-structured interviews provided a trail of evidence.

3.3.1.6 Final interactive focus group discussion

In an attempt not only to confirm the reliability of the findings, but also to quantify the potential benefits and concerns, a final plenary focus group session was conducted on 10 July, 2019. It comprised of participants with an interest in

dedicated aspects of urban development, conservation and sense of place regarding the Rietvlei Nature Reserve. During this focus group session, the potential benefits and risks identified during the previous phases of the research were evaluated. Participants were challenged to rank social, environmental and ecological benefits and stressors according to their understanding of their relevance to the Rietvlei Nature Reserve. This turned out to be an important phase in support of the basic components underlying the relevant stressors captured for the Greenspace Stress Model of Urban Impact. .

The focus group discussion is a suitable research technique to gain insight into social issues and is being increasingly used in research on biodiversity and conservation (Nyumba *et al*, 2018). In this research study, individuals were purposively selected for participation in the discussions to ensure that different viewpoints could be heard. Potential participants were identified during the fieldwork phase and while they were participating in various activities in the study area. They were invited to represent the respective perspectives of development, conservation and sense of place. The decision to conduct a diversified group was an attempt to not only further unbundle different viewpoints regarding the interplay between urban development, conservation and sense of place, but also gain a perspective from the different groupings on the relative importance of the respective benefits and stressors.

3.3.2 Secondary sources

A variety of secondary data sources were consulted to obtain relevant data on the history, current multiple-use and environmental benefits, and the risks and stressors experienced in the study area. Published research reports, marketing

material, media reports and the internet formed the basis for the identification of benefits, risks and environmental stressors in the case of the Rietvlei Nature Reserve.

A literature study of previous research and reports provided information on various environmental stressors as experienced in the Rietvlei Nature Reserve. Furthermore, maps and remote sensing images were analysed to evaluate the extent of environmental change in the surrounding area.

Various sources were consulted to obtain data on, for example, the activities of the Friends of Rietvlei group through its official constitution; their unpublished report on maintenance for 2016; the programmes of events; as well as newsletters from the official website. Data on another role player, the Honorary Rangers in Rietvlei, were collected from the SANParks website.

Quantitative data were sourced from Statistics South Africa, as well as from management reports of the Rietvlei Nature Reserve and Tshwane Metropolitan Municipality, to establish the importance and challenges of the Rietvlei Nature Reserve in respect of the growing urban population of Tshwane.

The interpretation of maps and remote sensing images elucidated development trends in the catchment area of the Rietvlei Nature Reserve and clearly unveiled the importance of the location of the Rietvlei Nature Reserve in respect of its dedicated functions. The South African National Land Cover Database for 1993 and 2014 were compared in order to identify land use changes in the catchment area of the Rietvlei Dam.

3.4 Reliability and validity of data

The research design was structured to support the triangulation of data from the different models, methods and sources (Torrance, 2012). Data was therefore collected using different methods and also from different sources to gain a comprehensive understanding of the Rietvlei Nature Reserve case study and to build the Greenspace Stress Model of Urban Impact.

The South African National Land cover database for 1994 and 2013/14 as well as the associated Landsat 8 false colour image as analysed by GeoTerraImage was used to illustrate the extent of land use changes in the catchment area of the Rietvlei Nature Reserve. The data on land-use changes, the literature sources relating to anthropological eutrophication and observations relating to the Rietvlei Nature Reserve, semi-structured interviews, participation in meetings the Hennops Catchment Forum and focus group discussions were collectively considered in order to identify water quality as a potential stressor to the Reserve. Triangulation therefore contributed to the validity of the data.

Semi-structured interviews with key informants created an initial understanding of the benefits and functions, as well as an evaluation of the objectives of the Rietvlei Nature Reserve as stipulated in the Ecological Management Plan (Marais, 2015). A questionnaire was used in the structured on-site face-to-face interviews with visitors to the Reserve to ensure the consistency and validity of the empirical data. Quotations, as well as references to the sources consulted, improved the trustworthiness of the data. Two online surveys were presented on the Facebook Pages of the Rietvlei Nature Reserve and conducted to confirm the benefits and stressors pertaining to the Rietvlei Nature Reserve. Furthermore, the Rietvlei

Photographers and the Friends of Rietvlei respondents were found to be knowledgeable about the Reserve, and able to impart much valuable information.

The opinions of visitors were obtained to identify the characteristics of the place and its significance to them. However, to truly address the sense-of-place component of the Rietvlei Nature Reserve, a more detailed investigation of the characteristics of the visitors should be conducted. In order to establish the extent to which the Reserve is used as an escape from busy city life, information should be gathered on the location and characteristics of particular visitors' places of residence. Demographic information should also be analysed in depth for a better understanding of the sense-of-place experiences reported by the respondents. In reality, this did not transpire. In fact, there is a need for a follow-up study to establish the profile of visitors, as well as the perceived advantages of the Reserve.

Twenty (20) participants were purposively selected, and, based on their expertise and prior involvement in face-to-face interviews with the researcher, they were invited to a diversified focus group discussion. However, only twelve participants attended the discussion. The selection of participants included representatives from development, conservation and sense-of-place perspectives. The benefits and stressors identified through the previous phases of the fieldwork were again evaluated and finally validated. The empirical results of the research were verified by the 14 purposively-selected key specialist informants, who evaluated and ranked the identified benefits and stressors

The findings of the research were also confirmed by the researcher during various field visits, from observations made, and through her participation in activities

during the research period. She became knowledgeable about the area from 1990 onwards, and actually made observations regarding the changing landscape even before the research commenced. In order to remove researcher bias, data collection instruments were developed to be used in semi-structured interviews (Appendices C, E and J). This was done to support the reliability and validity of the research. As all interviews were conducted by the researcher, the interpretation of the data collection instruments was consistent.

The intention behind the study was not to obtain results that could be generalised to a specific population, but rather, for the findings to be considered as relative to a particular case, and a model that could be replicated for other cases that, by nature, would be similar. Furthermore, the data collection instruments, especially in Appendix J, could be adapted for possible future research in this field. Reproducibility of the research is ensured by developing guidelines for applying the GSMUI in other case studies.

3.5 Ethical considerations

The Ethics Committee of the College of Agriculture and Environmental Sciences (CAES) considered the proposed methodology and data collection tools for this research and provided ethical clearance for the researcher to commence with the data collection process in 2015 (Appendix A: Ethical clearance letter: Ethics number: REF #: 2014/CAES/152). In support of the application for ethical clearance for this research, permission to undertake the research in the Rietvlei Nature Reserve was obtained from the Tshwane Metropolitan Municipality (Appendix B: Letter of Approval from the Tshwane Metropolitan Municipality).

Appointments for semi-structured face-to-face interviews were made with the selected informants. The researcher conducted all interviews on her own, without the assistance of field workers. In each case, discussions took place in a safe and convenient place that suited both the interviewer and the informants. Informed consent was also obtained (Appendix D: Consent forms for semi-structured interviews). An interview schedule was arranged for the semi-structured interviews to be conducted in order to ensure rigour in the research process (Appendix E: Interview schedule for the semi-structured interviews). The interviews were used in a flexible manner with due consideration being given to the time constraints and the expertise of the informants.

Participation in the structured face-to-face visitor interviews, which were conducted on site in the study area, was voluntary and only those participants who agreed to a brief discussion were interviewed (Appendix F: Questionnaire for the face-to-face interviews). Participants had the option not to answer all of the questions or to withdraw from the interview. The information obtained was generalised and the identity of the respondents remained anonymous.

The researcher adhered to the regulations of the Rietvlei Nature Reserve when participating in the research activities, and care was taken not to harass participants or harm the environment in any way. Neither did the research project require any invasive procedures on humans or animals. Furthermore, owing to the frequency of other research activities in the study area, the risk of creating unrealistic expectations from the research was limited. The objectives of the research were verbally communicated to the participating visitors during the on-

site structured interviews. Consent forms were also attached to the semi-structured interviews for the consideration of each respondent.

Written feedback was given to the management of the Rietvlei Nature Reserve in the form of e-mail correspondence, abstracts of conference presentations, and copies of the published academic work.

3.6 Towards a Greenspace Stress Model of Urban Impact

The Rietvlei Nature Reserve, Tshwane, is an urban greenspace experiencing development stressors, and the Greenspace Stress Model of Urban Impact represents the interplay between urban development, conservation and sense of place. The relative location of the Rietvlei Nature Reserve between two growing metropolitan areas in the Gauteng province of South Africa is significant in the context of this conservation area and on different resolution levels.

The models by Haase and Rink (2014) and Pacione (2001) were selected from the relevant literature sources to emphasise the importance of environmental quality on human quality of life. The nexus between urban shrinkage, ecosystem services and human quality of life of the global North (Haase & Rink, 2014) was adapted to the global South, where urban change involves growth and development rather than urban shrinkage. Chapter 4 presents an analysis - based on satellite images and thematic maps - of the extent of urban change (growth and development) in the catchment area of the Rietvlei Dam.

In the stress model of urban impact by Pacione (2001), emphasis is placed on the importance of environmental perception and the relevant coping strategies for dealing with environmental stressors in an urban context. In addition to its

application by researchers in the global North (Pacione 2003), this model has also been applied in the context of the global South. The focus in this research study on the Rietvlei Nature Reserve is on urban greenspace and human perceptions concerning the benefits and stressors experienced within the greenspace, rather than on humans experiencing stress on account of environmental factors such as floods, landslides or overcrowding in cities.

Also incorporated into this GSMUI model, are the theoretical aspects of sense of place. In fact, Chapter 5 of this research study focuses on the components of the Place Model of Montgomery (1998), as well as its later adapted versions, since conservation and sense of place are critical elements in the context of this research study of the Rietvlei Nature Reserve.

Environmental perception is also important in the interplay between urban development, conservation and sense of place, as are the identification of environmental stressors and the application of relevant mitigation strategies for sustainable development and the protection of the ecosystem services of urban greenspace. Thus, these aspects were also considered in this study.

The concepts of carrying capacity and destination life cycle are widely applied in the field of tourism and tourist destinations (Butler 1980), but are also relevant to the ecosystem benefits emanating from urban greenspaces. As such, an adapted version of the tourism area life-cycle model was incorporated into the Greenspace Stress Model of Urban Impact.

To achieve the objectives of the research, three important components of the Rietvlei Reserve, namely, development, conservation and sense of place, received

attention. Chapter 4 involves an analysis of the development component (Objective 1), while Chapter 5 presents an analysis of issues related to the conservation and sense-of-place attributes (Objective 2) of the Rietvlei Reserve. The third objective, namely the development of a Greenspace Stress Model of Urban Impact is the focus of Chapter 6. Finally, the recommended implementation guidelines (Objective 4) for the Greenspace Stress Model of Urban Impact are presented in Chapter 7.

3.7 Conclusion

A mixed-method case-study approach was applied to analyse the Rietvlei Nature Reserve in the context of urban growth and development in the global South. Relevant models from literature were selected to inform the method of collecting data for the purpose of developing a Greenspace Stress Model of Urban Impact (Objective 3).

The expected contribution of this research to the body of knowledge concerning urban greenspaces would be the development of a model and implementation guidelines to potentially support future applications of it to other urban greenspace areas. The Rietvlei Nature Reserve case study and the Greenspace Model of Urban Impact could also potentially support future contributions towards improved environmental awareness and sustainable development.

Chapter 4: The case of the Rietvlei Nature Reserve: an urban greenspace in a growing metropolitan area

4.1 Introduction

Improved quality of life is often stated as a motivation for rural-urban migration. The experience of the city, together with the perceptions around it, is a joint function of the objective environmental conditions and the subjective perceptions of the individual (Pacione, 2009; 2003; 2001) and determines to a large extent the expectations that migrants or settled residents have of the quality of life that the city could potentially offer them. However, increasing urban population densities, have led to various direct and indirect environmental stressors that detract from the migrant's or the settled resident's initial hopes of a quality life in the city. Furthermore, the resource base that is expected to provide for human needs is coming under increasing pressure.

As clearly revealed in the overview of urban greenspace within the contexts of both the global North and South, there are environmental, economic, and social and cultural pillars of sustainability that remain central to quality of life in cities. Areas of natural vegetation, for instance, are more likely than any other type of urban greenspace to be regarded as areas that are available and can be used for development. Furthermore, the specific location and context of an urban greenspace could influence the suitability of such an area for development.

The Rietvlei Nature Reserve, as an urban greenspace surrounded by industrial areas, formal and informal residential settlements and infrastructure is a vulnerable area, but protected through legislation from urban development at the provincial

level (Gauteng Department of Agriculture and Rural Development, 2014; Gauteng Province, 2011), as well as at the local government level by the City of Tshwane (City of Tshwane Metropolitan Municipality, 2012; City of Tshwane, 2005).

This chapter details the history and functions of the Rietvlei Nature Reserve, and places the conservation area within the context of urban development. As previously indicated, the location of the Rietvlei Nature Reserve in the dynamic urban fringe also has important implications for the interplay between development, conservation and sense of place. Potential stressors are identified which could be included in the Greenspace Stress Model of Urban Impact.

4.2 Structure of the chapter on greenspace in the context of urban development

The focus of Chapter 4 is to map and assess the implications and challenges that urban growth and development have had on the land use changes in the catchment area, and the infrastructural implications for the conservation of Rietvlei Nature Reserve as a prominent urban greenspace in Tshwane (Objective 1). To achieve this, Chapter 4 added to the detail on the description of the study area as presented in Chapter 1, by focusing in greater depth on the history of the Reserve. As such, the spatial pattern of urban development surrounding the catchment area of the Reserve could be determined.

This was achieved mainly by studying planning framework documents, maps and remote sensing images. Furthermore, the implications and challenges of urban development, the restructuring of boundaries on different spatial and administrative levels, and the link between development, conservation and sense of place, are

placed under the spotlight in this chapter. (The structure of Chapter 4 is presented in Figure 4.1.)

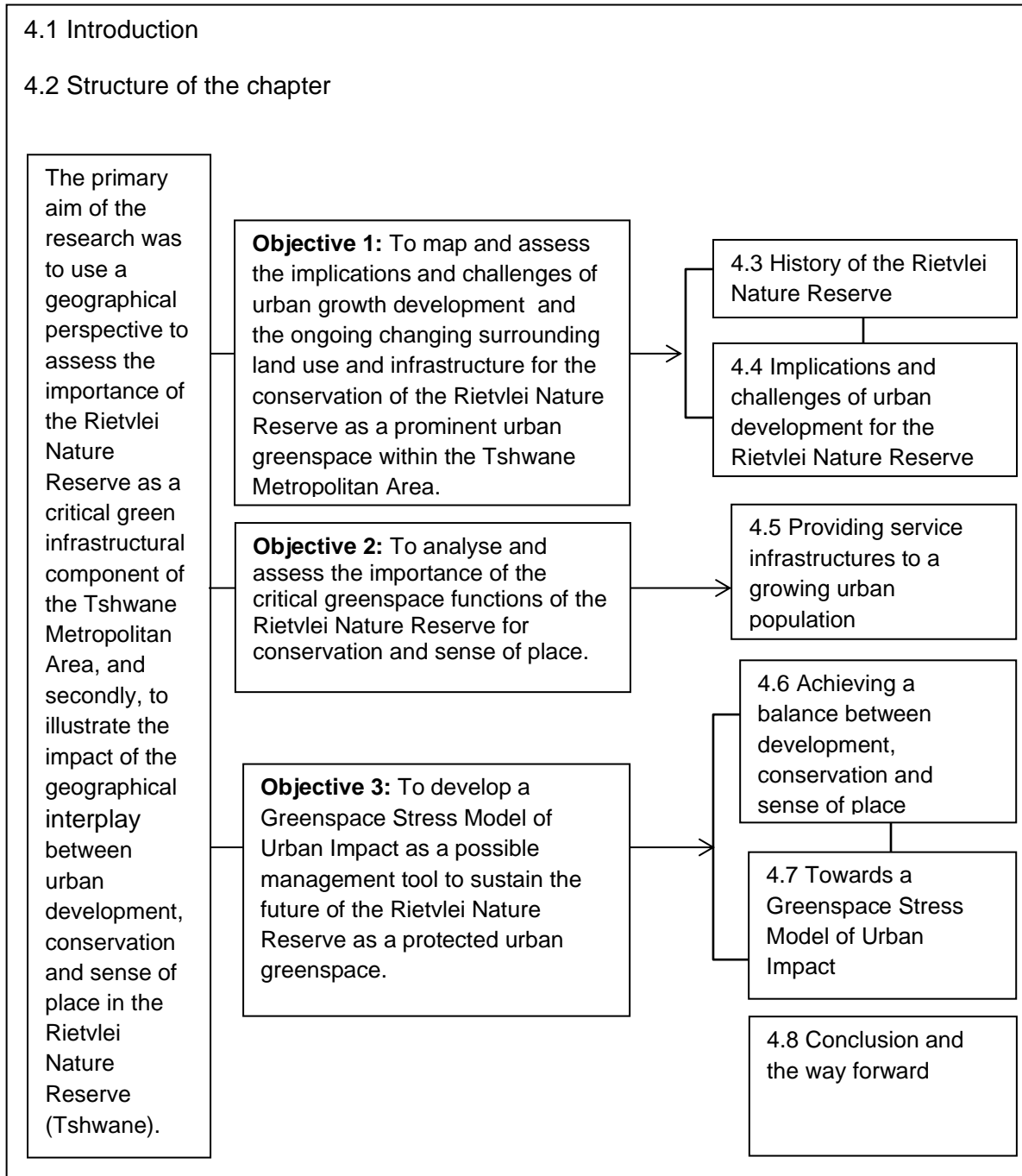


Figure 4.1: The structure of the chapter focusing on the development component of the interplay between development, conservation and sense of place

4.3 History of the Rietvlei Nature Reserve

On 2 September 1929, the farm Rietvallei (Extent 1) was bought by the local government in order to extend the water-provisioning capacity to the growing urban population of Pretoria. At first, only the six natural springs were tapped, and the ground dam wall was completed in 1934 (City of Tshwane, 2015; Dippenaar, 2013). Other farms were incorporated later to create the Nature Reserve. At the time, the Nature Reserve fell outside of the then Pretoria boundary, and there was still some wildlife on the farms that were incorporated. In order to enhance the game species in the Reserve, 67 blesbuck were chased by horses from Doornkloof, the nearby farm of General Jan Smuts, to the Rietvlei Nature Reserve (City of Tshwane Metropolitan Municipality, 2012).

Names of places are deeply rooted in the context where they occur, and often reflect the history or the physical characteristics of the area. Placename changes therefore often reflect changes within a specific context, including the sense of place. The area surrounding the Rietvlei Dam, proclaimed a game reserve on provincial government level in 1937, was named the *Rietvlei Game Reserve* (Reader's Digest, 1990). Historically, the purpose for which the land in this area was set aside embraced more than wildlife conservation only.

In terms of Administrators Notice No. 205, the Rietvlei Game Reserve was proclaimed a reserve for indigenous flora on 1 September 1948 and renamed *The Rietvlei Reserve for Game and Indigenous Flora*. In 1952, the name of the section of the reserve to the west of the Delmas Road was changed to the *Maria van Riebeeck Nature Reserve* to mark the arrival, three centuries before, of the van Riebeecks to the Cape of Good Hope in 1652 (Reader's Digest, 1990). The name,

Maria van Riebeeck Nature Reserve, was published in the Provincial Gazette on 24 November 1954 (City of Tshwane Metropolitan Municipality 2012) (Figure 4.2).

There is an overlap between the Rietvlei Nature Reserve and the Maria van Riebeeck Nature Reserve (Figure 4.2). The Lion Camp to the east of the Delmas Road and the Witkoppies Farm to the south of the Rietvlei Nature Reserve were not included in the Maria van Riebeeck Nature Reserve. On account of their importance in terms of water provisioning, however, both of these areas were subsequently incorporated into the re-proclaimed Rietvlei Nature Reserve.

Despite the fact that the Lion Camp was separated from the larger conservation area at the time that the Delmas Road was built, it remained part of the Rietvlei Nature Reserve. The green space encompassing Moodie-se-loop created a buffer zone along the stream that feeds into the Rietvlei Dam and also around the natural springs. Thus, this entire area supports the water-provisioning function of the Reserve.

The Rietvlei Game Reserve was about 31Ha in area (Reader's Digest, 1990). Over time various portions were, however, de-proclaimed or incorporated (City of Tshwane Metropolitan Municipality, 2012).

The large-pivot irrigation systems on the farm South of the reserve had a negative impact on the groundwater levels and the capacity of the dam to provide water to the Tshwane Metropolitan Municipality. Therefore, Witkoppies Farm was incorporated into the Reserve to mitigate the negative impact of the extraction of groundwater, and to protect the peat wetlands on the south-eastern portion of the farm which falls within the catchment area of the Rietvlei Dam (City of Tshwane

Metropolitan Municipality, 2012). After the incorporation of the Witkoppies Farm into the Rietvlei Nature Reserve, its farming activities were terminated.

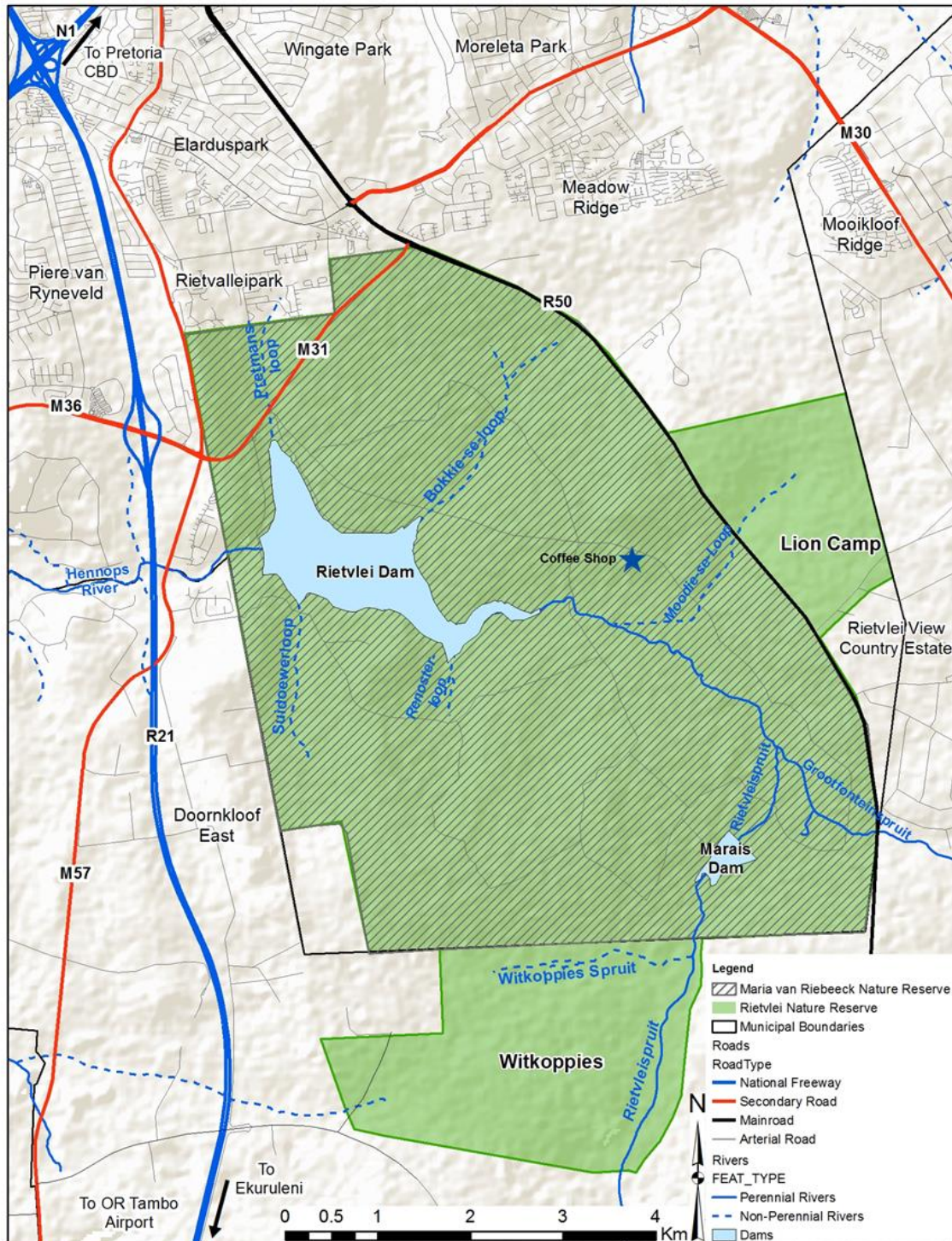


Figure 4.2: Spatial overlap of the Maria van Riebeeck Nature Reserve and the Rietvlei Nature Reserve

Source: Compiled by S. Carow: Data: ESRI data in a box (2018)

There have been various attempts by the local government to revoke the proclamation of some of the fragmented areas for development, as these did not appear to be functionally part of the Reserve. In 1942, a portion of the Reserve (580 ha) to the east of the Delmas Road was indeed sold for the establishment of the Agricultural Research Station (Marais, 2015). According to the Tshwane City Planning Department, the proclamation of the Triangle Camp could be revoked in order to extend the road network, as the camp is no longer a functional part of the Rietvlei Nature Reserve.

Furthermore, over time, there have been changes in the perception of the functions of the section of the Reserve to the north of the Rietvlei Dam Road. The wetland was initially protected in order to preserve the source of the Pretmansloop and to allow for the natural purification of the water flowing into the Rietvlei Dam (Andrews, 1993).

Also, at the time of the research, the camps to the north of the Rietvlei Dam Road were used for the grazing of the Nooitgedacht ponies. They were bred in the Reserve and are descendants of the working animals that pulled the municipal waste and sewage carts in the 1900s (Manager, Rietvlei Nature Reserve. Personal communication. 8 September 2016). At the time when the Reserve was initially proclaimed, the municipal working animals were accommodated in the Reserve. However, owing to technological developments over the last hundred years, the stabling of the animals in the Rietvlei Nature Reserve became redundant. Later, the ponies were primarily kept for trails through the Reserve and for children's rides in the Marais Dam environs. On account of the changing context, the function of

the Rietvlei Nature Reserve to accommodate draught animals for the city is no longer applicable.

In 2012, there was strong resistance from Friends of Rietvlei (an NGO), the Pretoria East branch of the South African Hunters and Game Conservation Association (SAHGCA), as well as local communities, to a decision of the Tshwane Metropolitan Municipality to make 100 hectares of the Rietvlei Nature Reserve available to the Super Sport United Soccer Club for the development of a sports centre (Chairperson, Friends of Rietvlei. Personal communication. 8 August 2016; Hlahla, 2012).

The proposed development of the triangular camp (Figure 4.2) was subsequently prevented and a decision was made that should portions of the Reserve be used for other land-use functions in the future, their proclamation as part of a conservation area should be revoked. Furthermore, it was recommended that a formal Environmental Impact Assessment (EIA) be conducted, and a process of public participation be instituted to evaluate not only the impacts arising from the development of the site in question, but also on the adjacent conservation area.

This brief historical overview of the Rietvlei Nature Reserve highlights the need to strike a balance between the initial established objectives of the Rietvlei Nature Reserve and the objectives of urban expansion in the adjacent area and of accommodating the needs of a fast-growing urban population as well. In terms of the environmental stress model, it is therefore important to also look at the broader context of the greenspace and not only the physical characteristics of the conservation area itself.

In the next section, some of the implications and challenges of urban growth for the Rietvlei Nature Reserve are explored.

4.4 Implications and challenges of urban development for the Rietvlei Nature Reserve

According to the model of urban impact of Pacione (Figure 2.4), the objective (actual, real) physical conditions of an area feed into the functions and benefits offered by the area, as well as into the environmental perceptions that the associated population holds of that area.

As a conservation area, the Rietvlei Nature Reserve falls within Zone 3, a high control zone in terms of the Gauteng Environmental Management Framework classification. In areas that fall into the Zone 3 control zone, limited urban development is allowed, and the dominant human activities are related to conservation, tourism and recreation. The fauna in the Reserve provide a resource for tourism and recreation, and also contribute to the conservation of the grassland biome and gene pools for biodiversity (SANBI, 2013).

Over time, urban development has had implications for the physical characteristics of the Rietvlei Nature Reserve. Thus, it was important not only to evaluate the demarcated conservation area, but also to place it in the context of its relative location. Growing population numbers imply greater needs for a variety of municipal services and also for the ecosystem benefits or services provided by this urban greenspace. As such, urban development may influence perceptions of the Rietvlei Nature Reserve and the sense of place attached to this greenspace.

4.4.1 Legislative spatial development frameworks

There is a continuing debate over the appropriate spatial planning frameworks within the cities of the global South (Satgé & Watson, 2018). Master planning prior to 1994 which was initially used for planning segregated cities in South Africa has been replaced by new approaches of integrated development (Sihlongonyane, 2018). Urban developments at the local level generally fit into a dynamic, broader and institutionalised context as a hierarchy of plans and spatial frameworks directing the spatial development path of cities and towns. Well-balanced inter-governmental planning is, therefore, important in the coordination of urban development.

The variety of frameworks, strategies, policies and guidelines for environmental management in South Africa collectively reflect the importance and priority given to environmental protection (Strydom & King, 2009). The National Environmental Management Act No. 107 of 1998 and related legislation are based on principles of sustainable development and require that land and infrastructural developments take place in an environmentally-responsible way (Dickens *et al*, 2003).

The South African Department of Environmental Affairs has developed a National Strategy for Sustainable Development and Action Plan (NSSD), which “is a proactive strategy that regards sustainable development as a long-term commitment, which combines environmental protection, social equity and economic efficiency with the vision and values of the country” (Department of Environmental Affairs, 2017). The restructuring of South African cities is an important principle associated with the National Development Plan (Gauteng Department of Agriculture and Rural Development, 2011) and the National Spatial

Planning and Land Use Management Act of 2013. In addition, the Gauteng Spatial Development Framework (2011) incorporates metropolitan frameworks for each of the metropolitan municipalities in the province, as illustrated by the researcher in Figure 4.3.

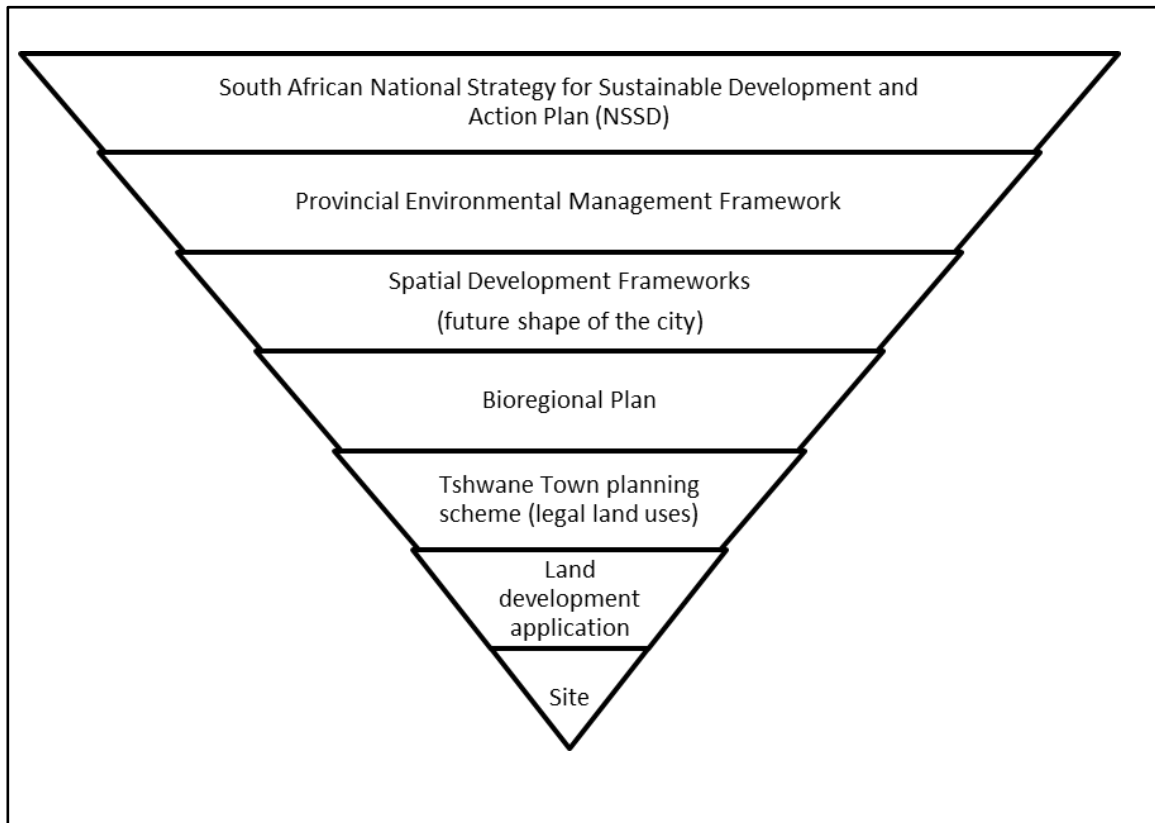


Figure 4.3: Hierarchy of spatial development frameworks guiding urban development

Source: Author (2020)

There are clusters of legislation related to the Spatial Planning and Land Use Management Act (SPLUMA, 2013), which are concerned with development, and to the National Environmental Management Act (NEMA, 1998), which is concerned with conservation issues. Even though legislation is in place, there are challenges in terms of balancing these clusters and implementing the legislation. An overarching body, similar to an ombudsman, has already been suggested in order

to coordinate different views on conservation development (Advocate: Personal communication. Jansen. 5 August 2016). This is especially important within the context of development pressures and conflicts on account of the increasing number of people, land claims and the burgeoning growth of informal settlements.

The Gauteng Provincial Environmental Management Framework (GPEMF) aims to direct urban development, including the required service infrastructure, to those areas with fewer environmental challenges and high development demands (Environomics, 2014). The spatial direction of urban development within the metropolitan and local municipal areas is managed in order to support the Gauteng Growth and Management Perspective, as well as to protect critical biodiversity areas and environmental management control zones. Since open spaces in Gauteng are protected through Metropolitan Open Space Systems regulations, the level of compatibility of land uses in all development applications is considered in conjunction with environmental impact reports.

It is important to protect the natural processes and ecology through effective wetland management (Mitch & Gosselink, 2011). Structures such as weirs and retention dams can be used to mitigate the risks associated with heightened water flows related to urban development. Thus, in order to protect and support the ecological functions of the greenspace itself, buffer areas need to be considered in the design of developments adjacent to the Rietvlei Nature Reserve. The natural flow patterns and flood lines also need to be considered in developments, so that green infrastructural benefits can be sustained. The removal of vegetation when land is cleared for development in the catchment areas can increase the risk of flooding and of volumes of sediment being transported into the wetlands of the

Reserve. The design of development projects and the infrastructure surrounding the greenspace, as well as the upgrading of the infrastructure within the conservation area, could also run the risk of negatively impacting upon the biodiversity of the Reserve.

4.4.2 The influence of municipal restructuring on the Rietvlei Nature Reserve

In the section on the history of the Rietvlei Nature Reserve, it was established that boundary demarcation has influenced the physical characteristics of the Rietvlei Nature Reserve over time. The interplay between urban development, conservation and sense of place was evident in the restructuring of the Reserve. It was therefore considered important to establish whether boundary delimitation would indeed be perceived as an environmental stressor.

Municipal restructuring aims at addressing the service needs and imbalances of the past. This is relevant to the municipal boundaries, as well as to spatial planning frameworks and development zones (Figure 4.4). In the previous section, boundary changes were identified on the local level (Figure 4.2), whereas municipal boundaries surrounding the Rietvlei Nature Reserve are explored in the next section. Figure 4.4 illustrates the location of the Rietvlei Nature Reserve relative to Planning Zone 6. In this figure, the spatial impact of administrative boundaries is evident. There is no spatial co-variation between the natural boundaries of the catchment area of the Rietvlei Nature Reserve and the administrative boundaries of this region (de Jager, 2018). The municipal boundary runs through the southern part of the Rietvlei Nature Reserve (Figures 1.2, 4.2 and 4.4).

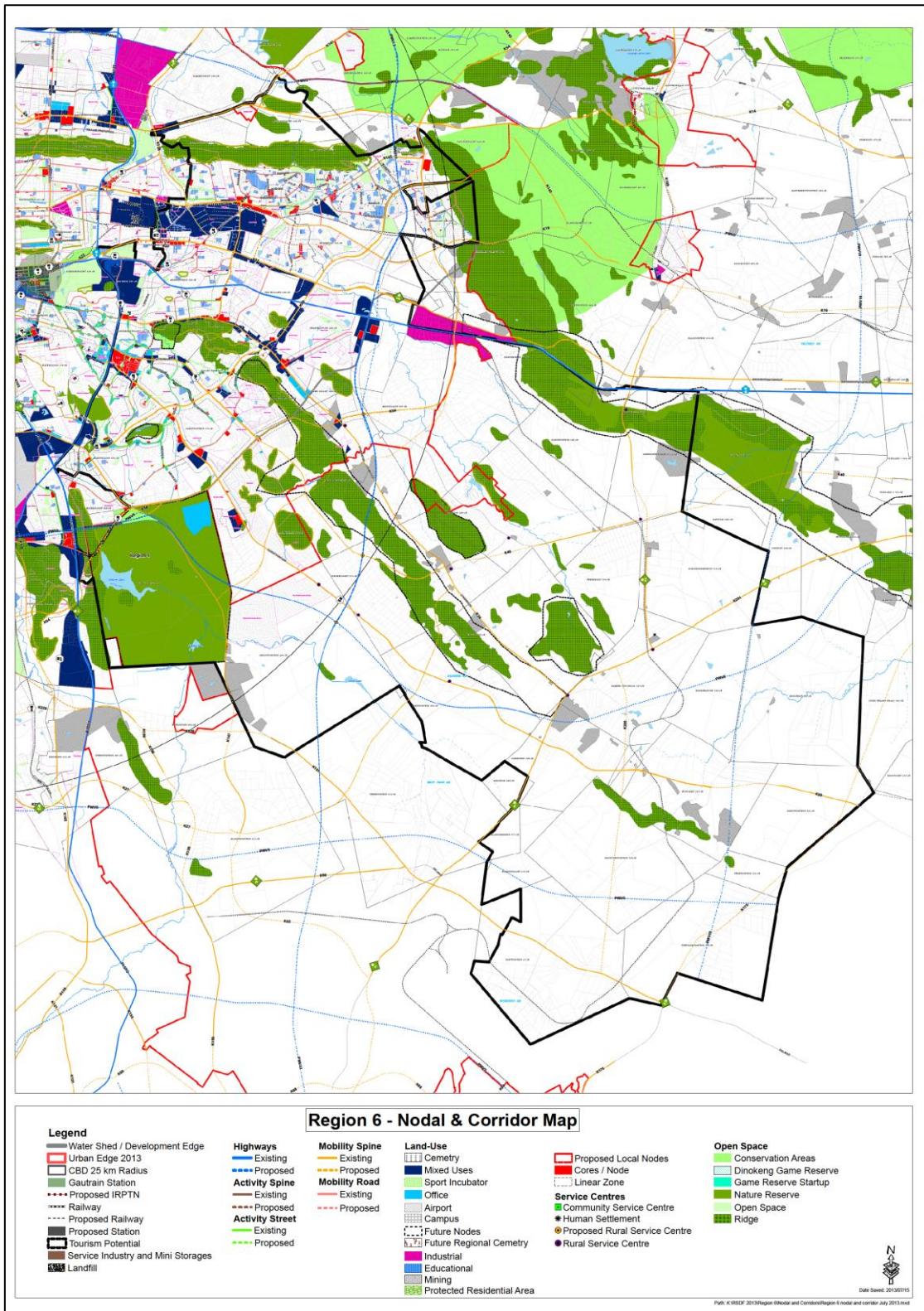


Figure 4.4: The location of the Rietvlei Nature Reserve in Planning Zone 6 as presented on the official website of the Tshwane Metropolitan Municipality
 Source: City of Tshwane 2017

As such, the Witkoppies section falls under the jurisdiction of the Ekurhuleni Metropolitan Municipality. However, this metropolitan authority is not responsible for the management of the conservation area as the latter belongs to the Tshwane Metropolitan Municipality. Another point to note is that on the nodal and corridor map of Region 6, which includes the Rietvlei Nature Reserve, the Witkoppies Farm is not indicated as part of the Reserve as it does not fall within the boundaries of the Tshwane Metropolitan Municipality (Figure 4.4).

The restructuring of boundaries has not only changed the way in which the Rietvlei Nature Reserve has been demarcated (Figure 4.4), but has also influenced the context in which it is located (Chapter 1). By 2010, the Rietvlei Nature Reserve was bordering on three different municipal areas, namely those of Tshwane, Ekurhuleni and Kungwini.

Yet another problem in this respect is that many of the developments in this region were approved at the Gauteng provincial level in terms of the then Development Facilitation Act (Act 67 of 1995). Although the Development Facilitation Act is no longer valid, its implications are still evident in the urban landscape. For example, the Tshwane Metropolitan Municipality inherited developments outside of the urban periphery and its proclaimed urban development line (UDL). When the township, The Hills, was developed beyond Tshwane's UDL, for instance, its sanitation infrastructure was not linked to Kungwini's bulk infrastructure. Where bulk infrastructure for sanitation is not available, developers are then forced to find other solutions (e.g. to install package plants and to obtain water directly from Rand Water).

4.4.3 Urban spatial development and externalities of land cover in the catchment area of the Rietvlei Dam

The spatial form of the city exacerbates development pressures in the area surrounding Rietvlei Nature Reserve. On the map of the Gauteng City Region Observatory (Figure 4.5), the red band between Tembisa and Centurion clearly illustrates the development along the R21 corridor (Hamann *et al*, 2018; Brand *et al*, 2017; Gauteng Province, 2011). Owing to the location of the Reserve on the urban fringe and along a proclaimed development corridor, it is continuously being subjected to pressures from the urban developments and expansion in the area adjacent to it – a serious matter, considering its potential critical biodiversity status. An example is the proposed development of a petrol filling station in Knoppieslaagte, just outside the Reserve (Pelser, 2019).

Emerging development nodes (e.g. the Route 64 industrial developments to the north of the Reserve, as well as the Irene Mall to the north-west), both of which are supported by the infrastructure around the Rietvlei Nature Reserve (Tshwane, 2017), places development pressures on this urban greenspace.

According to an urban planner involved in developments in the study area, M&T Developers were pioneers in terms of infrastructural development in the area adjacent to the Rietvlei Nature Reserve, thereby leading the way for leapfrog developments (Town Planner: Personal Communication; De Bruto, 2016). The development pressures on the Rietvlei Nature Reserve will therefore be most likely to increase in the future.

The land cover for the catchment area of the Rietvlei Dam is associated with agriculture and low-density urban development. According to the National Land

Cover database for 2014, natural vegetation (34, 7%); dryland agriculture (28%); and smallholdings (11, 5%) constituted the largest part of the catchment area. It is also significant that the high-quality agricultural land in the Ekurhuleni Spatial Planning Framework is protected and classified as an open area (Figure 4.6).

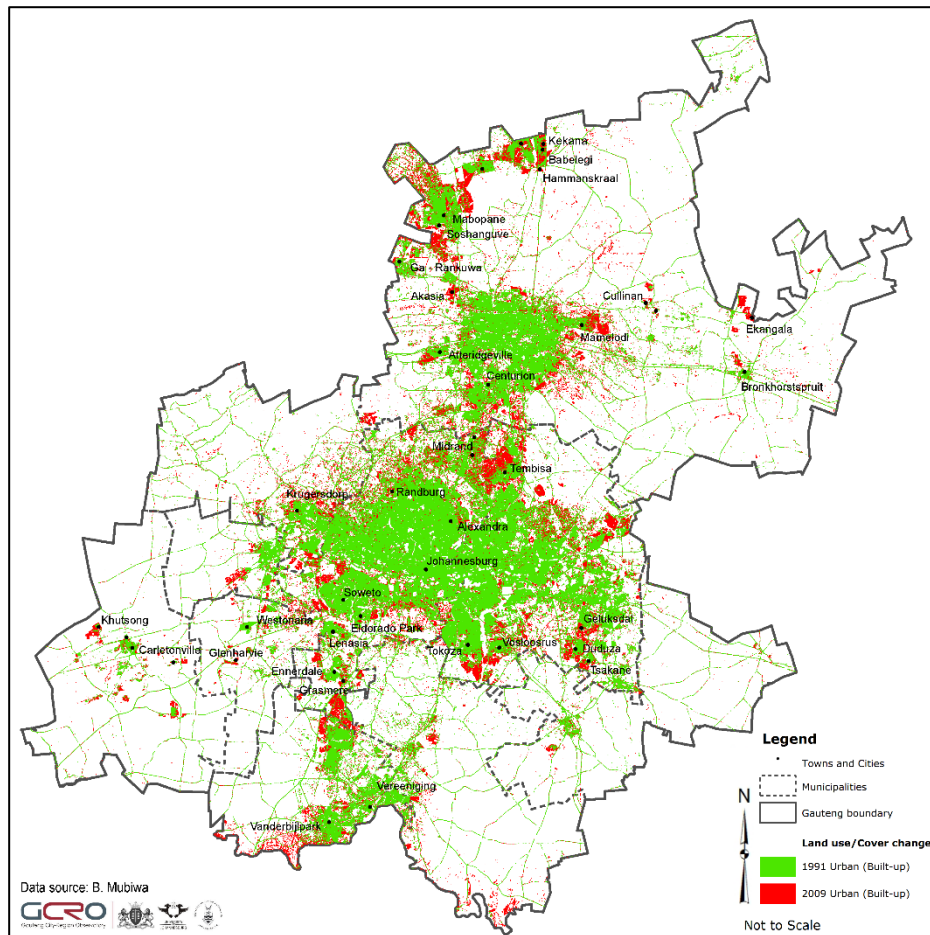


Figure 4.5: Urban land use and cover change 1991-2009
 Source: Adapted from Gauteng City Region Observatory (2015)

Urban expansion and the availability of greenspace to the east and south of the Rietvlei Nature Reserve would most probably intensify development pressure on the conservation area in the future (Figures 4.6 and 4.7).

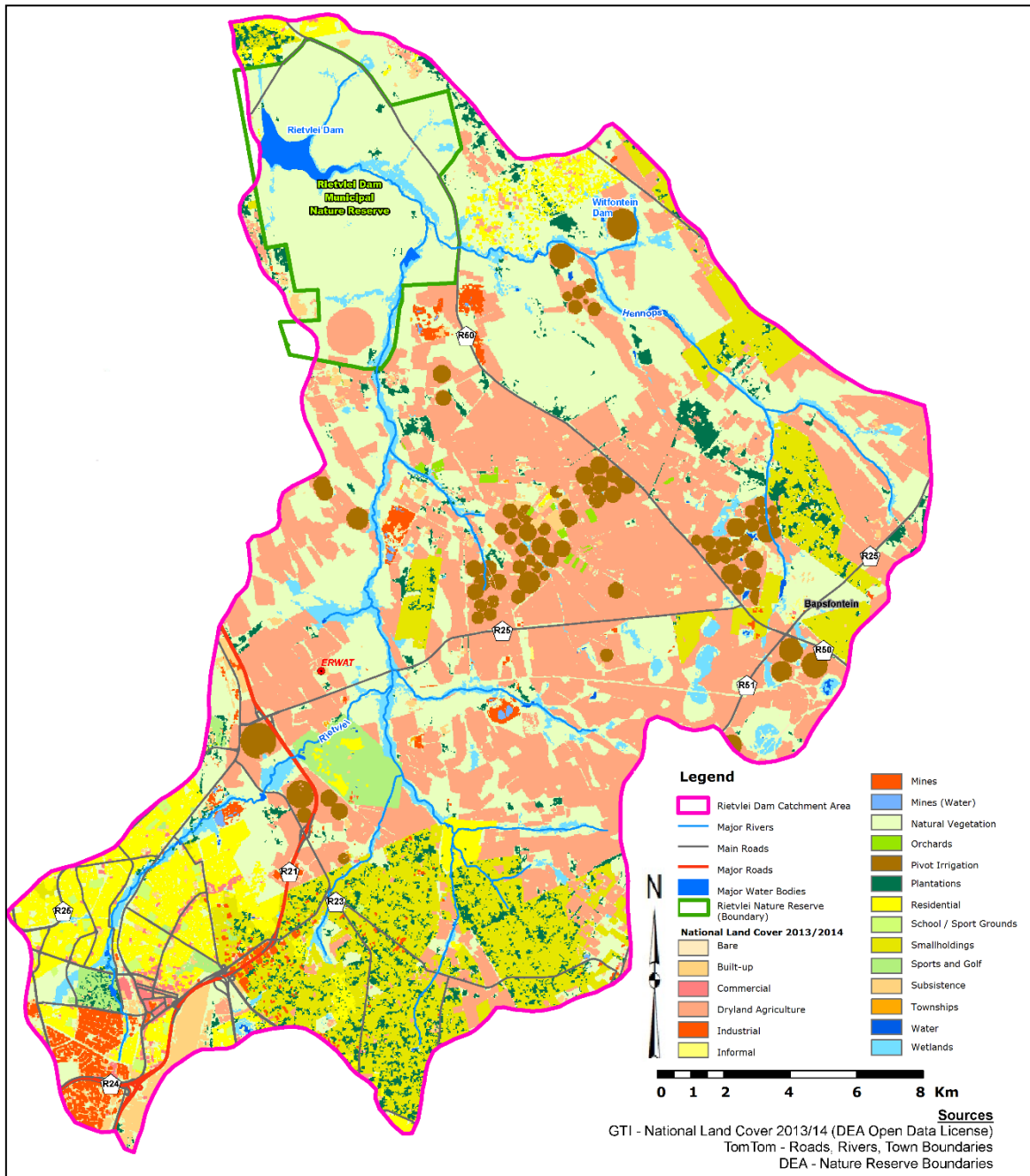


Figure 4.6: Land cover in the catchment area of the Rietvlei Nature Reserve: 2013/14

Source: Adapted from unpublished map compiled by GeoTerraImage (Pty) Ltd

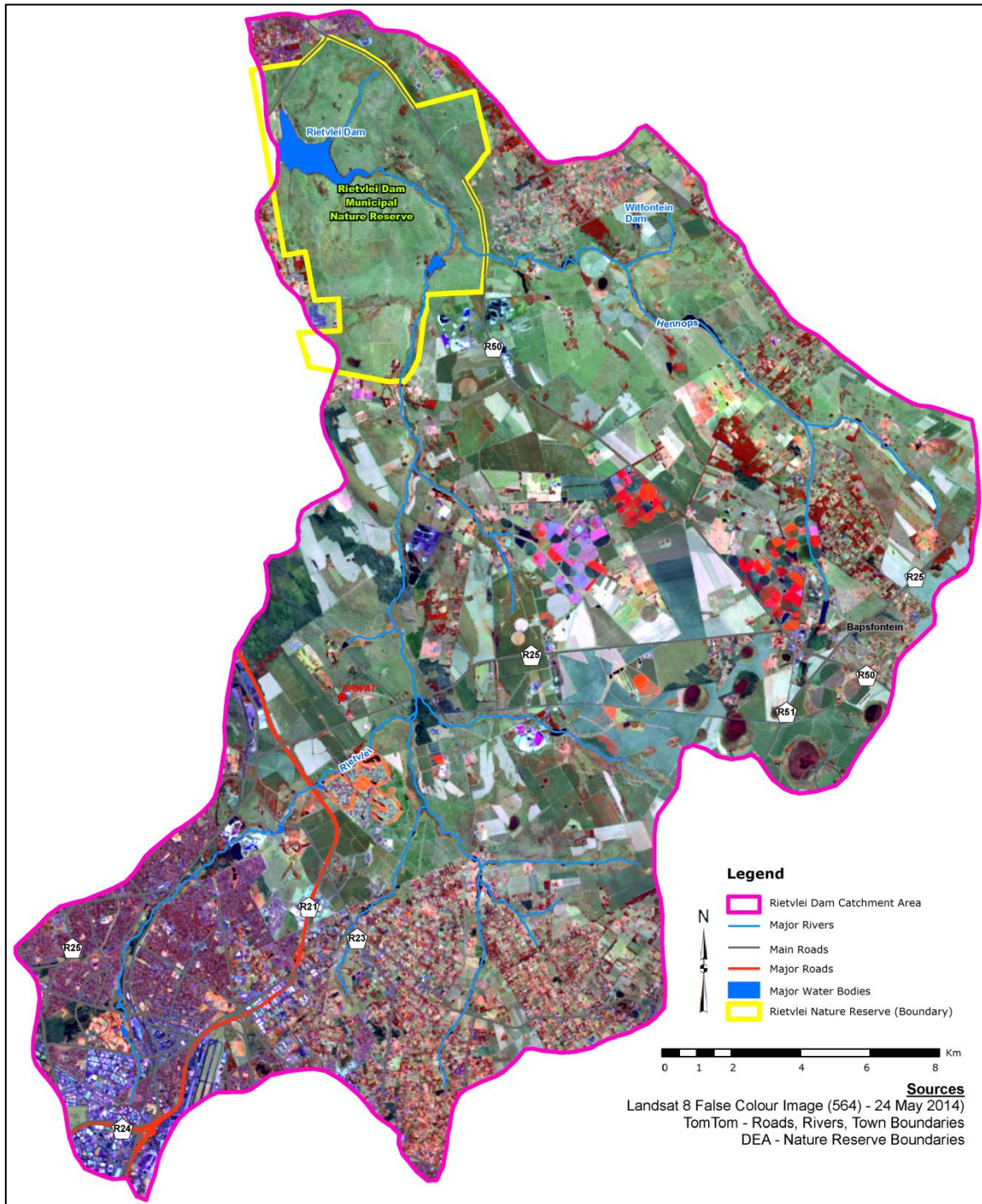


Figure 4.7: Satellite image of the catchment area of the Rietvlei Nature Reserve, 2014

Source: Adapted from unpublished map compiled by GeoTerraImage (Pty) Ltd

The Rietvlei Nature Reserve lies at the receiving end of the drainage system of the Swartspuit, Grootfonteinspruit and the Rietvlei River catchment area. Sesmylspruit, Bakkie-se-loop, Renosterloop, and the Suidoewerloop all feed into the Rietvlei Dam. The Rietvleispruit flows into the Marais Dam, which is a sludge dam for the Rietvlei Dam (Figure 4.2). The catchment area of the Reserve also includes undeveloped land that is potentially available for urban development (Figures 4.5, 4.6 and 4.7).

Many of the challenges experienced in the catchment area are socio-economic and are related to the increasing population numbers and building densities, as well as to the poor water- and sanitation-provisioning services (du Plessis, 2019).

The planned Olifantsfontein Wetland Rehabilitation Project proposes the construction of a wetland system to manage organic load, as well as litter (Hennops Catchment Management Forum meeting, 30 May 2017 attended by the researcher). One of the issues discussed at the Hennops Catchment Management Forum meeting (30 May 2017) was that the Ekurhuleni Metropolitan Municipality would have to foot the bill for an engineering project that would provide more advantages to the Tshwane Metropolitan Municipality than to its own area. However, this project should not necessarily be prioritised in an already stretched budget. The importance of improved inter-government communication and co-ordination was emphasised by the representatives from both metropolitan municipalities.

Conditions similar to those prevailing in the Hennops Catchment area (e.g. degraded wetlands and water pollution) also prevail in the catchment area of the

Rietvlei Dam. This matter is not only relevant to local government, but is also of provincial and national significance. Water from the Rietvlei Dam flows via the Hennops River to join the Crocodile River system that flows into the Hartebeespoort Dam, which is a major water resource, tourist attraction and source of outdoor water activity. The Hartebeespoort Dam is located in the North West Province and is thus subject to another decision-making level of authority (du Plessis, 2019).

The area to the south of the Rietvlei Nature Reserve includes different categories of greenspace. The rivers flowing into the Reserve all form part of the Ekurhuleni Metropolitan Open Space Framework. Those areas indicated as open space are thus part of the larger open greenspace framework. This again emphasises the need for better coordinated planning and ongoing communication between the Tshwane and Ekurhuleni metropolitan municipalities in order to more easily identify and protect urban greenspace.

4.4.4 Land-cover changes in the catchment of the Rietvlei Dam

The land-cover changes in the catchment of the Rietvlei Dam are presented in Table 4.1. The largest percentage of change within the said time period was evident in the residential land-use category, which increased from 4,3% to six percent (6,0%), and in the smallholding category, which decreased from 12,3% to 11,5%. The economic opportunities emanating from changes in land use from smallholding to formal residential developments would most probably further enhance this trend in the future.

Table 4.1: Land cover in the catchment area of the Rietvlei Dam: 1990 – 2014

Class Name	1990			2014			Land Cover Groups	1990		2014		
	Count	Ha	Perc	Count	Ha	Perc		Ha	Perc	Ha	Perc	
Water seasonal	367	33	0,1%	221	20	0	Water	214	0,4%	254	0,5%	
Water permanent	2 006	181	0,4%	2 599	234	0						
Wetlands	20 715	1 864	3,9%	22 730	2 046	4	Wetlands	1 864	3,9%	2 046	4,2%	
Thicket /Dense bush	12 325	1 109	2,3%	21 869	1 968	4						
Woodlan/Open bush	3 002	270	0,6%	7 914	712	1	Natural Vegetation	17 177	35,7%	16 709	34,7%	
Grassland	172 586	15 533	32,2%	154 819	13 934	28						
Low shrubland	2 943	265	0,5%	1 050	95	0	Dryland Agriculture	14 730	30,0%	13 925	28,9%	
Cultivated comm fields (high)	58 725	5 285	11,0%	65 203	5 868	12						
Cultivated comm fields (med)	71 830	6 465	13,4%	69 756	6 278	13	Pivot Irrigation	812	1,7%	1 581	3,3%	
Cultivated comm fields (low)	33 112	2 980	6,2%	19 766	1 779	3						
Cultivated comm pivots (high)	6 711	604	1,3%	14 328	1 290	2	Orchards	23	0,0%	81	0,2%	
Cultivated comm pivots (med)	1 856	167	0,3%	2 694	242	0						
Cultivated comm pivots (low)	456	41	0,1%	549	49	0	Subsistence	32	0,1%	-	0,0%	
Cultivated orchards (high)	242	22	0,0%	716	64	0						
Cultivated orchards (med)	8	1	0,0%	99	9	0	Plantations	3 086	6,4%	1 908	4,0%	
Cultivated orchards (low)	-	-	0,0%	81	7	0						
Cultivated subsistence (high)	214	19	0,0%	-	-	0	Mines	206	0,4%	267	0,6%	
Cultivated subsistence (med)	99	9	0,0%	-	-	0						
Cultivated subsistence (low)	39	4	0,0%	-	-	0	Mines (Water)	10	0,0%	44	0,1%	
Plantations / Woodlots mature	32 105	2 889	6,0%	20 002	1 800	3						
Plantation / Woodlots young	2 183	196	0,4%	1 198	108	0	Bare	11	0,0%	61	0,1%	
Mines 1 bare	1 491	134	0,3%	2 431	219	0						
Mines 2 semi-bare	796	72	0,1%	536	48	0	Commercial	291	0,6%	288	0,6%	
Mines water seasonal	35	3	0,0%	85	8	0						
Mines water permanent	73	7	0,0%	399	36	0	Industrial	533	1,1%	618	1,3%	
Bare none vegetated	127	11	0,0%	674	61	0						
Urban commercial	3 237	291	0,6%	3 198	288	0	Informal	5	0,0%	18	0,0%	
Urban industrial	5 919	533	1,1%	6 871	618	1						
Urban informal (dense trees / bush)	6	1	0,0%	97	3	0	Residential	2 072	4,3%	2 895	6,0%	
Urban informal (open trees / bush)	4	0	0,0%	8	1	0						
Urban informal (low veg / grass)	42	4	0,0%	148	13	0	School / Sports Grounds	138	0,3%	156	0,3%	
Urban informal (bare)	-	-	0,0%	4	0	0						
Urban residential (dense trees / bush)	19 221	1 730	3,6%	26 556	2 390	5	Smallholdings	5 931	12,3%	5 530	11,5%	
Urban residential (open trees / bush)	270	24	0,1%	1 001	90	0						
Urban residential (low veg / grass)	3 508	316	0,7%	4 414	397	0	Sports and Golf	169	0,4%	695	1,4%	
Urban residential (bare)	20	2	0,0%	200	18	0						
Urban school and sports ground	1 535	138	0,3%	1 733	156	0	Township	15	0,0%	10	0,0%	
Urban smallholding (dense trees / bush)	8 931	804	1,7%	26 743	2 407	5						
Urban smallholding (open trees / bush)	1 697	153	0,3%	3 448	310	0	Bultup	854	1,8%	1 086	2,3%	
Urban smallholding (low veg / grass)	55 181	4 966	10,3%	30 202	2 718	5						
Urban smallholding (bare)	92	8	0,0%	1 047	94	0	Urban township	140	0,3%	56	0,1%	
Urban sports and golf (dense tree / bush)	437	39	0,1%	3 400	306	0						
Urban sports and golf (open tree / bush)	38	3	0,0%	218	20	0	Urban township (bare)	-	-	-	-	
Urban sports and golf (low veg / grass)	1 399	126	0,3%	4 083	367	0						
Urban sports and golf (bare)	6	1	0,0%	26	2	0	Urban built-up (dense trees / bush)	1 825	164	0,3%	3 191	287
Urban township (dense trees / bush)	10	1	0,0%	39	4	0						
Urban township (open trees / bush)	15	1	0,0%	15	1	0	Urban built-up (open trees / bush)	397	36	0,1%	792	71
Urban township (low veg / grass)	140	13	0,0%	56	5	0						
Urban township (bare)	-	-	0,0%	5	0	0	Urban built-up (low veg / grass)	5 201	468	1,0%	2 661	239
Urban built-up (dense trees / bush)	1 825	164	0,3%	3 191	287	0						
Urban built-up (open trees / bush)	397	36	0,1%	792	71	0	Urban built-up (bare)	2 062	186	0,4%	5 424	488
Urban built-up (low veg / grass)	5 201	468	1,0%	2 661	239	0						
Urban built-up (bare)	2 062	186	0,4%	5 424	488	1						
		48 172			48 172			48 172	100%	48 172	100%	

Source: Compiled by GeoTerralmage from the South African National Land Cover Database: 1990 and 2014

Table 4.2 presents a summary of land-use changes between 1990 and 2014 in the catchment area of the Rietvlei Nature Reserve. The information in Table 4.2 was derived from the information presented in Table 4.1.

Table 4.2: Land-use changes in land-cover groups in the catchment of the Rietvlei Nature Reserve: 1990-2014

Decline in land area	Limited change in area of land	Increase in land area
Natural vegetation Dryland agriculture Subsistence agriculture Plantations Bare land Smallholdings	Township Commercial Water	Residential School Sportsgrounds Pivot irrigation Built-up areas Mines Orchards Industrial Informal Wetlands

Based on the summary in Table 4.2, it is evident that urban-type land-use functions are increasing in an area that used to be a typically rural area. Housing and retail developments in the area surrounding the Reserve have led to increased pressure on the already congested road infrastructure. The relative location of the Rietvlei Nature Reserve alongside a development and transport corridor could therefore contribute to long-term development pressures on the conservation area.

Owing to the prevalence of dolomite, it is anticipated that the underlying geological structure alongside the south-western part of the study area will remain an important factor in any future development applications for high-density residential development. The nature of the underlying geological structure of the study area was again emphasised when, on account of a sinkhole that had formed in the road, the Delmas Road, passing adjacent to the eastern side of the Rietvlei Nature Reserve, was closed in November, 2019.

From the discussion above, it is clear that environmental stressors might also originate beyond the boundaries of the Rietvlei Nature Reserve. Urban discharge and agricultural runoff from the catchment area within the Ekurhuleni Metropolitan Area, for instance, hold implications for the quality of the water in the Rietvlei

Nature Reserve. The intensity of this impact is discussed in greater detail in Chapter 5. This serves as evidence to the effect that the current and planned spatial development in the catchment area of the dam does indeed influence the quality and flow of water into the Rietvlei system. Thus, it can be concluded that the implications of and challenges for urban development should be prioritised in any catchment management scenario.

This conclusion is relevant to the Greenspace Stress Model of Urban Impact. According to Pacione (2001), the actual physical characteristics of the city feed into the environmental perceptions of the city held by the residents. Thus, not only the conservation area itself, but also the local context of the greenspace, should be recognised when considering the objective physical conditions and identifying the environmental stressors.

4.5 Providing service infrastructure to a growing urban population

An important function of the Rietvlei Nature Reserve is to support water and electricity provisioning to the Tshwane Metropolitan Municipality. The physical characteristics of the Rietvlei Nature Reserve are in fact influenced by the water and electricity infrastructure of the region.

In the designated area for the sailing club, the focus is on active recreation through competitive canoeing and sailing, and the facilities were designed and built for that purpose. In the camping and fishing areas alongside the Rietvlei Dam, there are ablution blocks and campsites, as well as designated areas for fishing and picnics. No fishing is allowed at the Marais Dam, and visitors may only exit their vehicles at the designated picnic area. Often, the visitors to the conservation area do not visit

the camping and fishing areas and as such, the gate between these areas is locked for security reasons. Furthermore, the survey found that there are visitors who prefer not to drive through the section of the Reserve where the powerlines are as it negatively impacts on their nature-based experience (Figure 4.9). The water purification section of the Reserve is not open to the public and only employees are allowed entry.

4.5.1 Infrastructure for water- and sanitation-provisioning to the Tshwane Metropolitan Municipality

Two dams, four fountains and five boreholes collectively contribute to the Rietvlei Water Scheme (City of Tshwane, Water and Sanitation Division, Public Works and Infrastructure Development, 2015). The smaller Marais Dam is a sludge dam built upstream on Sesmylspruit to support the Rietvlei Dam (Figure 4.2). In order to further increase the capacity of water provisioning from Rietvlei, the first boreholes were drilled in 1986, and in 1998 the capacity of the Rietvlei Dam was increased to provide approximately 41 000 litres of water per day (City of Tshwane Water and Sanitation Division, Public Works and Infrastructure Development, 2015). A Rand Water pipeline that feeds into the Tshwane water supply system runs through the Reserve.

The provision of water is challenging on different resolution levels - from global to national to local (du Plessis, 2019; Republic of South Africa. Department of Water and Sanitation, 2019). According to the Gauteng State of the Environment Report (2011), most of the water resources in Gauteng are over-utilised and degraded (Gauteng Department of Agriculture and Rural Development, 2011). This is attributed to “extensive urbanisation, encroachment into riparian areas, mining and

industrial development, as well as poor management of water resources” (Gauteng Department of Agriculture and Rural Development, 2011: 11).

The Tshwane Metropolitan Municipality is also experiencing challenges in providing an acceptable quantity and quality of water to the fast-growing population (Tleane, 2011). There is pressure on the existing infrastructure, not only for maintenance and capacity, but also for security.

Tshwane has three water treatment plants, which are located at Rietvlei, Temba and Roodeplaas respectively. When the infrastructure becomes incapable of dealing with the amount of wastewater, the efficiency of the water purification process is usually compromised. On 18 October 2016, for instance, water provisioning to parts of the City of Tshwane was interrupted when the Temba Water Treatment Plant was closed as a result of severe contamination (City of Tshwane, 2016 (c)). Cable theft at the Rooiwal Wastewater Treatment Plant and leakages of raw sewage into the system also led to the contamination of the water sources (City of Tshwane, 2016 (c)). The interconnectedness of the respective municipal services of electricity, water and sanitation is clearly manifested in this incident. This remains an important factor to consider in the sustainable provision of essential municipal services to a growing urban population.

The Rietvlei Dam, the peatlands, aquifers and wetlands in the Nature Reserve, and the Rietvlei Water Treatment Plant, all play an important role in providing water to the Tshwane Metropolitan Municipality. The Rietvlei Dam wall is 32 metres high (Figure 4.8) and the dam has a capacity of 12 000 000 m³ (City of Tshwane, City of Tshwane, Water and Sanitation Division, Public Works and Infrastructure

Development, 2015). The Rietvlei Treatment Plant was the first in South Africa to implement the Dissolved Air Flotation and Filtration process (DAFF), and later also the Granular Activated Carbon (GAC) filtration system (Clemens & Haarhoff, 2004; City of Tshwane, Water and Sanitation Division, Public Works and Infrastructure Development, 2015). The Rietvlei Water Purification Plant provides 40 megalitres of water per day; Grootfontein approximately seven megalitres per day, and boreholes, approximately six megalitres per day to the Klapperkop and Garsfontein reservoirs (Director of Water and Sanitation, City of Tshwane. Personal communication. 28 November 2016). The Tshwane Metropolitan Municipality's total demand for water is estimated at 1 000 megalitres per day (Director of Water and Sanitation, City of Tshwane. Personal communication. 28 November 2016). Thus, Rietvlei provides approximately five percent (5%) ($53/1000 \times 100$) of the total bulk water requirements of the city.



Figure 4.8: The ground wall of the Rietvlei Dam
Photo: Author (9 December 2015)

In line with the initiative of the National Department of Water and Sanitation to reduce its dependency on the Vaal System, the Tshwane Metropolitan Municipality has developed a water management plan to increase the capacity of water provisioning from its own sources (van Rooyen *et al*, 2015). It is envisaged that over the next forty years, the capacity of the Rietvlei Water Purification Plant will be increased to provide an additional 200 megalitres of water per day (City of Tshwane, 2016 (a)).

In order to provide for the growing water needs of the urban population, the capacity of the Rietvlei Water Purification Plant will have to be increased to meet expectations (van Rooyen *et al*, 2015). According to the Director of Water and Sanitation in Tshwane (Mouton. Personal communication. 2016), the planned extensions of the water purification plant will require a new inflow structure from the dam. More structures will also be required downstream of the dam wall, where the Rietvlei Water Purification Plant is located. It has been indicated that the current boreholes will not be affected by the increased capacity of the purification system. This does not mean that there will be no implications for the Rietvlei Nature Reserve, however.

Should the capacity of the purification plant be increased to the planned level, the status of the dam could possibly change from a storage dam to a balancing dam. Even though the dam wall would remain the same height and the area covered by the dam would not to be increased, it is anticipated that more water could then be extracted from the dam. Possible implications of the change in water flow and balance should therefore be monitored.

The average summer rainfall for the Rietvlei Wetlands Complex is between 600 and 750 mm per annum (Gründling, 2004). The volume of water flowing into the Rietvlei Dam is further influenced by precipitation, groundwater and inflow from the catchment area. This volume of water, issuing not only through natural processes, also includes stormwater, runoff from hard surfaces, and sewage from upstream areas.

The increased capacity of the water purification plant can be achieved only by pumping the water via an extended pipe network into the plant (Rietvlei Water Purification Plant. Personal communication. 2017). If implemented, this would be a significant achievement as water will not be channelled through the wetlands system and the dams in the Rietvlei Nature Reserve. The variety in the species of grasses and reeds, animals and birds in the wetlands is influenced by the level and rate of flow of the water (Sieben *et al*, 2017). It is thus important to manage the Rietvlei wetlands in a suitable way, while concomitantly supporting water provision for the growing urban population.

Environmental impacts are closely linked to the development of the infrastructure. Dealing with potential environmental stressors, a survey on invertebrates was conducted to inform the evaluation of alternatives for the location of Rand Water pipelines in the Rietvlei Nature Reserve and Bronberg Ridge (Hakwes, 2010). The focus of this evaluation was on the spatial distribution and habitats of significant invertebrate species (e.g. *ichnestoma stobbiai*).

In this report, it was emphasised that the laying of the pipes should be carried out in collaboration with the Reserve management. However, at the time of the

research, this had not yet commenced. Environmental damage should therefore be mitigated by timing the proposed intervention in accordance with the activity patterns of the invertebrate species; limiting the duration of the activity; carefully demarcating the designated work areas; and adhering to conservation practices. While these are very important aspects to consider in the development and expansion of infrastructure, the importance of the natural flow patterns of water should not be under-estimated.

The grassland habitat could be rehabilitated through the application of the appropriate seed mix, and by monitoring the spread of invasive species on disturbed soil. It is, however, much more difficult to restore peatlands and their ecosystem functions. As such, when evaluating the interplay between urban development, conservation and sense of place in a greenspace area such as the Rietvlei Nature Reserve, and evaluating the different development alternatives, it remains a matter of importance to consider all of the natural functions of the wetlands. Increased flow speeds, for instance, could destroy wetlands and lead to increased eutrophication and the silting of dams. Therefore, it is important to implement mitigation measures, such as weirs, in order to reduce the rate of runoff and to avoid the channelling of the water running through the Reserve.

4.5.2 Road infrastructure

The location of the Rietvlei Nature Reserve relative to the surrounding road infrastructure is illustrated in the map presented in Figure 4.2. The road network allows for physical access to the Reserve as there are off-ramps from the highways passing the Reserve on the western side, as well as via a turnoff from the Rietvlei

Dam Road. The relative location of the Rietvlei Nature Reserve in terms of the road infrastructure and development corridors could, however, also potentially lead to increased development pressures placing stress on the Reserve as a municipal conservation area.

At the time when the Delmas Road and the Rietvlei Dam Road were being built, sections of the Reserve were cut off from the main area occupied by the Reserve. The impact of roads on the fragmentation of habitats and stream flow is well established in the literature, and is also evident in the Rietvlei Nature Reserve. The wetlands to the north of the Rietvlei Dam Road, namely the Triangle Camp (Driehoekkamp) and the Ostrich Camp (Volstruiskamp), for instance, were cut off by the Rietvlei Dam Road, while the wetlands to the east of the Delmas Road were also subjected to the same act (Figure 4.2).

The R21, linking the Pretoria CBD to the industrial areas in Ekurhuleni and the O.R. Tambo International Airport, was identified as a development axis (Figure 4.2). The Rietvlei Dam Road connects the development nodes to the east of Pretoria with Centurion and the adjacent urban development nodes. It also separates the wetlands to the north of the Rietvlei Nature Reserve (Triangle Camp and Ostrich Camp) from the Reserve. This situation was initially regarded as a potential opportunity for development when the Tshwane Metropolitan Municipality proposed the selling of sections of the Reserve for high-density residential development. Even though this proposal was not approved, this part of the Reserve will most probably be cut off in the future when the surrounding road infrastructure is upgraded.

The planned upgrade of the Rietvlei Dam Road would not only strengthen the East-West corridor, but also improve the link between the R21 and the Delmas Road. This would increase the development pressures on the Rietvlei Nature Reserve. The PWV 6 highway was already planned as far back as the 1970s, in order to strengthen east-west mobility between the N1, R21 and the Delmas Road (Urban planner. Personal communication. 14 November 2016). As higher-order traffic boxes create opportunities for the development of a lower grid of road networks (Tshwane, 2017), this road network development will probably further intensify the pressure of development on the Rietvlei Nature Reserve.

The prevailing challenges with the road infrastructure, as well as the lack of available land for further urban development, are illustrated in the following statement, which was taken from the Overview of Zone 6 on the official website of the Tshwane Metropolitan Municipality: *“Almost all the developable land within the southern section of the Region has been developed and the uncontrolled development in the old Kungwini area places a burden on the existing saturated road infrastructure”* (City of Tshwane, 2017).

4.5.3 Infrastructure for the provision of energy

The Rietvlei Nature Reserve provides servitudes for the engineering services involved in the provision of water and electricity. The high-voltage transmission lines of the Cahora Bassa scheme to the Apollo High-voltage Direct Current Converter Station were constructed during the period when the Reserve was under the management of the Engineering Department of the local government. These power lines run through the Reserve, past the Marais Dam, and to the Apollo Power

Station on the south-western side of the Reserve. The Apollo Substation, where power is converted from the Cahora Bassa network, is located adjacent to the Reserve (Figure 4.9).



Figure 4.9: A portion of the electricity network running through the Rietvlei Nature Reserve towards the Apollo Power Station
Photograph: A Williams (17 October 2016)

According to the Bioregional Plan for the City of Tshwane (City of Tshwane, 2016 (d): 34), power lines could be a compatible accessory to the land-use function for grassland ecosystems as long as “ they are appropriately planned, kept out of wetlands and areas where threatened birds breed/feed, and do not lead to ecosystem fragmentation”. It is therefore important to implement measures to protect species (e.g. secretary birds).

The servitude function of the Rietvlei Nature Reserve is important for urban development. When planning the upgrade of bulk infrastructure, however, it remains vital to consider the nature of the critical biodiversity area and the impact of the disturbance of the soil on water flow and habitats. The characteristics of the stream level and flow, for instance, are important for the variety of species that the Reserve accommodates (Goodlet, 2017). Water that is channelled not only contributes to the erosion and de-hydration of wetlands, but also influences the habitat and the variety of bird species in the Reserve. Wader birds, such as the Green Sandpiper, prefer shallow, muddy water and migrate to other areas after rains, when conditions are no longer ideal. Environmental implications of developments should therefore be discussed at *inter alia* community or public participation meetings.

In fact, through a process of community participation, environmental groups were successful in redirecting the construction of power lines so that new lines were placed along the boundaries of the Reserve, rather than through the Reserve (Manager. Personal communication. 8 September 2016). Through a process of community engagement, environmental pressure groups also influenced the spatial location of the Rietvlei electricity sub-station (Former land-owner and developer. Personal communication, 16 August 2016).

While it is difficult to objectively measure the significance of the environmental impacts of high-voltage power lines, the visual impact of the structures is strongly evident in the natural environment. These cases clearly illustrate the importance of proper buffer-zoning regulations pertaining to conservation areas such as the Rietvlei Nature Reserve.

4.6 Achieving a balance between urban development, conservation and sense of place

Providing sustainable service infrastructure and human settlements is a high priority for the Tshwane Metropolitan Municipality (City of Tshwane, 2014(a)). To achieve this goal, the authority plans development nodes, corridors and infrastructure as part of an integrated process towards sustainable development.

As opposed to compact urban development and the densification of land use, urban sprawl, with its associated decentralised development patterns, is often regarded as unsustainable (du Plessis, 2015; City of Tshwane, 2014(b)). In terms of the IDP, densification and compaction are important principles for achieving a sustainable urban form, in that service infrastructure and public transport can be concentrated. Socio-economic integration and appropriate mixed land use are also important principles for spatial restructuring (du Plessis, 2015; City of Tshwane, 2014 (a)).

Decisions regarding urban development and land-use changes in and around the Rietvlei Nature Reserve are influenced by the characteristics of the natural environment, as well as the different options and proposals for development within the available greenspace. Balanced development is about achieving maximum economic output and production, with a minimal environmental footprint (Tshwane Town Planner. Personal Communication. 19 August 2016). Unfortunately, urban development implies that the ecological value of an area proposed for development often has to make place for the priority of providing for immediate human settlement

needs. Thus, it was important to contextualise and evaluate the urban development benefits and risks associated with urban growth in a development scenario (Figure 4.10).

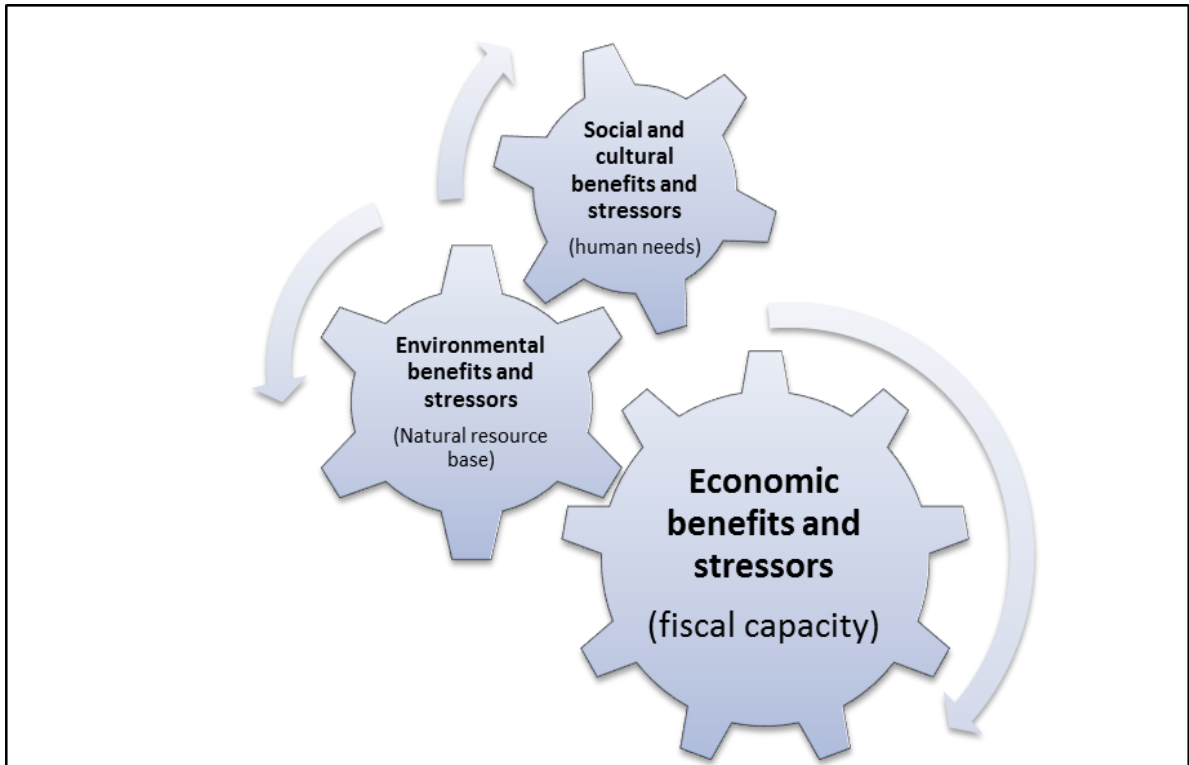


Figure 4.10: The dynamic interplay between economic, social and environmental aspects of sustainability can focus on different components at different points in time.

Source: Author (2020)

The interplay between urban development, conservation and sense of place is demonstrated in the example of the proposed Rietvlei Lifestyle Estate Development. A multi-functional development was proposed on Portion 20 of the farm Grootfontein (394-JR). However, the proposed development was rejected by the local authority. According to the official documentation, this decision was based on the following criteria:

- Misalignment of the proposal with the Gauteng Provincial Spatial Development Framework (2011) and the Tshwane Integrated Development Programme, 2011 to 2016 (City of Tshwane Metropolitan Municipality, 2012). The Gauteng Spatial Development Framework does not support lifestyle developments in the urban periphery, as such a trend would contribute to urban sprawl (Gauteng Province, 2011). Should a development take place outside of the urban margin, additional roads and bulk infrastructure for urban services must then be installed and maintained by the local government. This might also require public transport networks to be extended to the fringe areas. In addition to the spatial development objections, the proposed development could also have a negative impact on the water-provisioning function of the Tshwane Metropolitan Municipality.
- Groundwater sourced from the Grootfontein borehole feeds into the water-supply network to the Tshwane Metropolitan Municipality. If the development proposal were to be implemented, the water would be directed to this new development rather than to the existing water-provisioning system of the City of Tshwane. This could potentially have a negative impact on the water-provisioning capacity of Rietvlei to the greater Tshwane Metropolitan Municipality. Furthermore, at the time of the research, the area for the proposed development did not have any bulk infrastructure for sanitation, which could also pose further risks in terms of the safety of the water source.
- The motivation for rejecting the proposed development also raised concerns regarding conservation. According to official correspondence, proposed developments in greenspace areas that were classified as important in terms

of their provision of ecological support, or that were considered to be irreplaceable, were rejected. The relative location of the proposed Rietvlei Lifestyle Development in respect of the wetland and the perennial river in the catchment area of the Rietvlei Dam was a further factor of significance in the decision to reject the proposed development. This was clearly stated in an official comment: “The proposed area is a habitat to Gauteng Grassland, which is primary vegetation; *hebanaria bicolor*, which is an orange-listed plant; *brachycoryhis conica*, which is a red-listed plant; *lutra maculicollis*, which is a red-listed mammal; and *tyto capensis*, which is a priority red-listed bird.” (City of Tshwane Metropolitan Municipality, 2012).

- Furthermore, the proposed development was situated in an agricultural hub outside of the urban edge, and was, therefore, not in a priority area for the formal bulk sanitation system of the Tshwane Metropolitan Municipality (City of Tshwane Metropolitan Municipality, 2012). As such, the decision to reject the Lifestyle Development clearly showed that the Tshwane Metropolitan Municipality has prioritised the importance of the Rietvlei Nature Reserve as a conservation area.

The Tshwane Metropolitan Municipality has formulated very strict requirements for eco-development, to the extent that eventually it becomes economically unviable to meet these requirements (Developer. Personal communication, 5 August 2016). However, three different developers indicated during interviews that they have had experience of good intentions for eco-developments, but that these have not materialised on account of stringent environmental legislation and processes. The limitations they referred to ranged from developments that were prohibited on a

smallholding adjacent to the Rietvlei Nature Reserve, and to eco-developments further afield that did not take place as intended.

The Leeufontein Eco-friendly Security Estate development in the City of Tshwane was highlighted during a face-to-face, semi-structured interview with a developer (Developer. Personal communication, 24 August 2016.). The original idea was for a low-density township development with game roaming freely between the houses. However, the intentions of the developer were not respected by the owners purchasing the properties on the estate. The reality was that despite the intentions of the developers, residents tended to fence off areas, and thus changed the eco-character of the estate.

4.7 Towards a Greenspace Stress Model of Urban Impact

Multiple benefits of urban greenspace have been identified in the literature and also confirmed in the case of the Rietvlei Nature Reserve. The ecosystem services provided by urban greenspace as green infrastructure, namely the cooling of the urban heat island effect, the mitigating effects of flooding, the protection of wildlife habitats within a growing city, carbon sequestration in the peatlands, as well as the social and health benefits of people living in the city, are also evident in the Rietvlei Nature Reserve.

The Reserve provides a greenspace buffer area that supports natural water purification and protects the water source. Natural fountains, streams and wetlands, as well as a water-provisioning infrastructure, including dams, boreholes, pipelines, a water purification plant, fountains and wetlands collectively support the function of providing water to the City of Tshwane.

The Rietvlei Nature Reserve is important in that it provides basic services to the Tshwane Metropolitan Municipality as it is not only vital for water provision, but also provides a servitude for the electricity network focused on the Apollo Substation.

The conservation status of the Rietvlei Nature Reserve provides protection against development. This is an important benefit within the Reserve since the area would most probably have been transformed into another land-use function if it had not been legally protected against urban development.

The stressors impacting on the Rietvlei Nature Reserve that were identified from a development perspective are those emanating from the context of the Reserve, as well as those within the Reserve. Spatial re-structuring and the lack of spatial co-variation between the administrative boundaries and the natural boundaries (e.g. watersheds) add to the pressures from outside the Reserve. The relative location of the Rietvlei Nature Reserve between two growing metropolitan areas, Tshwane and Ekurhuleni, and its proximity to spatial economic development corridors, as well as to major transport routes, contributes to the intensification of development pressure on the Reserve. The land-use changes associated with urban development in the catchment area of the Rietvlei Dam also contribute to the pollution of the Reserve, especially water pollution, which was identified as a stressor within the Reserve.

The benefits and stressors discussed in this chapter are summarised in Tables 4.3 and 4.4. Table 4.3 provides a summary of the link between the benefits of the Rietvlei Nature Reserve and the selected models from the literature, while Table 4.4 presents the relevant stressors within the Reserve.

Table 4.3: Explanation of how the benefits link up with the existing models relating to urban greenspace

Benefit	Pacione (2001)	Haase and Rink (2014)	Butler (1980)	Montgomery (1998)
Ecosystem services	The urban environment influences human quality of life in the city. There is equilibrium where the greenspace is fit for a purpose and human needs are met.	The healthy functioning of ecosystems is important for sustainability. Human quality of life is enhanced by ecosystem services.	A physical characteristic of a place is important and attracts people to that place.	Urban development changes the form of the surrounding urban area, and influences the ecosystem services in the Reserve.
Supporting municipal services (water and electricity provision)	The Stress Model of Urban Impact by Pacione emphasises that environmental factors influence human quality of life in the city. Lack of access to water and electricity can lead to stress for people living in the city.	Wetland restoration improves healthy ecosystems	The capacity for water provision is increased at critical points (e.g. when the water purification plant was built, when boreholes were drilled, and when the height of the dam wall was increased).	Awareness of functions of the Rietvlei Nature Reserve contribute to the sense of place
Rietvlei Nature Reserve provides a buffer between urban development and water sources	The focus of the Pacione model is on how the urban environment influences human quality of life. In the Greenspace Stress Model of Urban Impact, the focus is not only on human quality of life, but extends to environmental quality, specifically within an urban greenspace.	The context of the model is urban shrinkage in the global North rather than urban growth in the global South. The model was therefore adapted.	This benefit has not been directly included in the TALC model of Butler. It can, however, be linked to the physical characteristics of the destination.	The functions of the Rietvlei Nature Reserve are influenced by Form and Activity. The particular functions and activities identified in the Rietvlei Nature Reserve informed the Greenspace Stress Model of Urban Impact.
Conservation status of the Rietvlei Nature Reserve	Pacione (2001) indicates that the behaviour setting influences appropriate behaviour at a particular place.	Not addressed in Haase and Rink (2014)	This benefit was not directly included in the TALC model of Butler. It can, however, be linked to the physical characteristics of the destination.	The conservation status is part of the Form and Functions of the Rietvlei Nature Reserve.

Table 4.4: Explanation of how the stressors link up with the existing models relating to urban greenspace

Stressors	Pacione (2001)	Haase and Rink (2014)	Butler (1980)	Montgomery (1998)
Lack of spatial co-variation between administrative boundaries and natural boundaries such as watersheds. Re-demarcation of boundaries and spatial re-structuring	This stressor is not specifically addressed in the Stress model of Urban Impact. It is, however, relevant as the quality of life of individuals in the city is influenced not only by their specific life world but also by its context.	This stressor is not specifically addressed by Haase and Rink (2014). They have, however, indicated that the broader ecosystem functioning should be considered at the site level.	This stressor is not specifically addressed. The model was developed for site-level evaluations of tourist destinations.	The sense of place is influenced by the form, activity and image of a place. The spatial resolution level, as well as the boundaries that are selected, will influence the conclusions made on a place.
Development pressures issuing from relative location. The proximity to spatial economic development corridors and major transport routes between two growing metropolitan areas, Tshwane and Ekurhuleni, has led to an increase in development pressure on the Rietvlei Nature Reserve	This stressor is not specifically addressed	The context of Haase and Rink (2014) is in the global North, where urban change involves shrinkage rather than growth. The model therefore needed to be adapted to the global South context where urban change involves growth rather than shrinkage.	Butler (1980) focused on the life cycle of a destination and how over-tourism changes the characteristics of a destination. In the Greenspace Stress Model of Urban Impact there are also other stressors identified within the urban greenspace. Stressors do not operate only within the destination but also from the environs (surrounding environment) or external context of the urban greenspace.	Montgomery does not specifically analyse the influence of the context of the place on sense of place. <i>Table 4.4 continues ...</i>

Table 4.4 (continued)

Stressors	Pacione (2001)	Haase and Rink (2014)	Butler (1980)	Montgomery (1998)
Increasing demands for water and electricity by a growing urban population	Environmental load refers to how much pressure can be tolerated for human quality of life in the city. This can be expanded to refer to the capacity of Rietvlei for water and electricity provision to a growing city.	Haase and Rink (2014) explore a context of declining population numbers. Therefore, the model had to be adapted for a global South context.	Increased use changes the characteristics of the destination. Based on the way in which ecosystem services are managed within a changing context, different scenarios are possible.	Urban development changes the activities within the Reserve.
Land-use changes in the catchment area of the Rietvlei Dam.	This specific aspect has not been included in the model. Land-use changes do, however, change the objective characteristics of the city and could influence environmental perceptions. Pacione indicates that the individual social context influences perceptions and the stressors experienced. The type of land-use changes have social, as well as environmental implications, for the Rietvlei Nature Reserve.	Ecosystem functioning is influenced by land use.	Not specifically relevant to Butler	Changing form and functions influence sense of place.

Particular gaps were identified when the applications of the selected models were evaluated. As such, it was important to adapt the models before integrating them into the Greenspace Stress Model of Urban Impact. This was is in Chapter 6.

4.8 Conclusions and the way forward

The availability of greenspace in Tshwane is declining on account of urban development. The impact of human actions on the natural environment is not yet fully understood. However, there are indications of risks to greenspace and specifically to wetlands. Even though natural systems may be resilient, there are risks that could become stressors, which would create irreversible damage to their ecosystem functions. As such, since open spaces are often regarded as places for development, the proclamation of a conservation area could assist in protecting the ecological functions of the green infrastructure.

The Rietvlei Nature Reserve serves the surrounding urban areas in that it provides ecosystem services to the growing urban populations, whereas the demand for housing and services is burgeoning, and it has become necessary for the municipal authorities to develop strategies to provide for such needs. In this respect, specifically in the areas of water and electricity provisioning, the Rietvlei Nature Reserve has been and is still able to play an important role.

In fact, the *raison d'être* of the Rietvlei Nature Reserve is water provisioning, which is of increasing importance to the Tshwane Metropolitan Municipality on account of not only the growing population, but also the limited capacity of Rand Water to provide for the growing demands for water

Urban development has led to stressors on the Rietvlei Nature Reserve as a conservation area on the urban fringe. Urban development and land-use changes in the areas adjacent to the Reserve have led to increased pressure on the already congested road infrastructure in its vicinity. The relative location of the Rietvlei Nature Reserve adjacent to a development and a transport corridor could contribute to long-term development pressures on the Reserve.

This is further complicated by a lack of spatial co-variation between the municipal boundaries, the boundaries of the Rietvlei Nature Reserve and the boundaries of the natural ecosystems. In fact, the stressors to the Rietvlei Nature Reserve emanate from beyond the administrative boundaries of the Reserve (e.g. water pollution from the ERWAT Water Purification Plant in Ekurhuleni (Figure 4.6)). The relative location of the Rietvlei Nature Reserve is therefore an important consideration in the interplay between development, conservation and sense of place.

Furthermore, since the events in the history of the Rietvlei Nature Reserve have contributed to changing perceptions around the expected functions of the Reserve as an urban greenspace, the focus in Chapter 5 now shifts to the interplay between conservation and sense of place and how these two aspects impact on the development of the Greenspace Stress Model of Urban Impact.

Chapter 5: Conservation and sense of place as critical elements within the Rietvlei Nature Reserve (Tshwane)

5.1 Introduction

Within the context of increasing population pressure on the growing Tshwane Metropolitan Area, the question that needs to be answered is whether the Rietvlei Nature Reserve has sufficient capacity and resources as an urban greenspace to resist the pressure for development within the urban fringe adjoining the Reserve. It was explained in the preceding chapter that urban development and spatial manifestations in the areas adjacent to the Reserve tend to have serious implications for conservation within the Rietvlei Nature Reserve. As such, it is important to evaluate to what degree urban growth and spatial encroachment are threatening the Rietvlei Nature Reserve as a protected conservation area. As open spaces are often regarded as places for development, demarcated conservation areas are necessary for the protection of the ecological functions of the green infrastructure.

Chapter 5 focuses on the conservation and sense-of-place components of the interplay between development, conservation and sense of place in an attempt to establish whether an acceptable balance can be achieved to the benefit of all stakeholders and interest groups. This chapter indicates how the conservation and sense-of-place perspectives are incorporated into the selected models from literature towards the development of the Greenspace Stress Model of Urban Impact.

5.2 Structure of the chapter

The structure of this chapter, focusing on the conservation and sense-of-place perspectives on the interplay between development, conservation and sense of place, is presented in Figure 5.1.

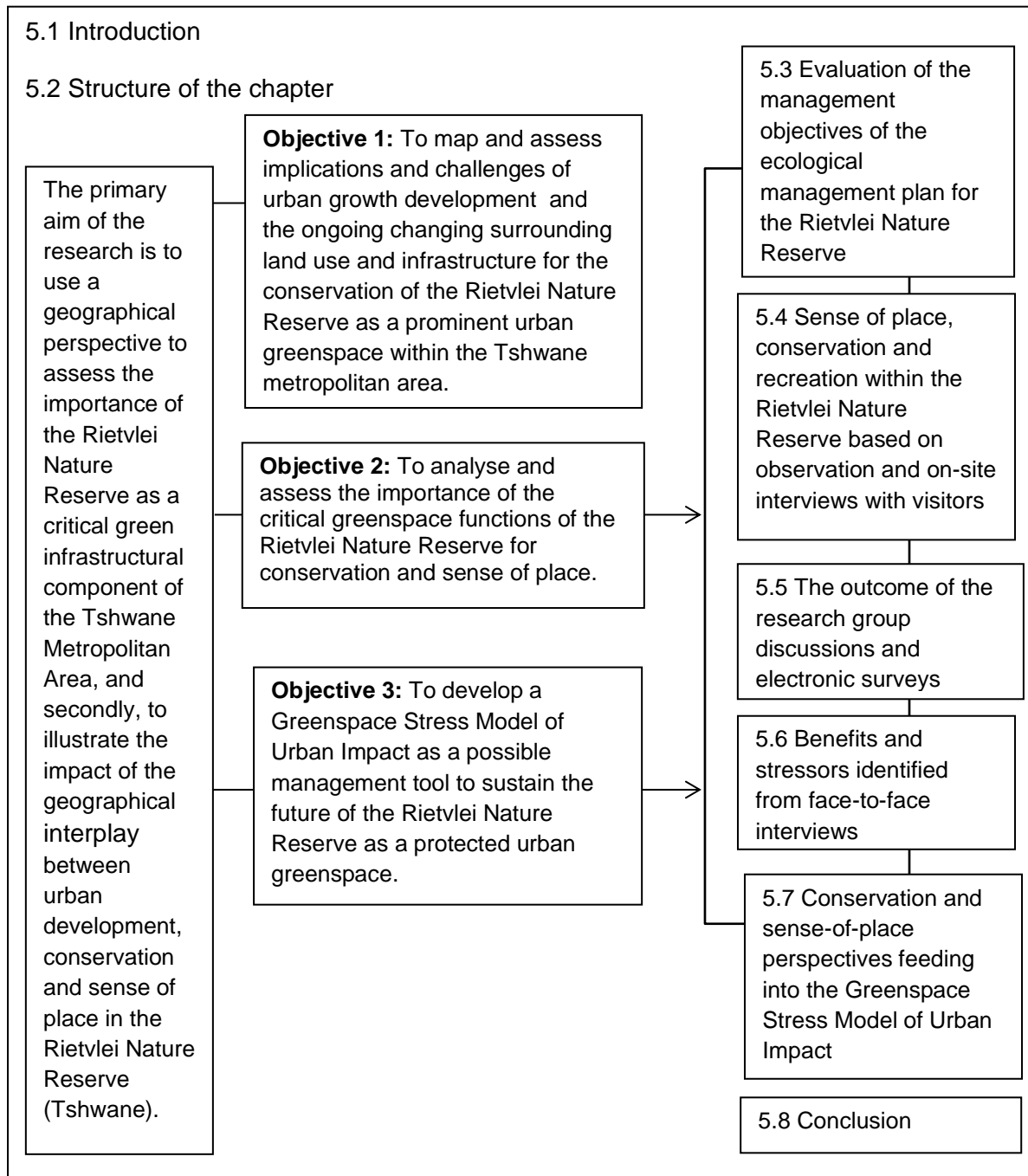


Figure 5.1: The structure of the chapter focusing on the conservation and sense of place perspectives

Conservation and sense of place have important implications for decision making, as well as for the sustained management of the Rietvlei Nature Reserve. The management objectives of the Ecological Management Plan (Marais, 2015) were evaluated in semi-structured interviews. Sense of place, conservation and recreation were explored through observations and on-site semi-structured interviews with visitors to the Reserve. These were followed by discussions held with interest groups. The perceived benefits of the Reserve, as well as the stressors to the sustainability of the Reserve, were identified. The information obtained from this chapter was then linked to the identified models towards the Stress Model of Urban Impact.

5.3 Evaluation of the management objectives of the Ecological Management Plan for the Rietvlei Nature Reserve

In an attempt to establish and illustrate the interplay between urban development, conservation and sense of place, the functions and objectives of the Rietvlei Nature Reserve, were discussed during face-to-face interviews conducted with 18 purposively-selected respondents. The functions and objectives that were evaluated were tabled by Marais (2015) and accepted by the authority as the official Ecological Management Plan of Tshwane. The respondents were selected based on their prior knowledge or their involvement in development, conservation, or sense-of-place initiatives.

The respondents were requested to identify the four most important objectives of the Reserve, and to rank them in order of importance. Table 5.1 presents a ranking of these objectives based on the interview data.

Table 5.1: Ranking of the objectives of the Rietvlei Nature Reserve based on the semi-structured interviews with key informants (2016)

Ranking	The objectives of the Rietvlei Nature Reserve are to:
1	Supply the city with clean drinking water;
2	Protect and conserve a sample of the natural environment around the city, keeping it in a relatively pristine state;
3	Give local and foreign visitors the opportunity to visit the Reserve, go into the veld and take part in activities;
4	Provide facilities and opportunities for environmental education, research, and monitoring;
5	Conserve genetic diversity and curb the loss of species;
6	Make live game available for relocation.

Source: Based on interview data, 2016

The majority (75%) of the respondents indicated that the objective of supplying the metropolitan area with clean drinking water was the most important objective of the Rietvlei Nature Reserve. Water provisioning from the Rietvlei Nature Reserve is increasingly important in the context of urban development (Mouton *et al*, 2015), but it emerged from the on-site interviews with visitors that even some visitors from Tshwane did not realise that water from the Rietvlei area feeds into the water-provisioning system of the Tshwane Metropolitan Municipality. Thus, limited public awareness of the importance of wetlands for water provisioning to a growing urban population could potentially be a stressor to the Rietvlei Nature Reserve.

In the semi-structured interviews with the purposively-selected key respondents, 12% indicated that the most important objective was to protect and conserve a sampled area of the natural environment around the city. This objective is important in the interplay between development, conservation and sense of place because of the rapid decline in natural areas arising from urban development in Gauteng (Gauteng Provincial Government, 2017).

According to the City of Tshwane Bioregional Plan (City of Tshwane, 2016(d)), 28% of the land area in the city had no remaining natural areas. On the other end of the

spectrum, three percent (3%) of the land area of the city is formally protected (Table 5.2). The Rietvlei Nature Reserve is one such area, as it provides a large green node and habitat for a diversity of species (Wolhitz, 2016). With an area of 40 km² (4 000 hectares), it comprises 25% of the land area that is protected in Tshwane (Table 5.2).

Table 5.2: The extent (in Hectares and as percentages) of critical biodiversity areas and ecological support areas identified by the Gauteng C-plan Version 3.3 for the City of Tshwane

Critical biodiversity area category	City of Tshwane	
	Hectares	Percentage
Protected areas	15 900	3
Critical biodiversity area 1	156 876	25
Critical biodiversity area 2	4 499	1
Ecological support area 1	67 725	11
Ecological support area 2	38 487	6
Other natural areas	172 854	27
No natural areas remaining	173 445	28
Total	629 786	100

Source: City of Tshwane (2016 (d) :33)

The legal protection of this conservation area between the Tshwane and Ekurhuleni metropolitan areas aims to protect the ecosystem functions and biodiversity, as well as the natural processes of the wetlands and grasslands, against development. Thus, as discussed in the previous chapter, this urban greenspace was integrated into the planning frameworks on different levels of governance and planning in order to support conservation, water provisioning and green infrastructure (Schäffler *et al*, 2013).

Only five percent (5%) of the key informants regarded the opportunity for local and foreign visitors to visit the Rietvlei Nature Reserve as the most important objective. However, this does not imply that recreation and tourism are not important at

Rietvlei. Sustainable nature-based recreation and tourism are not only sources of income for the Tshwane Metropolitan Municipality; they also offer benefits for human physical and psychological health (Mayer-Grandbastien *et al*, 2020; Kondo *et al*, 2018; World Health Organisation, 2017).

No respondents ranked any of the other objectives as the most important for the Rietvlei Nature Reserve. Despite the important servitude function for the provision of electricity, this was not mentioned as one of the service objectives of the Reserve in the Ecological Management Plan (Marais 2015). However, the visual intrusion of the powerlines running through the Rietvlei Nature Reserve was identified as a negative impact on the recreational experience and sense of place of the Rietvlei Nature Reserve. In fact, this seemed to be but a small price to pay for electricity provisioning to a growing urban population. However, infrastructural maintenance and upgrades could be stressors to the Rietvlei Nature Reserve. Thus, when decisions are made on the positioning of powerlines and for upgrading the network, the environmental impact should be carefully considered in order to protect the ecosystem functions of the grasslands and wetlands in the Reserve.

The objective which was ranked third in the hierarchy of importance is related to recreation. This implies that most of the respondents who were interviewed acknowledged that the water-provisioning and ecosystem functions are more important than recreation and tourism. Some respondents indicated that they acknowledged the importance of the Rietvlei Nature Reserve for water provisioning, the protection of biodiversity, and resilience to floods or natural disasters. However, they did not deem it necessary to personally visit the Reserve

in order to enjoy a nature-based experience, because they also have access to other greenspace areas that offer these same opportunities.

Based on the evaluation of the functions of the Rietvlei Nature Reserve, the six objectives ranked in Table 5.1 were clustered into three broad functions, namely water provisioning (Objective 1), protecting the biodiversity (Objectives 2, 5 and 6), and the social and cultural functions (Objectives 3 and 4). These functions are related to the ecosystem functions of greenspace, namely the provisioning and supporting of habitat, social and cultural functions, as identified in the Millennium Ecosystem Assessment (2005).

As is the case with all cities and towns in South Africa (Knuppe, 2011), Tshwane experiences major capacity challenges in providing clean drinking water for the growing population. The respondents in this research study clearly indicated that the Rietvlei Nature Reserve is and will remain a crucial resource for the Tshwane Metropolitan Municipality in its supply of water to the growing urban population within its geographical area (Objective 1 in Table 5.1).

As water is a natural resource, its continued preservation lies in the key aspects of a holistic approach towards environmental sustainability that preserves the unique ecosystem, of which it is a vital component, within a growing urban environment. For this reason, the other objectives ranked by the respondents in Table 5.1, namely those concerning the protection of biodiversity (Objectives 2, 5 and 6) are significant for the conservation function of the Reserve. The final cluster of objectives (i.e. those concerning the social and cultural functions (Objectives 3 and

4) is related to the sense of place and the significance attached by visitors to the Rietvlei Nature Reserve.

Sense of place amounts to more than the mere destination image that visitors hold in their minds, as it is also related to the perceptions of different stakeholders and decision makers about the benefits of and risks to the Rietvlei Nature Reserve. The importance of sense of place is demonstrated in the different evaluations of the respondents to the benefits emanating from the Reserve. In contrast to the high priority of the water-provisioning function of the Rietvlei Nature Reserve indicated in the semi-structured interviews, the provisioning of ecological goods and services received a relatively low score (3) as an indicator in the Gauteng Ecosystem Assessment of 2011, as quoted in Marais (2015) (Table 5.3).

Table 5.3: Gauteng Biodiversity Stewardship: Site Assessment - September 2011

Summary of scores from the Biodiversity Assessment			
	Indicator	Score	Average score
Habitats	Threatened ecosystems	4	4.5
	Vegetation type	5	
	Vegetation condition	5	
	Fragmentation	4	
Species	Red-listed species	4	2.75
	Number of red-listed priority species	2	
	Endemism	-	
	Priority species	5	
Ecological Process	Size of property	5	4
	Landscape heterogeneity	4	
	Adaptation to climate change	-	
	Ecological process	4	
	Corridor / Stepping stone	5	
	PA consolidation or expansion	5	
Ecological Goods and Services	Provisioning Services	3	4
	Regulating Services	5	
	Cultural Services	3	
	Overall average score		15.25
Qualifying criteria : Nature Reserve			

Source: Adapted from Marais (2015)

The reason for the relatively low score on the provisioning services function under the category of ecological goods and services (Table 5.3) is that the Rietvlei Nature Reserve does not provide a source of wood. Nor does it allow the harvesting of herbs, hunting or fishing in the conservation area.

Within the context of urban development and the growing population numbers, there is an increasing human demand for water. Even if water provision was to be the only provisioning function for ecosystem goods and services, it nevertheless remains the most important function of the Rietvlei Nature Reserve.

In the Gauteng Biodiversity Stewardship Assessment (Table 5.3), the function of protecting biodiversity (Table 5.1: Objectives 2, 5 and 6), was supported by a high score (4,5) for the habitat function. An example worthy of mention in this respect is the partnership agreement concluded between the Rietvlei Nature Reserve and the Carnivore Conservation Project of the Endangered Wildlife Trust (EWT), which led to the re-introduction of cheetahs into the Reserve.

EWT is a meta-population project that places cheetahs in different reserves in order to ensure a large enough gene pool for the sustainability of future breeding populations on the international level (Buk *et al*, 2018). As such, this project protects the cheetah gene pool on an international level. Furthermore, the presence of cheetahs at the Rietvlei Nature Reserve has provided invaluable opportunities for the training of nature conservation students. In May 2017, for example, students from the Tshwane University of Technology, the University of South Africa and Saarsveld (George) participated in dedicated conservation

training and research at the Rietvlei Nature Reserve (Friends of Rietvlei. Personal communication. 2017).

Bankenveld grassland is the most dominant type of vegetation conserved in the Reserve. As the condition of the veld is subject to change on account of factors such as rainfall, the presence of invasive species, pollution and erosion, veld management is important (Zhao *et al*, 2020). Even though there are not large varieties of red-listed priority species, the Reserve plays an important role in protecting the prevalent priority species.

The social or cultural function (Table 5.1: Objectives 3 and 4) is important in the light of the ecological goods and services available in the Reserve (Table 5.3). The difference in the assessments of the importance of the cultural-ecological goods and services clearly demonstrates a level of subjectivity in the evaluations, and that it remains difficult to measure the cultural value of greenspace in terms of ecosystem functions (Artmann *et al*, 2019; Colley & Craig, 2019; Boulton *et al*, 2018; Wood *et al*, 2018; Derkzen *et al*, 2017; Jennings *et al*, 2016; Faranaaz, 2015; Boc *et al*, 2014; van Vollenhoven, 2010).

The functions of the Rietvlei Nature Reserve are not only of benefit to the immediate surrounding communities, but are also relevant to the entire Tshwane metropolitan population. The habitat that is protected by the conservation area is not for the exclusive enjoyment of visitors to the Reserve, however, but also for protecting biodiversity as it represents a collection of ecosystems in the broader framework that needs to be monitored.

Even though the conservation, recreational, environmental education and networking functions are important, it can be concluded that water provisioning remains the most important function of the Reserve. As explained in Chapter 4, water from the Rietvlei Dam is pumped to the reservoir system of the city, from where it is distributed to any of the reservoirs in need of water (City Planning. Personal communication. 11 January 2017). In the context of water scarcity, all possible water sources need to be protected and managed for long-term sustainability.

5.4 Sense of place, conservation and recreation within the Rietvlei Nature Reserve based on observations and on-site interviews with visitors

Environmental perception is an important component of the Stress Model of Urban Impact (Pacione 2001) and this seems also to be relevant to the adapted model for the Reserve. Sense of place in the Rietvlei Nature Reserve is focused on conservation and nature-based experiences (Figure 5.2). The physical characteristics of the Reserve, as well as individual differences and situational and social conditions, collectively determine the sense of place and perceptions of the Reserve.

Peace and tranquillity, as well as escape from the city and participation in recreational activities related to nature conservation, were found to be important components of sense of place in respect of the Rietvlei Nature Reserve. From on-site face-to-face interviews with 181 visitors to the Rietvlei Nature Reserve, it became evident that visitors appreciate the opportunity that the Rietvlei Nature Reserve provides for nature-based recreation.

This finding was confirmed during observations that the researcher made and from her participation in activities in the Reserve. Figure 5.2 provides evidence of the observations made on the characteristics of the Rietvlei Nature Reserve. The design of the facilities and amenities supports nature-based experiences and promotes a positive sense of place (e.g. the panoramic view over the Reserve from the Panorama Hide, and the view over Marais Dam from the Hippo Hide). The children's play area at the Coffee Shop includes climbing frames in the shape of wildebeest (Figure 5.2). These images contribute to the aesthetic and experiential component of sense of place (Ghoomi *et al*, 2015; Montgomery, 1998; Canter, 1977).

Figure 5.2 illustrates that the form and activity of the Rietvlei Nature Reserve are reflected in the images, for example of the entrance to the Reserve and the adjacent residential area; waterbodies; birds and animals and grasslands reflect the form of the Reserve. The picnic spots; chalets and the game drive vehicle with the rhinos next to the road are illustrating the activities of visitors. This is important for the sense of place of the Rietvlei Nature Reserve and these aspects were included when applying the model of Montgomery (1998) for exploring sense of place in the Rietvlei Nature Reserve.

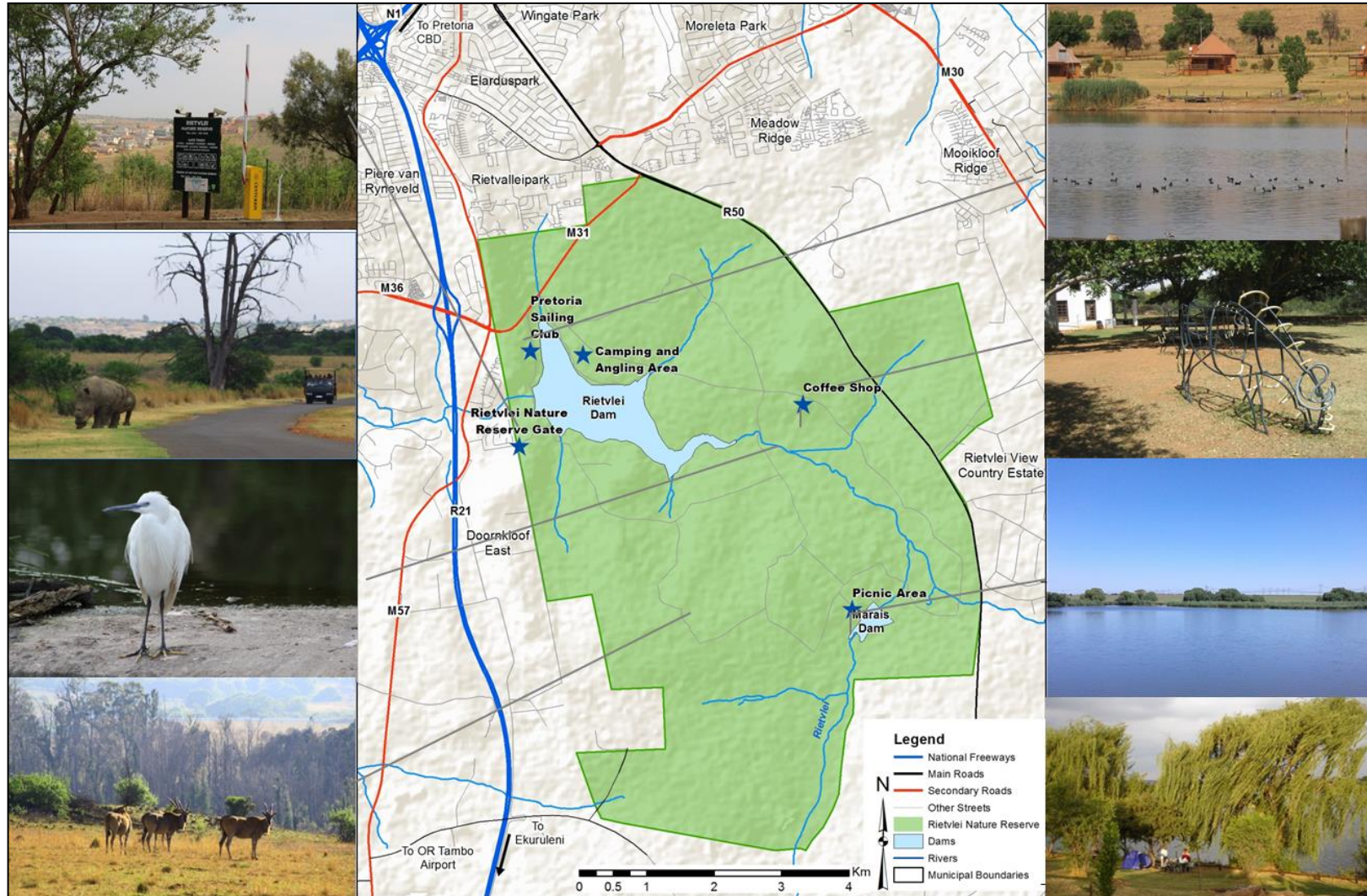


Figure 5.2: Images informing the sense of place of the Rietvlei Nature Reserve
Photographs: Author and A. Williams (reproduced with permission)

This is significant because, in the context of tourism, the goals of a destination impact on the design elements of the destination, as well as on the marketing of the place's image (Barendse *et al*, 2016; Haussman *et al*, 2016; Wilhelm-Rechmann *et al*, 2013; Stobbelaar & Pedroli, 2011; Farnum *et al*, 2005; Stedman, 2003).

Many of the visitors (49%) did not identify particular areas that they favoured most. "*Otter Bridge, Island View, the hill over there, the Coffee Shop, and all the places that join it together. There is no place we do not like*". Landmarks such as the bird hides, Coffee Shop, Marais Dam picnic site, the Rietvlei Dam camping and fishing areas, the sailing area and Otter Bridge were specifically mentioned, as well as the routes through the Reserve. The identified favourite areas were often found to be linked to the particular activities in which the visitors participated. These are specifically related to the camping and fishing areas, as well as to the sailing area adjacent to the dam.

Based on the on-site face-to-face interviews, different types of visitors (Table 5.4) and different connections with the Rietvlei Nature Reserve (Figure 5.3) were identified. In underpinning the attempts to assess the development potential of the conservation area, it was important to understand the characteristics of the visitors to the Reserve. Based on observations and interviews with them, the following visitor types were identified (Table 5.4).

Table 5.4: Types of visitors to the Rietvlei Nature Reserve

Type	Selected Verbatim Quotations from the various types of visitors	Comments based on observations of the researcher
Drifters and explorers	<i>We are from Johannesburg. We like to drive around to get to know the area. We drove past and saw the road sign. We have never been to Rietvlei before – we are just here to see what they have. It is a nice surprise. We did not know about this place. It is wonderful.</i>	The accessibility of the Reserve from major freeways makes it a possible destination for drifters and explorers.
Individual travellers	<i>This is my alone time. I can work here during the week when there are not a lot of other people. I often bring my children here to camp. They let me drive around in the Reserve until they see rhinos. I live in ... just around the corner, we can quickly come here. They like to go shopping with their mother and camping with me - sometimes we come together.</i>	The proximity of the greenspace to the city makes it possible for individuals to get away for a few hours and then return home.
Friends and Family	<i>It is a nice experience to come together with people who talk the same language as us [similar values] and appreciate nature. We do not judge one another, but just gather here and have interesting discussions. Many of us are pensioners and we gather at the Coffee Shop on a regular basis. It is interesting to learn new things and experience nature*</i>	There are often private parties, such as birthdays, farewell parties and even weddings at Rietvlei. These range from a stop at the Coffee Shop, a picnic, or an event at the Lapa. Religious groups, youth groups and groups of senior citizens were also observed.
Small-scale packaged tour experiences	<i>I often bring international guests to Rietvlei Nature Reserve to experience something of the African open space and wildlife. It is in close proximity to the city and you can experience more in a shorter space of time than going to Pilanesberg. As Rietvlei Nature Reserve is adjacent to the route to the O.R. Tambo International Airport, international travellers can have a convenient stop en route.</i>	Rietvlei is a popular destination to which South African hosts can bring their international guests. There are also business opportunities for small-scale package tour operators. <i>Table 5.4 continues ...</i>

Type	<i>Selected Verbatim Quotations from the various types of visitors</i>	Comments based on observations of the researcher
<i>Table 5.4 (continued)</i>	Photography: <i>I have more than 20 000 photographs to prove my birding experiences at Rietvlei Nature Reserve.</i>	Photographers not only capture images but also influence the sense of place and experiences of other visitors.
Special interest	Fishing and camping: <i>A day at Rietvlei is like a week on holiday. I came with friends and family for a weekend. My friends were fishing. It was very tranquil. I cannot believe it is in the city.</i>	Fishing and camping are restricted to a dedicated area. Not all campers visit the conservation area.
	Education: The tour guide made the following statement: <i>We want to give them a good experience and plant the seeds of caring for the environment. It is more about awareness than knowledge sharing. It is important to repeat the names of the animals so that the little ones remember a few at the end of the day. They can learn more detail at a later stage but the positive experience they had can encourage them to learn more.</i>	There are opportunities for observations to be made through a game drive, with interpretations by a qualified guide. Learners have the opportunity to touch and smell an ostrich egg on site.
	Sailing: <i>I come here every Saturday and love this place.</i>	Sailing club practice in the dam and participation in events
Organised events	<i>We came for the Canon Function at the Big Lapa. Canon gave some of their clients a rhino-shaped savings box to donate the money to Friends of Rietvlei. After the braai, we decided to take a drive through the rest of the Reserve. It was more than what we expected.</i>	A variety of <i>ad hoc</i> events, including the annual programmes of Friends of Rietvlei and the Pretoria Sailing Club are hosted in the Reserve.
Employment	<i>I have never been to the conservation area. My work is at the water purification plant and I am always stressed for time when I go there.</i> <i>I just came to deliver a parcel. I often drive past the Reserve but it is the first time I have come inside.</i>	Work-related visits to the Rietvlei Nature Reserve
Volunteer	<i>Our company is involved in volunteer work. We fixed fences last weekend.</i>	NGOs such as Friends of Rietvlei, Honorary Rangers, People for Elephants and Rhinos, as well as business and private volunteers.

Visitors come to the Rietvlei Nature Reserve for various reasons and have different perceptions about the place and their level of connection with it (Sabyrbekov, 2020; Shamai, 1991; Williams & Stewart 1998). These range from no connection or association (41%), to willingness to make personal sacrifices to protect the Rietvlei Nature Reserve (28%). Most of the visitors indicated that they just love this place, in spite of their having no other connection to Rietvlei.

Emotional connections with a particular place are considered to constitute a component of sense of place (Tuan, 1977). Many visitors (28%) were found to enjoy visiting Rietvlei Nature Reserve, but indicated that they could just as well visit any other greenspace (Figure 5.3). Surprisingly, only 14% had a sense of belonging to the Reserve. Not all visitors realised that the City of Tshwane relies on water from the Reserve, but 51 (28%) indicated that they rely on the resources from the Reserve. The concept, “resources”, was interpreted as referring to water provisioning, and also the recreational resource and ecological benefits. The most frequently mentioned special or unique features of the Rietvlei Nature Reserve were considered to be nature, proximity to the city, animals, the dam, birds, and peace and tranquillity.

From the discussions with the visitors, it became apparent that there were those who did not have any connection with the Rietvlei Nature Reserve. A higher percentage (30%) indicated that the Rietvlei Nature Reserve was part of their heritage. Through the discussions regarding the term “*heritage*”, it emerged that not only the cultural heritage (van Vollenhoven, 2010), but also the heritage of the natural environment, was acknowledged through an environmental awareness that was broader than only this unique local greenspace.

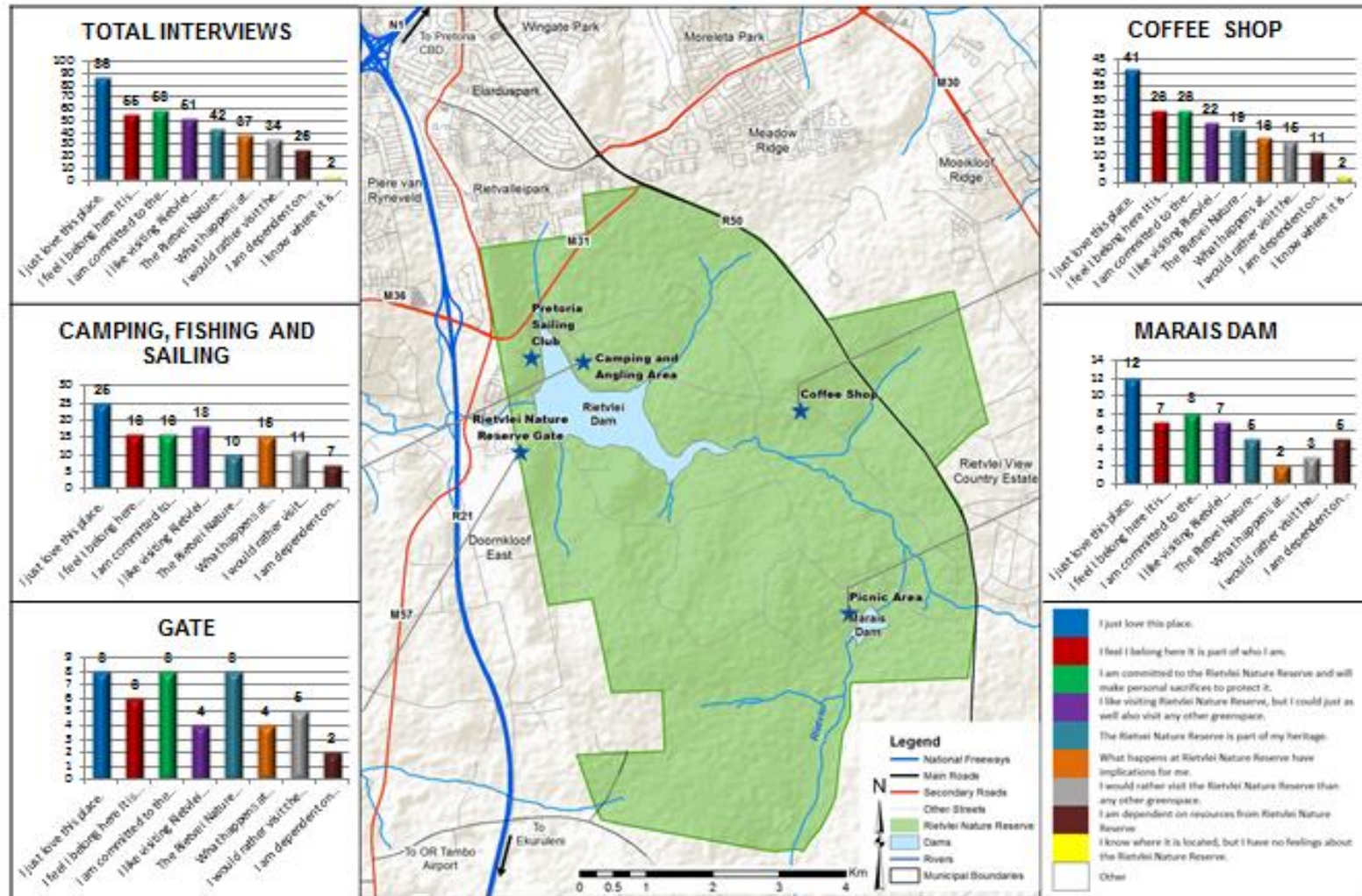


Figure 5.3: Levels of connection with the Rietvlei Nature Reserve based on the categories used by Shamai (1991)

Figure 5.3 shows the spatial distribution of the levels of connection as identified at the different data collection points. In all the data collection points the largest percentage of respondents indicated that they just love Rietvlei. The different types of visitor activities at the data collection points are reflected in the connectedness to the Reserve at different data collection points.

The concerns mentioned in all the data collection points were combined in the following figure. Figure 5.4 presents themes of concern that emanated from the open-ended questions in the face-to-face on-site discussions with visitors to the Reserve.

Many visitors (45%) did not express any concerns - an indication of a low level of awareness of the stressors to the Rietvlei Nature Reserve. The concerns mentioned in the highest frequency category were related to the experiences of the visitors while visiting the Reserve.

The maintenance of facilities was the most frequent concern raised as it is directly related to the tourism experience at the Reserve. Some of the facilities at the Reserve were seen to require maintenance (e.g. the dilapidated bird hide at the Marais Dam which was re-built in 2019). Some of the concerns expressed by visitors were directly related to their recreational experience (e.g. fish not biting; the behaviour of other visitors; the lack of information provided; and the lack of focus on environmental awareness). All of these concerns seemed to be linked to the environmental perceptions, experiences, expectations, and sense of place, of the visitors (Montgomery, 1998).



Figure 5.4: Themes identified in the concerns expressed by visitors to the Rietvlei Nature Reserve

The frequencies portrayed in Figure 5.4 were also an indication that there was awareness about the potential stressors that the Reserve was facing. Water quality, for example, was identified as a stressor in the literature (Fisher, 2017; Hart & Mathews, 2018; Department of Water and Sanitation, 2016; Booyens *et al*, 2012; Oberholser *et al*, 2008; Toerien & Walmsley, 1979), as well as from the responses

issuing from the semi-structured interviews with key informants. However, the frequency with which water quality was indicated as a concern, was relatively low.

Poaching is a concern for the management of the Reserve, as well as for the conservation of the Reserve's biodiversity. Not only the poaching of rhinos and lions, but also the poaching of smaller game, were issues that were commented upon. This concern was again confirmed in a semi-structured interview with the Reserve management, as well as in group discussions with the Friends of Rietvlei and Honorary Rangers.

Environmental perception is an important factor in sense of place and in decision-making. Thus, the conclusions reached through these findings emphasise the importance of disseminating information regarding environmental concerns.

During the on-site interviews with visitors in 2016, particular informed stakeholder groups which were involved in specific functions of the Rietvlei Nature Reserve were identified. The following section presents the results of research group discussions with informed stakeholders at the Rietvlei Nature Reserve.

5.5 The outcome of the research group discussions and electronic surveys

Specific interest groups were identified in the face-to-face interviews with visitors to the Reserve in order to provide further insights into the potential benefits and stressors in terms of conservation and sense of place. In order to obtain specific information from people involved in the Rietvlei Nature Reserve, research group discussions were held with Honorary Rangers, Friends of Rietvlei, the Pretoria

Sailing Club and Birders and Photographers. This researcher also attended meetings of the Hennops Catchment Forum as an observer.

5.5.1 Honorary Rangers

The Honorary Rangers are affiliated with SANParks (the South African National Parks Board), which is dedicated to the conservation of biodiversity and the development of tourism in all the national parks. Even though the Rietvlei Nature Reserve is not a national park; nor is it included in the SANParks registry, the Honorary Rangers are providing voluntary services for conservation in the Reserve. They can do the practical work required for their accredited qualifications and are involved in conservation initiatives. As they are in uniform, the Honorary Rangers contribute to visible patrolling and provide invaluable conservation services. They are also involved in environmental education activities in the Reserve, since learners from the surrounding schools in the area and further afield are given the opportunity to observe animals in their natural environment.

There was consensus amongst the Rangers that the most important function of the Rietvlei Nature Reserve is to supply the City of Tshwane with clean drinking water. Conserving genetic diversity and curbing the loss of species were two functions that they considered as more important than the tourism and recreational functions of the Reserve. The voluntary Rangers interviewed indicated that they also frequently visit other conservation areas in South Africa and therefore have a broader perspective on issues related to conservation. From the Rangers' perspective, Rietvlei Nature Reserve is an important conservation area. Although, owing to its proximity to the city, the Reserve cannot be regarded as able to offer a true wilderness experience, it is a convenient site to visit. Within the broader

context of diversity of species and for the ends of conserving water, it does, however, have an important function to fulfil. In terms of this research project, the link between conservation in the Rietvlei Nature Reserve and that of the broader environment was deemed to be important.

Participation and collaborations are important for sustainable conservation initiatives. Previously, the Honorary Rangers were also involved in the Groenkloof Nature Reserve, also belonging to Tshwane Metropolitan Municipality and an important source of water for the city of Tshwane. Owing to political tensions, the Honorary Rangers withdrew from the Groenkloof Nature Reserve but are still operating in the Rietvlei Nature Reserve (Honorary Ranger. Personal communication. 17 November 2016). There are clear indications that it could be beneficial to the conservation of species that the Rietvlei Nature Reserve be managed in collaboration with SANParks rather than on the local government level only. The Honorary Rangers share the opinion that there must be a balance between different aspects of the Reserve and that field management, including the restoration of wetlands, and good water quality, are important issues.

5.5.2 Friends of Rietvlei

While the Honorary Rangers are concerned with the principles of conservation in general, the focus of the Friends of Rietvlei as a non-governmental organisation was found to be specifically directed towards the Rietvlei Nature Reserve. The Friends of Rietvlei group are affiliated with the Wildlife and Environment Society of South Africa (WESSA) (Friends of Rietvlei, 2017). WESSA is a founder member of the International Union for Conservation of Nature (IUCN) and a United Nations Educational Social and Cultural Organisation (UNESCO) partner (Wildlife and

Environment Society of South Africa, 2018). As such, the goals of these organisations are integrated into the local conservation and environmental education initiatives of the Friends of Rietvlei. Volunteers play an invaluable role in maintenance, finding sponsors for specific needs and supporting events and conservation activities (Friends of Rietvlei, 2016). Their annual programme includes regular work sessions for eradicating invasive species, the maintenance of facilities, the feeding of rhinos during winter, guided hikes and social activities (Friends of Rietvlei, 2017).

The social functions and health benefits of the Rietvlei Nature Reserve are important focus areas for the Friends of Rietvlei. In an on-site, semi-structured interview, the chairperson of the Friends of Rietvlei ranked the supply of facilities and opportunities for environmental education, research and monitoring in second place to water provisioning, which, according to the organisation, remains the most important function of the Rietvlei Nature Reserve (Chairperson of Friends of Rietvlei. Personal communication. 8 August 2016). The location of the Rietvlei Nature Reserve, in close proximity to the city, provides opportunities for school visits, and the Friends of Rietvlei arrange specialist talks on environmental aspects. Despite their quest to significantly attract the interest of children and students in environmental awareness, the Friends of Rietvlei group also identified a need to intensify the awareness of adults regarding the importance of ecosystem functions, eradication of invasive species, protection of water sources, and appropriate behaviour relating to nature (Friends of Rietvlei, 2017).

The Friends of Rietvlei group supports and promotes the functions of the Rietvlei Nature Reserve. In line with their supervisory function of overseeing the principles

of WESSA, they have participated in various maintenance projects, obtained sponsors for conservation initiatives, and provided training and information sessions (Friends of Rietvlei, 2017). Guided hikes through the Rietvlei Nature Reserve are used as an opportunity to enhance environmental awareness through on-site observations and interpretations.

Community engagement can be enhanced through initiatives such as the Urban Nature Programme for Social Learning, WESSA, and Working for Water. Through the Urban Nature Programme of SANBI, communities in Cape Town, for example, took ownership of environmental quality by clearing up litter, cleaning penguins after an oil spill, spotting birds and building nesting for them (Pitt & Boulle, 2010). Important lessons can be learnt from the Cape Town experience and should be applied in the Rietvlei Nature Reserve.

Based on this analysis, it became evident that the functions of the Friends of Rietvlei are not limited to the area within the boundaries of the Reserve but are also linked to a broader international network of environmental concerns.

5.5.3 Pretoria Sailing Club

The demarcated sailing area of the Rietvlei Dam occupies a particular recreational niche. The Pretoria Sailing Club (including the Pretoria Yacht Club and Canoe Club) leases the site from the Tshwane Metropolitan Municipality, and the facilities were designed and constructed by the club according to its needs. Sailing is allowed only in the demarcated areas where regular competitions, coaching sessions and fun regattas take place. In line with the constitution of the Pretoria Sailing Club, opportunities are provided for visitors to participate in events and

experience the natural environment through competitive recreational activities (Pretoria Sailing Club, 2013).

The Pretoria Sailing Club fulfils an important social function and could potentially benefit the quality of life of urban residents. The activities of the Club are not only for the 250 members, but also for participants in competitions between clubs and for the development of the youth. The annual programme of the sailing club extends to promoting youth development and training parties interested in sailing. Since the events hosted at the Rietvlei Dam have a regional and international reach, the Club is not only of local significance. Its membership includes a Springbok canoeist who regularly practises on the Rietvlei Dam (Former Commodore of the Pretoria Sailing Club. Personal communication. 5 November 2016).

The social and recreational functions of the Pretoria Sailing Club are supported through their affiliation with the South African Sailing Federation (an ISAF National Member Authority) (Pretoria Sailing Club, 2013), and cooperation with the Croc's Sailing Centre, which offers sailing training and youth sailing development programmes (Development coordinator of the Pretoria Sailing Club. Personal communication. 5 November 2016). The Pretoria Sailing Club also supports the National Sea Rescue Institute (NSRI), and the activities of the sailing club are in line with the goals of the NSRI. Thus, the activities at the sailing club benefit not only the members of the club, but also the visitors to events hosted at the club.

The perceptions of members of the Pretoria Sailing Club regarding the image and sense of place of the Rietvlei Nature Reserve were found to be influenced by the

specific functions that the space has to offer them (Pretoria Sailing Club, 2013). The sense of place of the demarcated sailing area therefore differs from that pertaining to the rest of the Rietvlei Nature Reserve, owing to the particular activities and needs of the users.

During the semi-structured interviews, the members of the club were requested to rank the objectives of the Rietvlei Nature Reserve on the basis of an Ecological Management Plan for Rietvlei (Marais, 2015). The Development Officer of the Sailing Club was the only respondent to rank the objective “to give local and foreign visitors the opportunity to visit the Reserve, to go into the veld and to take part in activities” (Marais, 2015), as the most important function of the Rietvlei Nature Reserve.

The second ranked objective was to supply facilities and opportunities for research and monitoring in the field of environmental education. The reason for the high ranking of these two objectives was based on the specific activities of the club. It is important to be able to sail and attract other sailors to this area. The informants who were interviewed indicated that they often host international visitors. In fact, a suggestion was made to introduce a packaged experience for international tourists. They could be picked up at the O.R. Tambo International Airport, the Gautrain station or their hotel, and take a guided game drive through the Reserve and enjoy a lunch at the Coffee Shop.

The conservation objectives of the Reserve management are related to nature-based experiences, such as paddling in the Rietvlei Dam, and the opportunity to observe wildlife from the water. Conservation is also an important component of

the sense-of-place activities of the sailing club. The regulations stipulated in the Pretoria Sailing Club Handbook (2017) are not only aimed at effective sailing practice, but also of sensitivity towards the natural environment: “No person shall harm or disturb any animal, bird or fish life in the reserve; and boats that have sailed at other venues should be hosed down to minimise the risk of weed contamination at Rietvlei” (Pretoria Sailing Club, 2017:13).

The importance of the quality of the environment is reflected in the objectives stated in the constitution of the Pretoria Sailing Club. Besides promoting the sport and organising races, it is also important to “preserve the peace and serenity of the flora and fauna at the sailing venue which is proper to the sport of sailing” (Pretoria Sailing Club, 2013: 1). The number of boats is therefore restricted to 100 at a time, and the use of the dam is regulated by the parameters in the Statutes of the Pretoria Sailing Club (Development Officer at the Pretoria Sailing Club. Personal communication. 5 November 2016).

The water quality, as well as the water level, are important for the activities of the sailing club. One of the positive aspects identified was the relatively constant level of the Rietvlei Dam, making it suitable for races. Even during the drought in 2016, such events could still take place (Development Officer at the sailing club. Personal communication. 5 November 2016). The water quality of the Rietvlei Dam is therefore an important aspect of the sense of place, as expressed by the key informants from the club. The water in Rietvlei Dam was described as “*a bit green, but not as green as Hartebeespoort Dam or Seekoeivlei in Cape Town, which stinks of sewage.*” The close interaction of paddlers with the natural environment implies that views and smells do impact on how they experience the place.

Paddlers can observe the circulation of the water in the dam caused by the current generated by the solar BEEs. This was identified as a unique aspect of the Rietvlei Dam, and thereby distinguishes the Reserve from other blue greenspace areas where the sport can be practised.

Despite concerns over the quality of the water, the Rietvlei Dam water was regarded by an interviewed member of the Pretoria Sailing Club as much better than that of most other dams where canoeists and sailors practise for competitive events (Member of the Pretoria Sailing Club. Personal communication. 5 November 2016). *I would hate it to become an open sewage [cesspool] like the Hartebeespoort Dam. ... We have no control over the quality of water coming into the Reserve. We try not to pollute the water from this side. When somebody uses their boat somewhere else, they need to wash their boat in order to mitigate the risk of water pollution. We don't want water hyacinths to take over here.* (Member of the Pretoria Sailing Club. Personal communication. 5 November 2016).

The function of supplying the City of Tshwane with clean drinking water, as outlined in the official Ecological Management Plan (Marais, 2015), was ranked in fourth place by the informants from the Pretoria Sailing Club. The argument was that the city also receives water from other sources, and even though the contribution from Rietvlei Nature Reserve is important to the City of Tshwane, the other functions are of greater importance in terms of the needs of the Pretoria Sailing Club.

Urban development in the surrounding areas seems to have had an impact on the members of the Pretoria Sailing Club's sense-of-place experience. When, on account of its deteriorating water quality and the silting of the lake, the Centurion

Lake was no longer suitable for water sport, members of the Centurion Canoe Club joined the Pretoria Sailing Club at Rietvlei (Former Commodore of the Pretoria Sailing Club. Personal communication. 5 November 2016).

The Centurion Lake is an example of what could happen to a greenspace in an urban area as a result of the unacceptable quality and mismanagement of the water entering the greenspace area. In the 1980s, the Centurion Waterfront was a popular visitors' attraction, particularly so as a result of its water organ. For many years, the silting of the lake was managed by removing the silt. Unfortunately, the quality of the water deteriorated and there were problems with the flooding of the parking areas, specifically at the Centurion Lake Hotel site. The Centurion Lake was thus converted into a constructed wetland, which is not suitable for rowing. The state of the quality of the water in the catchment of the Hennops River, specifically the Kaalspruit, continues to impact on areas downstream as evident from meetings of the Hennops Catchment Forum attended by the researcher in 2017).

The importance of the Rietvlei Nature Reserve as a conservation area for protecting the water quality was again acknowledged in discussions with members of the Pretoria Sailing Club who made statements such as: "Grey water moves through various farms before it reaches the dam. When it gets to the dam, it has been purified to a great extent. The natural water purification of the wetlands upstream helps with the water quality here" (Personal communication. 5 November 2016).

As water provisioning and conservation are the main goals of the Reserve, the limits in terms of acceptable change to the natural environment need to be considered before any new development within the Reserve can take place. There has been resistance, for example, to the development of a hotel within the Reserve and the provision for powerboats on the dam (Pretoria Sailing Club. Personal communication. 5 November 2016). It was stressed that the visual impact of a hotel complex, as well as the risk of noise and water pollution, would harm the sense of tranquillity and peace in experiencing nature. Resistance to developments within the Rietvlei Nature Reserve is based on the fear that the nature reserve would be ruined. This example can be interpreted in terms of the destination cycle of Butler (1980) where at a critical point, a decision must be made to maintain the peace and tranquillity of the greenspace.

5.5.4 Birders and Wildlife Photographers

The Rietvlei Nature Reserve is a key birding site for Southern African birding in Gauteng (Marais & Peacock, 2016). Photographers share their images on social media, such as the respective Pinterest and Facebook Pages for Rietvlei Nature Reserve and Rietvlei Photographers. The Nature Reserve is not only of local importance to birders and photographers, but also internationally acknowledged. The *Photographers' Guide to Rietvlei* explains how opportunities for wildlife photography can be explored, despite the fact that the area is not a pristine wildlife space (Goodlet, 2017). In this guide, the Rietvlei Nature Reserve is branded as an African conservation photo destination, which places it in the international arena.

From the research, it became apparent that birders and wildlife photographers play an important role in creating the identity of Rietvlei Nature Reserve. The images

become signifiers of birding opportunities and wildlife experiences (Goodlet, 2017; Erasmus & de Crom, 2015; Hall & Page, 2014; de Jager, 2010; Montgomery, 1998; Farnum *et al*, 2005). A guided tour of the Rietvlei Nature Reserve by representatives of Birdlife South Africa resulted when photographs were posted on social media (Rietvlei Photographers' focus group. 18 May 2017). Photographers can benefit from the first-hand experiences of people visiting Rietvlei Nature Reserve once they have posted special sightings on the social media platforms, such as Facebook. Through their lenses, signs and signifiers in the landscape are captured and posted on social media (Figure 5.5).



Figure 5.5: A young cheetah running across a gravel road in front of a rhino at the Rietvlei Nature Reserve

Photograph: Johann Perie (reproduced with permission)

Informal discussions, as well as formal workshops on photography techniques and social gatherings, regularly take place at the Rietvlei Coffee Shop. The Rietvlei Coffee Shop was therefore a logical choice for a discussion with a group of five Birders and Photographers at the Rietvlei Nature Reserve on 18 May 2017. This amenity is therefore not only an activity space, but also a space for socialisation.

Besides the expected significant landmarks or special areas, such as the Rietvlei Dam and Marais Dam, the Coffee Shop, Otter Bridge, and the bird hides and picnic spots, the secretary birds' nest was also pointed out as a landmark by the Photographers. They also highlighted the variations in the beauty of particular areas in the Reserve which vary according to the seasons and what is generally happening in the Reserve at the time. While other interested photographers might concentrate on large game or spectacular sightings, in the opinion of those Photographers who were interviewed, there is "always" something "beautiful" or "amazing" to see, and visiting the Reserve is regarded as "food for my soul". Phenomena such as spider webs, water reflecting sunlight, a rock with water bubbling over it, dragon flies, and dew on the grass, all contribute to a sense of appreciation for the natural environment. According to them, fulfilment also comes not only from the sightings of animals and birds, but also from observations of their behaviour. Careful observations in these respects add to this group's sense-of-place experience. Collectively, these influences were all found to contribute to the experience of and interaction of the Photographers with the natural environment.

Owing to aspects such as increased environmental awareness or changed needs, sense of place can be considered to be a dynamic concept in that it can change. The following statement by a participant in the discussion of 18 May, 2017 shows

how perception changes the sense of place: “I came here with my mom for the first time six years ago, and it was painful. But since I bought my camera last year, I have been coming here at least once a week. I come with my photographer friend. She is now my mentor and taught me [to observe]”.

Observing wildlife, marking checklists of birds, and experimenting with photographic equipment, are all aspects that have added interest to the Photographers’ photographic and sense-of-place experiences at the Rietvlei Nature Reserve.

Environmental awareness is an important attribute associated with the activities of the Photographers. Concerns were expressed that children need to learn that there is more to life than iPads and iPods, and to enjoy nature-based experiences. In this regard, regular photography workshops are already being presented at the Rietvlei Nature Reserve.

Sense of place is related to the meaning attached to a place (Masterson *et al*, 2017) and it need not be the same for everyone. The presence of invasive species, such as the pompom weed and eucalyptus trees, was identified as a serious problem in personal observation, face-to-face interviews and literature (Fisher 2017, Friends of Rietvlei, 2017; Mbiza 2014; McConnachie *et al* 2011). Some photographers, however, appreciated the aesthetic value of these invasive plants (Rietvlei Photographers’ focus group. 18 May 2017). The eucalyptus trees in the Reserve, which were poisoned in the Working for Water Project, provided a dramatic backdrop for landscape photographs. The stark contrast between the dead trees

and the blue sky was identified as a characteristic of the landscape that adds to the sense of place.

More research should be done on comparing the expectations created by professional photographs on Facebook with the experiences of first-time visitors to the Rietvlei Nature Reserve. The influence of social media on tourism experiences and destination images did not fall within the scope of this study, but could be explored in a future project

5.5.5 Hennops Catchment Management Forum

In terms of the South African Water Act (Act No 36 of 1998), catchment management forums are created as a platform for public participation, and play an important role in improving awareness of the importance of catchments and the rehabilitation of wetlands.

This researcher was present as an observer at two meetings of the Hennops Catchment Management Forum (30 May 2017; 26 July 2017). These meetings were attended by government officials from the Tshwane and Ekurhuleni Metropolitan Municipalities, as well as by registered, interested, and affected parties, and the general public. According to the chairperson of the forum, the attendance at meetings is usually between 20 and 30 people, and varies according to the critical issues on the agenda, as well as the individuals who are driving particular interests at any point in time.

From this discussion, it became clear that the goals of service delivery to growing metropolitan populations on the one hand, and environmental protection on the other, are often in conflict. Poverty and poor sanitation in the relevant areas of

jurisdiction of the Ekurhuleni Municipality were stated to have negative environmental impacts on the Hennops River catchment area. The quality of the water is not only reflected in visible solid waste and chemical pollution, but also in high levels of conductivity, which lead to higher electrical currents moving through the water. Nutrient enrichment and high levels of conductivity occur on account of the discharge of sewage on the one hand and inadequate sanitation networks on the other, as well as from industrial effluent and agricultural runoff. These facts confirmed the concerns expressed in the literature.

In their turn, degraded wetlands also have implications for downstream areas. The silting of Centurion Lake should be regarded as a warning sign of the risk to the wetlands and dams at Rietvlei. During the period of this research, the degradation of the Kaalspruit and its impact on Centurion Lake featured as a high priority issue for the Hennops Catchment Management Forum . Although the Kaalspruit does not flow into the Rietvlei Dam, it does join the Hennops River below the dam wall. Even though the wetlands in the catchment area of the Rietvlei Dam are not yet as degraded as the wetlands of the Kaalspruit, similar characteristics are evident in the sub-catchment where the Rietvlei Dam is located.

From the Hennops Catchment Management Forum discussions, it became clear that improved levels of collaboration are required between the responsible sections of the respective local governments and the higher tiers of government. What is happening at a particular place in a catchment has implications for areas downstream, and it is vital for local authorities to effectively manage the current water-provisioning capacity. This is partly because the officials who identify pollution through monitoring processes often have limited authority to act on the

polluters – as long as the point of pollution is outside of their area of jurisdiction .What became patently evident from the discussions at this forum was an urgent need for a generally improved sense of environmental awareness in terms of the quantity and quality of the water in this area. This conclusion was confirmed in a personal communication with managers at the Tshwane Nature Conservation presentations (Wolhitz, 2016), organised by the Hennops Catchment Management Forums (30 May 2017; 26 July 2017), which were attended by the researcher. Subsequent discussions also confirmed this viewpoint.

5.5.6 Electronic surveys

In order to gain further insights into the interplay between development, conservation and sense of place, online surveys were posted on the respective Facebook pages of the Rietvlei Nature Reserve, Friends of Rietvlei and Rietvlei Photographers. In the case of the face-to-face interviews, as well as the online survey, more than 90% of the respondents were from Gauteng. The first survey was run from 25 to 26 October, 2017 and N=175 responses were received on the Survey Monkey platform.

Tables 5.5 and 5.6 summarise the data obtained from these surveys. A large variety of concerns were expressed in the electronic surveys. This is most probably because the respondents, who are in fact members of these closed groups, are concerned about what is happening at the Reserve. The timing of the survey also influenced the high frequency of concern shown over rhino poaching as the survey was featured soon after a poaching incident. Only 6,62% of the respondents expressed no concern.

Table 5.5: Concerns expressed in the electronic survey of 25 October 2017

Category	N=136	%
Safety and security	40	29,41
Poaching	31	22,79
Rhinos	28	20,59
Inappropriate visitor behaviour	27	19,58
Maintenance	15	11
Human resources	15	11
Limited funding	11	8,09
Ecological balance	10	7,35
Safety of the lions	10	7,35
None	9	6,62
Invasive species	7	5,15
Chalets not operational	6	4,41
Cheetahs to be relocated	6	4,41
Urban encroachment	5	3,68
Future of the Reserve	5	3,68
Accessibility	4	2,94
Quality of the Coffee shop	4	2,94
Water quality	4	2,94
More information needed	3	2,21
Condition of the bird hides	3	3,21

The concerns expressed in the electronic survey confirmed what was mentioned in the face-to-face interviews with visitors. *Ad hoc* visitors to the Reserve do not necessarily know what is happening at the Reserve or what the concerns and stressors within the Reserve are. The concerns scoring the highest frequency levels included maintenance, rhino poaching, the future of the Reserve, invasive species, fish not biting, drought, inappropriate behaviour of visitors for the particular setting, the carrying capacity of the Reserve and the limited availability of information for visitors.

These concerns were directly related to the experience of the visitors, and as such, the responses on the electronic survey did not include concerns over fish not biting.

Unacceptable behaviour of visitors was indicated as a matter for concern in the face-to-face interviews, as well as in the surveys. The researcher also observed unacceptable behaviour in visitors during her field visits to the Reserve over the period of the study, namely from 2016 to 2019. Incidents of visitors exiting vehicles in non-designated areas, rowdy behaviour and public consumption of alcohol, and speeding were observed. This behaviour not only negatively impacts on the sense of place and tranquillity of the Reserve, but also makes visitors vulnerable to negative animal-human interactions.

The results of the survey of 6 January 2018 are provided in Table 5.6. Even though 23% of the respondents in this survey indicated that they had no concerns, poaching remained a prominent concern.

Table 5.6: Concerns expressed in the electronic survey of 6 January 2018

Category	N=229	%
None	53	23,14
Poaching	48	20,96
Inappropriate visitor behaviour	38	16,59
Invasive species	33	14,41
Rhinos	28	12,23
Maintenance	18	7,86
More information needed	15	6,55
Human resources	13	5,68
Safety	12	5,24
Service at the Coffee shop	11	4,08
Insufficient funding	8	3,49
Safety of the lions	8	3,49
Chalets not operational	7	3,06
Accessibility	7	3,06
Ecological balance	7	3,06
Declining habitat area	5	2,18
Urban encroachment	5	2,18
Bird hides	3	1,31
Water quality	3	1,31
Cheetahs to be relocated	2	0,87
Future of the Reserve	2	0,87
More events needed	1	0,44
Power lines	1	0,44

Source: Data gathered through the electronic survey (2018)

The data from Tables 5.5 and 5.6 were combined and presented in Figure 5.6. From this presentation, it is evident that the frequency of the respective concerns differs according to the variations in time. That is an indication that there are varying levels of awareness of particular concerns at different points in time. Visitor behaviour was also a matter for concern that was frequently mentioned.

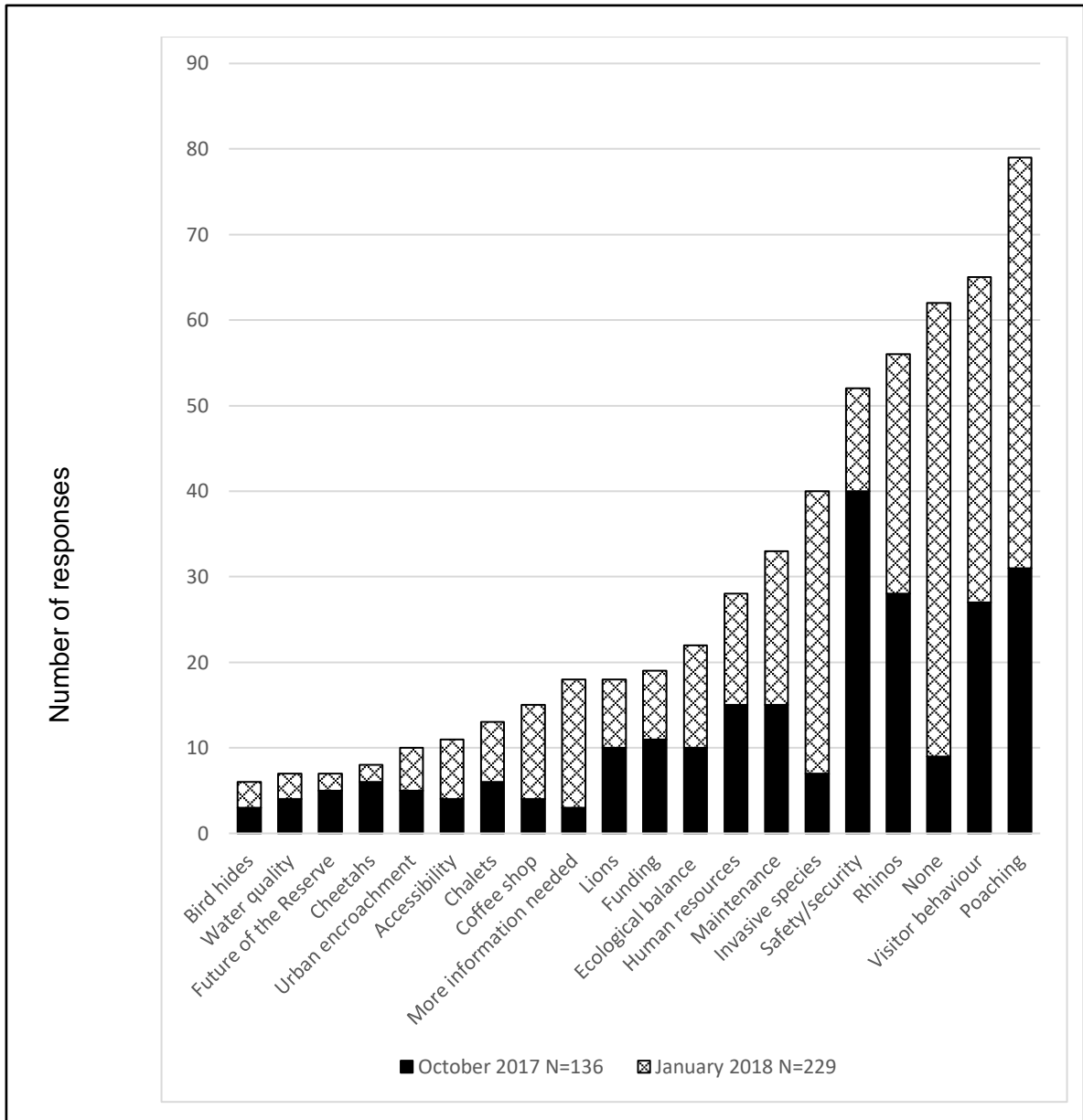


Figure 5.6: Concerns expressed in the electronic surveys: 2017 and 2018

From the bar chart in Figure 5.6, it is evident that there are fluctuations in the frequency levels for the respective concerns. This means that the level of awareness of the people participating in the survey, as well as the point in time when the survey was conducted, could influence the frequency in which particular concerns were raised. There was an increase in the frequency level of concerns mentioned regarding the Coffee Shop, the need for more information, the problem

of invasive species, and the number of respondents who indicated that they had no concerns. The concern for safety and security was much more frequently mentioned in the October 2017 survey than in the January 2018 survey. This could possibly be explained by the poisoning of two lions at the Reserve in the same month, soon before the survey. The fluctuation in the frequency levels illustrates the flexibility of concerns of the general public in respect of events at the site.

It can be seen from the survey that the presence of cheetahs, rhinos and birds is an important factor influencing the decision to visit the Rietvlei Nature Reserve. However, the presence of lions was not mentioned as a reason for visiting the Rietvlei Nature Reserve by any of the respondents in the electronic surveys. In the open-ended section of the questionnaire, the general experience and biodiversity were indicated as important reasons for visiting the Reserve.

Invasive species was also indicated as a concern, and the frequency level for this category increased from 2017 to 2018. This is most probably because this type of vegetation is highly visible in the flowering phase.

The concern relating to maintenance was found to be linked to concerns regarding funding. At the time of the research, this was particularly relevant to the ablution facilities, the dilapidated buildings, and the garden furniture outside the Coffee Shop, as well as to the maintenance of the bird hides at the Marais Dam and of the chalets in the camping area. Concerns over human resources ranged from insufficient numbers of staff to training. Examples provided in this regard were inefficient service at the Coffee Shop, the late opening of the gate, and inadequate measures for patrolling and the monitoring of vehicles.

Most of the concerns identified in the first survey were confirmed in the second even though the frequency levels mentioned were not the same (Table 5.7).

Table 5.7: Classification of concerns identified in the electronic surveys

	October 2017	January 2018
Concerns linked to development; government and governance	Funding; water quality; urban encroachments; maintenance; human resources; future of the Reserve	Maintenance; human resources; funding; future of the Reserve; water quality; urban encroachment
Concerns over conservation and biodiversity	Future of cheetahs in the Reserve; safety of the lions; invasive species; ecological balance; poaching	Poaching of lions; rhinos; future of the cheetahs; invasive species; declining habitat area; ecological balance
Concerns related to the sense-of-place experience	Safety and security; dissemination of information; condition of the bird hides; condition and service at the Coffee Shop; chalets not operational	Behaviour of visitors; dissemination of information; safety; visual impact of power lines; more events needed; condition of the bird hides; accessibility; chalets not operational; condition of the Coffee Shop

The concerns identified in the electronic survey confirmed the concerns identified in the interviews and group discussions. In order to identify the stressors within the Rietvlei Nature Reserve, these concerns are evaluated in the following section.

5.5.7 Summative conclusion on the groups interviewed

With the exception of the Hennops Catchment Management Forum, the groups which were interviewed were all direct stakeholders in the Rietvlei Nature Reserve. The groups may have different foci, but they are not necessarily mutually exclusive. Even though the Pretoria Sailing Club, Friends of Rietvlei, and the Birders and Wildlife Photographers were interviewed separately and reported upon in different sections of this thesis, many overlaps and dual memberships were recorded.

Many of the members of the Pretoria Sailing Club, for example, are also keen conservationists and photographers. The previous Commodore of the Pretoria

Yacht Club (principal flag officer) assisted with the building of bird hides in the conservation area, and was also involved in film shoots there (Secretary, Pretoria Sailing Club. Personal communication. 5 November 2016). Furthermore, on visiting the Rietvlei Dam to conduct on-site interviews, the researcher also observed Birders and Photographers in the sailing and camping areas. Pretoria Sailing Club members are also members of Friends of Rietvlei and some Honorary Rangers are also Birders and Photographers. The respondents on the Facebook pages were members of the Friends of Rietvlei group or Rietvlei Photographers.

The activities of each of these groups contribute to the sense of place of the Rietvlei Nature Reserve. In fact, sense of place is linked to identity (Montgomery 1998). The names, "Friends of Rietvlei" and "Honorary Rangers" are not only related to the nature conservation activities carried out in the Rietvlei Nature Reserve, but also to the identity of the group members. On the other hand, the Hennops Catchment Forum is compiled of government officials, as well as interested and affected members of the public who are not necessarily involved with or interested in the Rietvlei Nature Reserve as an urban greenspace. Since the Rietvlei River flows into the Hennops River only after the Rietvlei Dam wall, the physical characteristics of the Hennops River and the pollution of the catchment area are more important to this group than specifically the Rietvlei Nature Reserve as an urban greenspace.

Issues related to water provisioning and quality were mentioned in all of the group discussions. One of the most important functions of the Rietvlei Nature Reserve is to supply water. However, the quality of the water is one of the most serious of their concerns. In general, there seems to be only a limited awareness amongst

the visitors who were interviewed of the importance of water provisioning and the related challenges. The benefits and stressors that were identified through the afore-mentioned interviews, discussions and surveys were found to reflect the variety of experiences of the participants involved in using the amenities of the Rietvlei Nature Reserve.

In the following section, Section 5.6, the benefits and stressors applicable to the Rietvlei Nature Reserve and as identified by the purposively-selected key informants, are discussed in an attempt to also establish possible links to the selected models featured in the literature.

5.6 Benefits and stressors identified from the semi-structured interviews

Based on the semi-structured interviews with 18 purposively-selected respondents, broad themes could be identified for the benefits and stressors relating to conservation and sense-of-place applicable to the Rietvlei Nature Reserve. The aspects mentioned were firstly classified according to particular themes specifically identified as attributes of the benefits of the Rietvlei Nature Reserve. The themes were then sorted alphabetically in an Excel spreadsheet in order to establish the frequency level of each.

5.6.1 Benefits of the Rietvlei Nature Reserve identified through the semi-structured interviews

The benefits of the Rietvlei Nature Reserve which were mentioned by key informants in the semi-structured interviews are summarised in Table 5.8. The benefits were then categorised into themes and are presented in Figure 5.7.

The psychological benefits of the Reserve as an escape from the city, as well as the health benefits of interacting with the natural environment, were confirmed. These findings were also in line with the physical and psychological advantages of human interactions with the natural environment, as already established in the literature (Meyer-Grandbastien *et al*, 2020; Kondo *et al*, 2018; Jennings *et al*, 2017; de Crom & Nealer, 2017; Dickenson & Hobbs, 2017; Adams *et al*, 2016; Coutts & Hahn, 2015; Hausmann *et al*, 2015). It was therefore not surprising that recreation was most frequently identified as a benefit or an advantage associated with the Rietvlei Nature Reserve (Table 5.8).

Table 5.8: Benefits of the Rietvlei Nature Reserve

Aspects mentioned by informants	Themes or attributes	Relevant models
Good access to the reserve	Accessibility	Pacione (2001)
Variety of bird species	Flora and Fauna	Haase and Rink (2014)
Water birds feed over large areas and are not limited to the Reserve	Flora and Fauna	Haase and Rink (2014)
Rhino horn could become a commodity if it were to be legalised.	Economic benefit	None
Entrance fee	Economic benefit	None
Children of the city need to experience nature	Environmental awareness	Pacione, (2001); Haase and Rink (2014)
Rietvlei is more than an experience of playing outside	Environmental awareness	Pacione (2001); Montgomery (1998)
Environmental awareness	Environmental awareness	Pacione (2001); Montgomery (1998)
Children of the city need to experience nature	Environmental awareness	Pacione (2001)
It is a privilege to have a place like this	Environmental awareness	Pacione (2001); Montgomery (1998)
<i>Table 5.8 continues ...</i>		
Table 5.8 (Continued)		
More people are becoming interested in the reserve	Environmental awareness	Montgomery (1998)
Educational potential	Environmental awareness	Montgomery (1998)
Public education	Environmental awareness	Haase and Rink (2014)
Escape from the city	Escape	Pacione (2001)
I go there to clear my mind	Escape	Pacione (2001)
Escape from the city	Escape	Pacione (2001)

Aspects mentioned by informants	Themes or attributes	Relevant models
The Lapa is available for functions, conferences or meetings	Facilities	Montgomery (1998);Butler (1980)
People can camp	Facilities	Montgomery (1998)
Variety of plant species	Flora and Fauna	Haase and Rink (2014)
Conservation of habitats	Flora and Fauna	Haase and Rink (2014)
Health benefits of interaction with nature	Health benefits	Pacione (2001); Haase and Rink (2014)
Historic house (Coffee Shop)	History	Montgomery (1998)
Proximity is a positive externality for market values	Economic benefit	None
It is an added value for adjacent properties	Economic benefit	None
If it is well managed, more economic opportunities could be created for the surrounding businesses (also informal)	Economic benefit	None
Egg farmers can sell at stalls adjacent to the Reserve	Economic benefit	None
Nature on your doorstep	Proximity	Haase and Rink (2014)
It is a pull factor for people who would like to live close to the nature reserve	Proximity to nature	None
People are attracted by nature	Proximity to nature	Haase and Rink (2014)
Tourism and recreation	Recreation	Butler (1980)
Coffee Shop	Recreation	Butler (1980); Montgomery (1998)
People can leave the city	Recreation	Pacione (2001)
People can participate in game drives	Recreation	Butler (1980)
Braais	Recreation	Butler (1980)
Passive recreation	Recreation	Butler (1980)
Relatively safe destination	Safety	Pacione (2001); Montgomery (1998)
Selling of water to Tshwane	Water	None
Peat soil for water purification	Water	Haase and Rink (2014)
The Rietvlei Nature Reserve exists to protect the dam and to manage water flow	Water	Haase and Rink (2014)
Source of water for Tshwane	Water	Haase and Rink (2014)
Protection of animals	Flora and Fauna	None
Animals can live there (not caged)	Flora and Fauna	None

The frequency levels in which the themes were identified in Table 5.8 are presented in Figure 5.7.

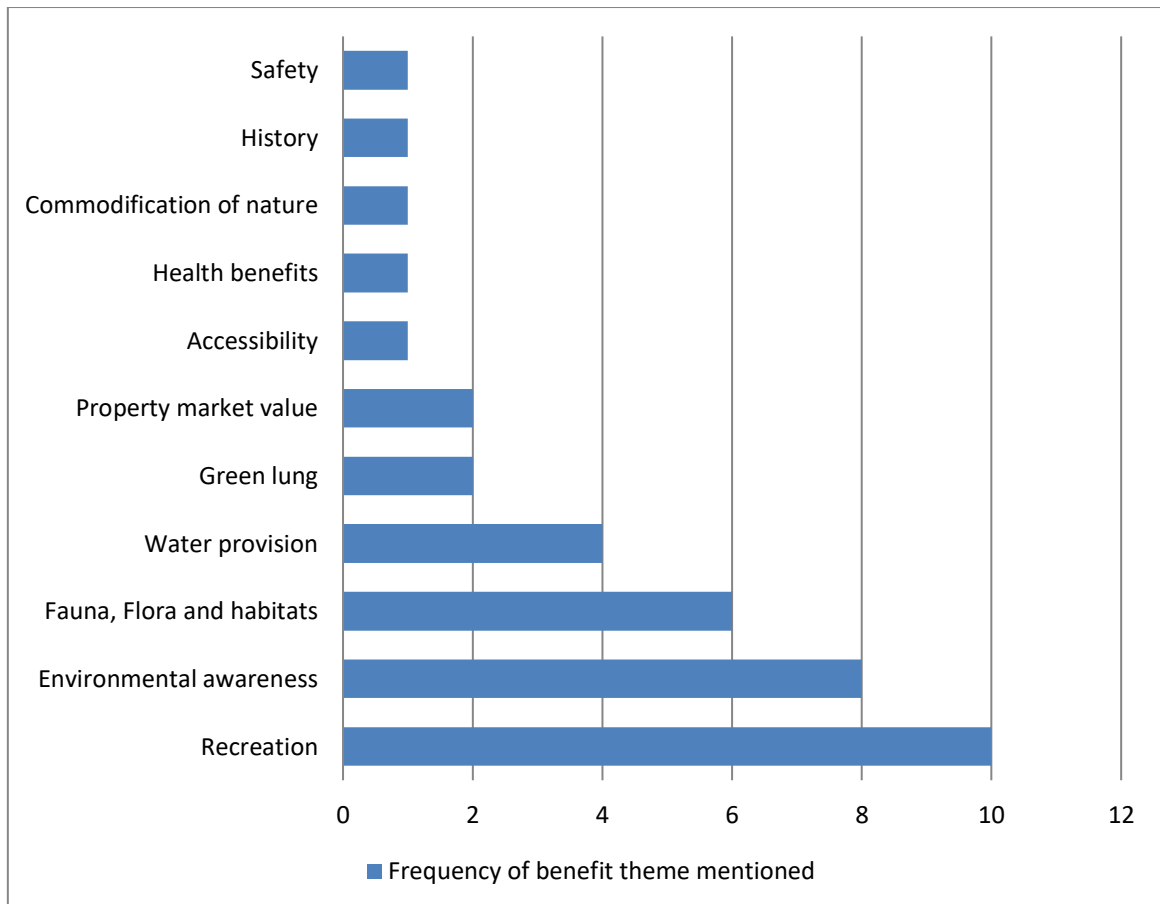


Figure 5.7: Frequency of themes related to the benefits within the Rietvlei Nature Reserve mentioned in the semi-structured interviews

On analysing the frequency levels of the different benefits, it became clear that recreation and opportunities for environmental awareness are important benefits offered by the Rietvlei Nature Reserve. They are followed by water provisioning and an escape from city life. The Rietvlei Nature Reserve provides social, economic and environmental benefits. The habitats and variety of birds and animals found in the Reserve were also indicated as benefits within the Reserve. These are linked to the benefit of offering opportunities for interaction with the natural environment, and for environmental education. Opportunities for promoting environmental awareness were mentioned by 50% of the respondents as a benefit

of the Rietvlei Nature Reserve. Environmental benefits, including biodiversity, habitats, flora and fauna, and the role of the Reserve as a green lung for the city, were mentioned by 33% of the respondents. Surprisingly, water provisioning was mentioned by only 25% of the respondents as a benefit. This is in contrast to the dominance given to water provisioning as a benefit to the development component. Economic benefits that were mentioned were the commodification of nature and the positive externalities of property values for residences adjacent to the Reserve.

5.6.2 Stressors within the Rietvlei Nature Reserve identified in the semi-structured interviews

Various risks to the Rietvlei Nature Reserve were identified through this research. Should the risks become more than mere hassles, stressors could develop that, if not addressed successfully, could lead to a situation where the functions of the Reserve could be negatively impacted upon or no longer sustained (Figure 5.8).

The risks to the Rietvlei Nature Reserve which were mentioned by the key informants in the semi-structured interviews are summarised in Table 5.9. These aspects were then categorised into themes and are presented in Figure 5.8.

Table 5.9 Stressors within the Rietvlei Nature Reserve mentioned by the key informants in the semi-structured interviews

Aspects mentioned by informants	Theme of risk attribute	Models
People who do not drive themselves will not have access.	Accessibility	Pacione (2001)
The Rietvlei Nature Reserve is a fiscal burden on the municipality.	Budget	Pacione (2001)
There are no nature reserves that are self-sustaining.	Budget	None
The land cover and agricultural patterns in the catchment area are changing.	Change in land cover	Haase and Rink (2014)
		Table continues...

Aspects mentioned by informants	Theme of risk attribute	Models
Enhanced runoff from roofs (e.g. large roofs in industrial areas) leads to the flooding of pans in Ekurhuleni.	Change in land cover	Haase and Rink (2014)
Larger areas of paving or tar increase runoff and rate of flow.	Change in land cover	Haase and Rink (2014)
Aspects mentioned by informants	Themes or attributes	Relevant models
Owing to the conservation status of the Reserve, there is an economic risk for potential developers who cannot develop smallholdings.	Economic risk	None
There are more economic risks to developers in areas adjacent to the Reserve than to the nature reserve itself.	Economic risks	None
The encroachment of the built environment impacts on the Reserve.	Encroachment	Haase and Rink (2014)
Urban greenspace could become a green desert if managed purely for recreational purposes.	Environmental management	Haase and Rink (2014)
There are large areas of degradation in the Reserve.	Environmental management	Haase and Rink (2014)
We cannot go back to a pristine environment; the only option is a functional habitat design. Management needs to not only remove trees for the water programme to work, but consider various other aspects (e.g. breeding places for birds of prey).	Environmental management	Haase and Rink (2014)
Natural processes are not contained by municipal or local boundaries or fences around the Reserve.	Environmental management	None
There are greater problems in the world than the conservation of the Rietvlei Nature Reserve. Why should we budget for conservation?	Governance	Pacione (2001)
Political appointments	Governance	None
The security cluster warned about possible poaching before it happened.	Governance	Montgomery (1998)
Economic opportunities are not taken. There is no tuckshop at the Marais Dam picnic spot. Chalets are not available.	Governance	Butler (1980)
The fence to the Rietvlei Nature Reserve is not in keeping with a nature reserve.	Image	Montgomery (1998)
The two- to four-storey houses adjacent to the Reserve have a negative visual impact.	Image	Montgomery (1998)
Different types of greenspace should be appreciated. Rietvlei is not a carbon copy of the Groenkloof Nature Reserve.	Image	Montgomery (1998)
The Delmas Road could impact on the ambience of the Reserve.	Image	Montgomery (1998)
The power lines over the Reserve are unsightly.	Image / services provision	Montgomery (1998)
Negative press in terms of management	Image	Montgomery (1998) <i>Table 5.9 continues ...</i>
The perception is that the Rietvlei Nature Reserve is for the exclusive use of affluent people.	Image	Montgomery (1998)
Possibility of land claims	Land claims	None
There are high levels of ignorance amongst the urban dwellers about the value of conservation areas.	Limited environmental awareness	Montgomery (1998)
Underestimation of the value of the Highveld grassland biome	Limited environmental awareness	Montgomery (1998)
Underestimation of the value of educational opportunities	Limited environmental awareness	None

<i>Table 5.9 (continued)</i> Aspects mentioned by informants	Theme of risk attribute	Models
Pollution from the brick factory	Pollution	Haase and Rink (2014)
Pollution from the tile factory	Pollution	Haase and Rink (2014)
Agricultural chemicals from the catchment area	Pollution	Haase and Rink (2014)
There are two sewerage works in the larger catchment area.	Pollution	Haase and Rink (2014)
High conductivity and pH pollution	Pollution	Pacione (2001)
Eutrophication	Pollution	Pacione (2001)
The presence of sewage in boreholes adjacent to the reserve is a warning sign of the deteriorating quality of the water from the Rietvlei boreholes.	Pollution	None
The risk of waste pollution owing to the Reserve's proximity to the city	Pollution	Pacione (2001)
The dam should not become polluted to the same extent as the Hartebeespoort Dam. .	Pollution	Montgomery (1998)
Lack of security at farm stalls	Security	Pacione (2001); Montgomery (1998)
Theft	Security	Pacione (2001)
Crime	Security	Pacione (2001)
Violent crimes on smallholdings adjacent to the reserve	Security	Pacione (2001)
The area next to the dam gate (in the reserve) is not safe.	Security	Pacione (2001)
The perception that it is unsafe to have picnics	Security	Pacione (2001); Montgomery (1998)
Poaching	Security	None
There are different needs and priorities in communities.	Service delivery to the surrounding community	Pacione (2001)
There are more people, but the capacity of the sewerage works has not increased.	Service delivery to the surrounding community	Pacione (2001)
The low level of access to formal service provision is a higher risk to the Rietvlei Nature Reserve than formal housing developments visible from the Reserve.	Service delivery to the surrounding community	Pacione (2001)
Pollution from informal settlements	Service delivery to the surrounding community	Pacione (2001)

As a result of the analysis, as presented in Table 5.9, the following themes emerged: pollution; safety and security; the image of the conservation area; limited capacity for service provision to a growing urban population; land-cover changes in the area surrounding the Rietvlei Nature Reserve; environmental management; governance; limited environmental awareness; budget constraints; the limited accessibility of visitors to the Rietvlei Nature Reserve; and land claims.

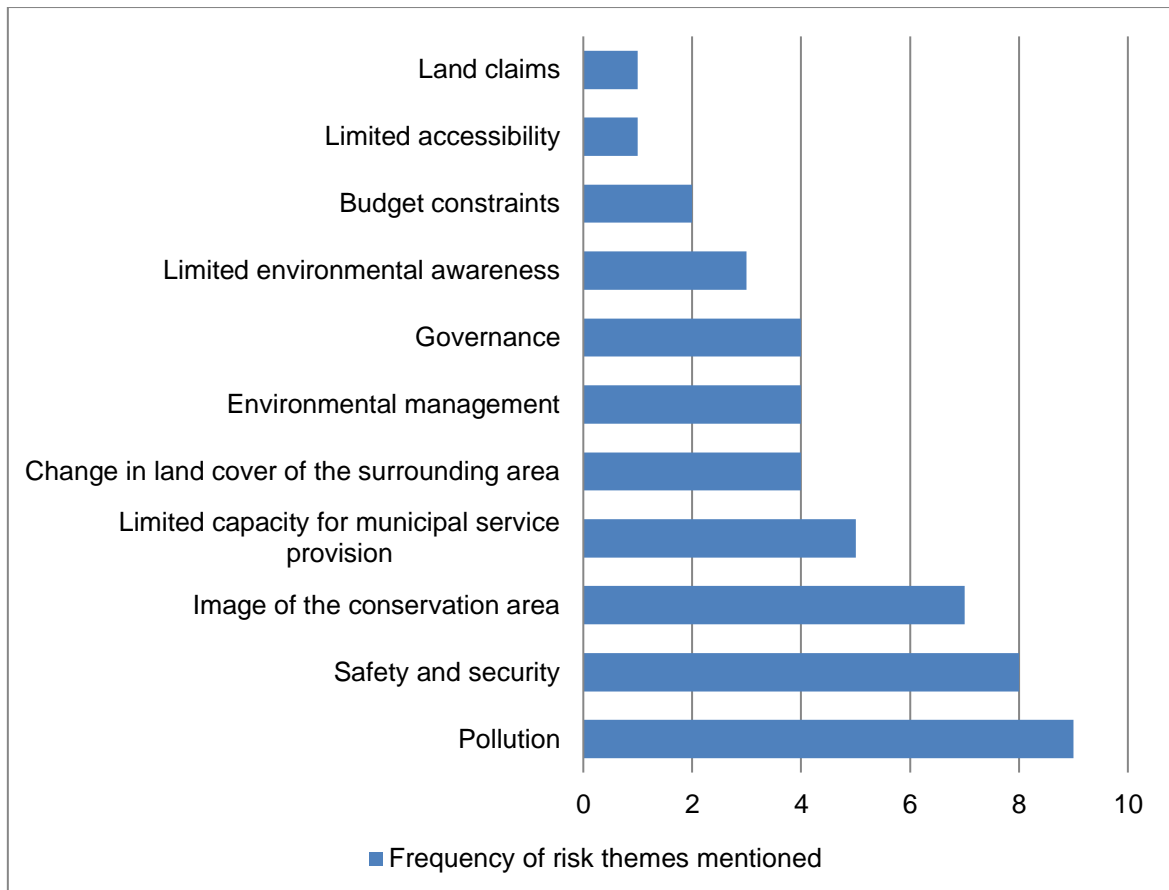


Figure 5.8: Frequency levels of risk themes within the Rietvlei Nature Reserves mentioned by the key informants

Risks related to the theme of pollution constituted the highest frequency category (56%) in the analysis of the data, with water pollution prominent in this theme. Thus, owing to the importance of the water-provisioning function of the Rietvlei Nature Reserve, the risk of water pollution could possibly be a stressor that would negatively impact on this conservation area.

The theme of safety of humans and security of animals was mentioned by 50% of the informants. Poaching and petty crime were also shown as matters for concern. Negative publicity after such incidents is also considered to negatively impact on the image of the Rietvlei Nature Reserve. The relatively high frequency category

(37,5%) representing aspects concerning the image of the conservation area is an indication in this survey of the importance of sense of place.

Aspects related to the variety of needs, service provision and capacity were indicated as risks to the Rietvlei Nature Reserve in 56% of the responses received. Governance was also linked to economic risk and competing budget needs. The perceptions of decision makers regarding the importance of conservation efforts are vital for budget allocations to the Rietvlei Nature Reserve.

Environmental awareness was mentioned as both a potential benefit *and* a risk to the Rietvlei Nature Reserve. Even though there were various possibilities available for enhancing environmental awareness (Friends of Rietvlei, 2017), limited environmental awareness was indicated as a risk. Managers should therefore consider extending the existing opportunities for enhancing environmental awareness and communication amongst the public. Should they not, a combination of limited environmental awareness and a negative image of the conservation area could eventually become a dominant stressor to the Rietvlei Nature Reserve. In fact, limited awareness of the importance of this greenspace could lead to decisions that could be catastrophic for the future of the Reserve.

The frequency at which these risks were mentioned is not necessarily an indication of the severity of the risk, but rather an indication of the awareness of the informants as to the particular types of risks to the Rietvlei Nature Reserve as an urban greenspace.

As such, the risks and stressors are further evaluated in Chapter 6 in order to identify potential stressors for the Greenspace Stress Model of Urban Impact.

5.7 Conservation and sense-of-place perspectives feeding into the Greenspace Stress Model of Urban Impact

The Greenspace Model of Urban Impact (GSMUI) includes both the objective (real-life) characteristics of the Rietvlei Nature Reserve, as well as the subjective perspectives pertaining to it. The models feeding into the GSMUI all include aspects of the objective physical characteristics of the place. Haase and Rink (2014), for example, showed how important the restoration of ecosystem functions is for the support of ecosystem services and quality of life. Butler (1980) indicated the importance of selecting appropriate mitigation strategies and scenarios for the future of a destination. Pacione (2001) demonstrated that environmental perceptions are informed not only by the objective characteristics of a place, but also by individual perceptions and social conditions. According to Montgomery (1998), sense of place is determined by Form, Activity and Image.

The identified benefits and stressors were subsequently linked to these models, as presented in Tables 5.10 and 5.11.

The resources of the Rietvlei Nature Reserve and the associated ecosystem functions are part of the physical characteristics of this greenspace. The Highveld grassland biome, dams and wetlands, biodiversity and scenic views are perceived to be resources for nature-based tourism and recreation. The motivation for systematic conservation planning is, however, more comprehensive than nature-based tourism and recreation or the protection of sacred sites, for instance. This is because systematic conservation planning also involves the protection of ecosystems, freshwater systems and habitats which are at risk owing to encroaching urban development (Republic of South Africa, 2011).

Table 5.10: Explanation of how the identified benefits are linked to the selected models

Benefit	Pacione (2001)	Haase and Rink (2014)	Butler (1980)	Montgomery (1998)
Recreation	The Rietvlei Nature Reserve provides a setting for nature-based recreation.	Restored degraded spaces can provide recreational spaces in the city.	Butler specifically focuses on tourism. Thresholds and possible mitigation strategies for degradation are also relevant to other uses of greenspace.	Recreation as an activity influences the sense of place and can be added to the list in the model.
Environmental awareness and education	Not only the objective physical conditions, but also individual differences, influence the perception of the environment and the stress experienced by individuals in the city.	Environmental awareness is important for the restoration of ecosystem functions in the city.	Managers should be aware of the impacts of tourist activities on the environment of the destination and develop suitable mitigation strategies when degradation occurs in order to maintain the attractiveness of the destination. Environmental awareness is, however, not only important for tourism but also for the ecosystem services expected from the greenspace.	Environmental awareness is not mentioned as such, but can be assumed as common knowledge. The model can be expanded by including environmental awareness in the list under Image in the model. The image of the place influences sense of place. Environmental awareness can be promoted by the way a place is represented.
Conservation of Biodiversity	The focus of Pacione (2001) is on human quality of life, especially in areas with unfavourable social conditions. The Greenspace Stress Model of Urban Impact expands the focus to include benefits and stressors of urban greenspace.	Restored ecosystems provide habitats. When the degraded hard open spaces are adapted to soft open spaces and ecosystem functions are restored, animals and birds return to their habitats.	This benefit was not directly included in the TALC model of Butler (1980). It can, however, be linked to the physical characteristics and attractiveness of the destination.	The Activities, Form and Image of a place are identified components of sense of place. Flora, fauna and habitats are not mentioned in the model but could be included under Form. The Activities and Image of the Reserve are linked to the conservation of flora, fauna and habitats.
Water provisioning	Water provisioning is an important component in the quality of life of individuals in the city. Lack of water provisioning leads to stress.	Ecosystem functions should be managed and restored in order to support ecosystem services.	This benefit was not directly included in the TALC model of Butler (1980). It could, however, be linked to the physical characteristics of the destination. It was, therefore, necessary to amend the model to include ecosystem functions and services.	Water provision is not specifically mentioned in the model but could be included under Form. The Activities and Image of the Reserve are linked to water provisioning.
Green lungs for the city	Environmental quality influences human quality of life.	Ecosystem functions and services are important for environmental quality.	This aspect was not relevant to the TALC model.	This could be linked to the Form of greenspace but ecosystem functions and services are not specifically mentioned in this model.
Property values	Property values in different areas of the city influence the socio-economic conditions experienced.	Improved ecosystem health can improve property values.	Over-use could reduce the value of the destination, but property values were not specifically addressed.	Property values could influence the image of a place.

Table 5.11: Explanation of how the identified stressors are linked to the selected models

Stressors	Pacione (2001)	Haase & Rink (2014)	Butler (1980)	Montgomery (1998)
Water quality (pollution)	Water quality and pollution are relevant to the quality of life of individuals in the city. Unacceptable levels lead to stressors for people in the city, as well as for the quality of the environment within the urban greenspace.	Restored ecosystem functions can improve ecosystem services such as the natural purification of water through grasslands and wetlands.	Over-use reduces environmental quality at a destination and consequently diminishes environmental quality, and changes the functions of the destination.	The sense of place is influenced by the form, activity and image of a place. Not all visitors realise the importance of the Reserve as a water-provisioning facility to the City of Tshwane, or water quality as a stressor.
Safety and security	Safety and security are important for quality of life in the city in general and specifically in the urban greenspace.	Not relevant to Haase & Rink (2014)	This specific stressor was not included in the model. Safety and security could influence the number of visitors to a destination.	Fear and crime are included in this model as components of the image of a place.
Image of the conservation area	The objective characteristics, as well as individual differences, influence the perception of the urban environment..	Image was not specifically mentioned in this model, but it is an important motivation for the restoration of ecosystems.	The attraction of a particular destination influences the number of visitors and could lead to over use.	Image is an important component of sense of place. The way the place is presented can influence conservation activities (or the lack thereof).
Limited capacity for service provision in the catchment area of the Rietvlei Dam	Basic provision is an important factor in the quality of life in the city. Different levels of service provision in the city, as well as socio-economic differences, influence the environmental stressors experienced by individuals. The environmental quality of an urban greenspace, however, is also influenced by the level of service provision in the surrounding area.	This stressor was not relevant to the model by Haase & Rink (2014)	The focus of the TALC model is on a particular tourist destination rather than on the surrounding area.	This aspect was not addressed by Montgomery (1998). Limited capacity for service provision does have implications for the Form, Functions (Activities) and Image of a destination and could, therefore, be included in an adapted version of the model.
Change in land cover in the catchment area	Not included in the model	Haase & Rink (2014) explored a context with a declining population. Thus, the model had to be adapted to a global South context.	Increased use of a destination changes its characteristics. Based on the way in which ecosystem services are managed within a changing context, different scenarios are possible.	Urban development changes the activities within the Reserve.
Environmental management challenges	Environmental management challenges are relevant to the environmental quality and quality of life in the city.	Ecosystem functioning is influenced by land use.	The choices made and the management strategies implemented at particular critical points influence the future scenarios.	Changing form and functions influence sense of place.

The environmental perceptions and awareness of managers, the public and visitors to the urban greenspace have important implications for decision making and possible future scenarios of the greenspace within the context of urban development. The stressors identified in terms of sense of place and conservation therefore need to be addressed in relevant management plans.

5.8 Conclusion

The conservation and sense-of-place perspectives of the respondents clearly reveal that Rietvlei Nature Reserve is more than a recreational space. The supply of clean water to the City of Tshwane was evaluated by the key informants as the most important objective in the Ecological Management Plan of the Rietvlei Nature Reserve (Marais, 2015). The Reserve also supports basic service provision to the Tshwane Metropolitan Municipality. Surprisingly, there was limited awareness of the importance of the water-provisioning function in the survey conducted with visitors to the Reserve.

Variety in the type of person visiting the Reserve was evident from observations made and from the responses to the on-site interviews. An assessment of the characteristics and the specific activities that the visitors were involved in was used as a basis for this differentiation, and based on their wider specific knowledge of the Reserve and their participation in events or in its management, particular interest groups were identified.

The social and cultural benefits offered by the Rietvlei Nature Reserve were identified based on their beneficial environmental properties or the favourable conditions that they foster. Visitors to the Reserve were not necessarily aware of

the stressors within the Rietvlei Nature Reserve. The specific benefits and stressors that were identified were influenced by the events prior to the data collection phase of this research, and also through the individual levels of awareness that prevailed at the time of the research in respect of the existing benefits and stressors.

In summation, Chapter 5 indicated how the sense of place in terms of the Rietvlei Nature Reserve as an urban greenspace is reflected in the interplay between development, conservation and image or sense of place of this conservation area. The environment proved to be an important component of sense of place in the Rietvlei Nature Reserve and was, therefore, built into the Greenspace Stress Model of Urban Impact. Against this background, Chapter 6 primarily focuses on the way in which the selected models, individually and collectively, feed into the Greenspace Stress Model of Urban Impact, which has been developed through this research for the Rietvlei Nature Reserve.

Chapter 6: The Greenspace Stress Model of Urban Impact for the Rietvlei Nature Reserve

6.1 Introduction

The aim of this thesis was to apply a geographical perspective to assess the importance of the Rietvlei Nature Reserve as a green infrastructural component, and to illustrate the geographical interplay between urban development, conservation and sense of place in the Reserve. The geographical perspective allowed for the contextualisation of the Rietvlei Nature Reserve as a critical greenspace interface between the growing metropolitan areas of Tshwane and Ekurhuleni.

In Chapter 4, the spatial pattern of urban development in the catchment area of the Rietvlei Dam was analysed and presented. The focus in Chapter 5 shifted to the conservation and sense-of-place perspective of the interplay between development, conservation and sense of place. In this chapter, Chapter 6, the findings of Chapters 4 and 5 have been integrated to demonstrate the complex relationships between these components and thus the potential interplay between the three pillars that form the basis for the development of a Greenspace Stress Model of Urban Impact for researching the Rietvlei Nature Reserve (Objective 3).

In the case of the Rietvlei Reserve specifically, it was established in Chapters 4 and 5 that not only the physical characteristics of the greenspace, but also environmental perceptions and sense-of-place experiences are important in influencing the respondents' assessments of the benefits and stressors that emanate from the Reserve, a greenspace in a geographical area where growth

and development in the surrounding urban areas are prominent processes and intensifying the demand for critical urban services.

As presented in Chapter 2, the selected models from the literature that informed the development of the proposed new model - using the Rietvlei Nature Reserve as a case study - and which form the focus of this chapter, are those presented by Haase and Rink (2014), Pacione (2001), Montgomery (1998), and Butler (1980).

Both Haase and Rink (2014) and Pacione (2001) theorised around environmental quality and quality of life within an urban setting. Butler (1980) also emphasised the importance of environmental quality and the selection of appropriate strategies for the sustainable use of a destination. Haase and Rink (2014) established the links between urban change, environmental quality and quality of life in the global North. The sense-of-place model such as that presented by Montgomery (1998), as well as later adaptations of it, include form, activity and image for place making. Recently, there has been evidence of an increasing focus on environmental quality in the sense-of-place context (Ghavampour & Vale, 2019; Ghoomi *et al*, 2015).

In spite of the global North context in which the identified models were developed, this study has demonstrated that adapted versions of the models are also relevant to the Rietvlei Nature Reserve. Also, that important lessons towards the development of a Greenspace Stress Model of Urban Impact can be learnt for the Rietvlei Nature Reserve in the context of the global South.

6.2 Structure of the chapter

This chapter embraces a critical reflection of Objectives 1 and 2 of the research by placing the findings of Chapters 4 and 5 within a context that would attain Objective 3 (Figure 6.1). The three objectives have been integrated into the various sections of this chapter, and the result is briefly summarised in Figure 6.1.

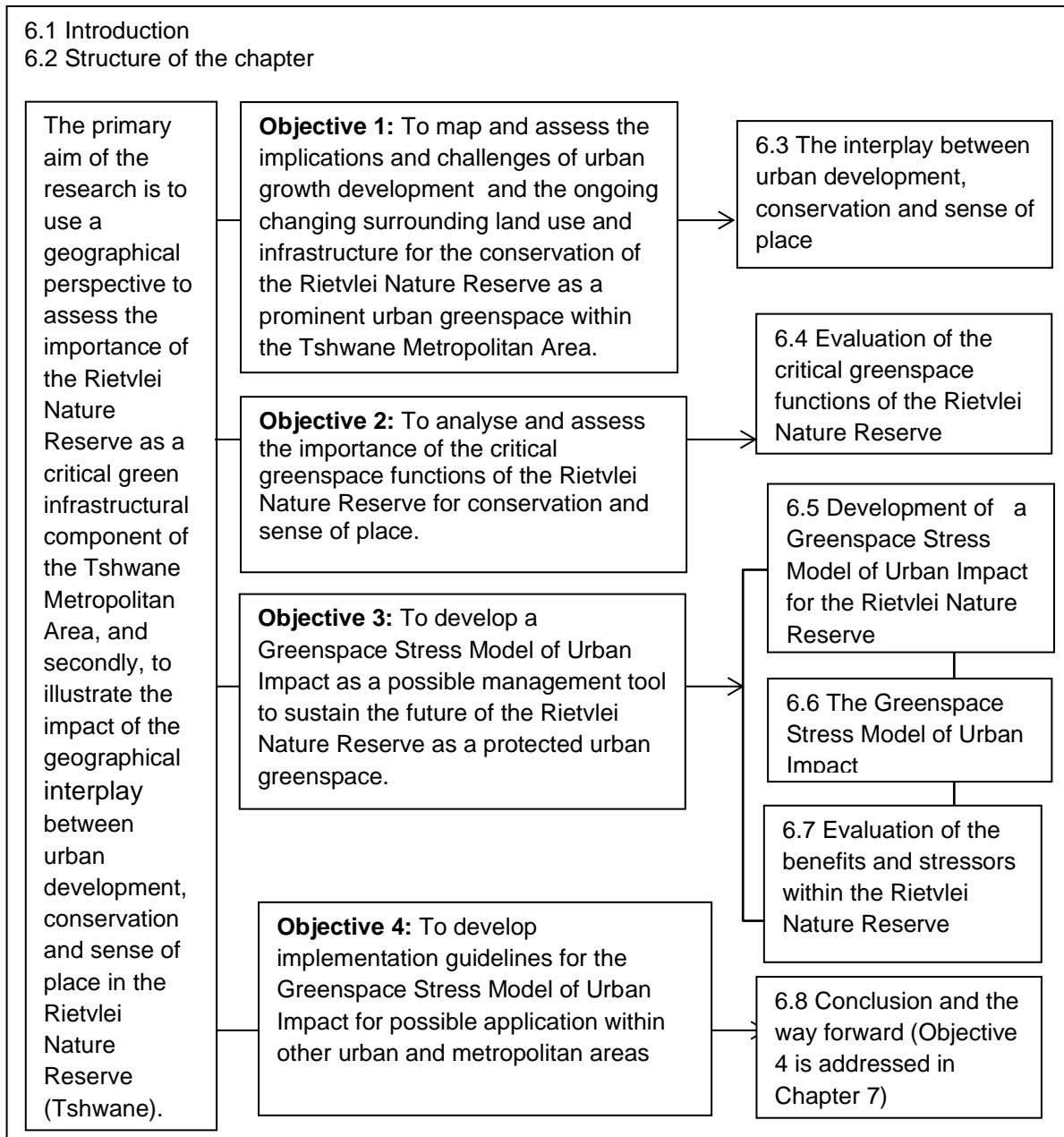


Figure 6.1: The structure of the chapter to integrate the interplay between development, conservation and sense of place

The interplay between urban development, conservation and sense of place reflects different goals associated with urban greenspace and the perceptions of it. Chapter 6 therefore critically analyses the benefits and stressors experienced in the Rietvlei Nature Reserve. These were previously identified by the researcher and presented in Chapters 4 and 5, in order to develop a generic theoretical framework that could be applied to the Rietvlei Nature Reserve

6.3 The interplay between urban development, conservation and sense of place as applied to the Rietvlei Nature Reserve

The interplay between development, conservation and sense of place is illustrated in the quote below:

“When the link between conservation and water provision is not understood, the economics of having a conservation area in the city may not make sense. Budget priorities of the Tshwane Metropolitan Municipality could be a serious economic risk to the management of the Rietvlei Nature Reserve as there are insufficient immediate economic advantages in nature conservation. There is a risk that the nature reserve can be regarded as an economic burden to the local authority as it is not economically self-sustaining. Politicians need quick and visible results during their term of office. Building houses and providing electricity are tangible and measurable outcomes in the short term, while nature conservation is a long-term concept.”

(Director, Tshwane Nature Conservation. Personal communication. 22 August 2016)

Regardless of the geographical location, the balance between development, conservation and sense of place can be a sensitive one.

Urban development is linked to the physical sphere, conservation to the ecological sphere, and sense of place to the social sphere, with all three of these aspects having financial implications which need to be weighed up against one another when management plans and budget allocations are devised. However, ecosystem services and the measures in place to protect them cannot always be evaluated in monetary terms (Pasquini & Enquist, 2019; Boyd, 2012). In such a case, sense of place (SoP) could, for example, play an important role during decision making when budget allocations are to be made for locations where there are competing needs (Hausman *et al*, 2015).

Figure 6.2 was compiled to illustrate the interplay between development, conservation and sense of place. It is aligned to MEA (2005), that stipulates that should the ecosystem functions not be understood and supported in the context of continuous urban development pressures, the protection of urban greenspace could be regarded as a barrier to achieving development goals and meeting human needs.

Conservation efforts are important for sustainable development on a hierarchy of scales, ranging from the study area, namely the Rietvlei Nature Reserve, to global environmental concerns such as urban heat islands and biodiversity loss (Sutherland *et al*, 2019). The worldwide decline in biodiversity is of growing concern as humans are destroying the natural environment on which they depend for their resources and for sustaining livelihoods (Svenning, 2018; Carson, 1962). It is in

this context that the South African National Biodiversity Assessment must be viewed in an attempt to protect and extend the identified protected area network (SANBI, 2019).

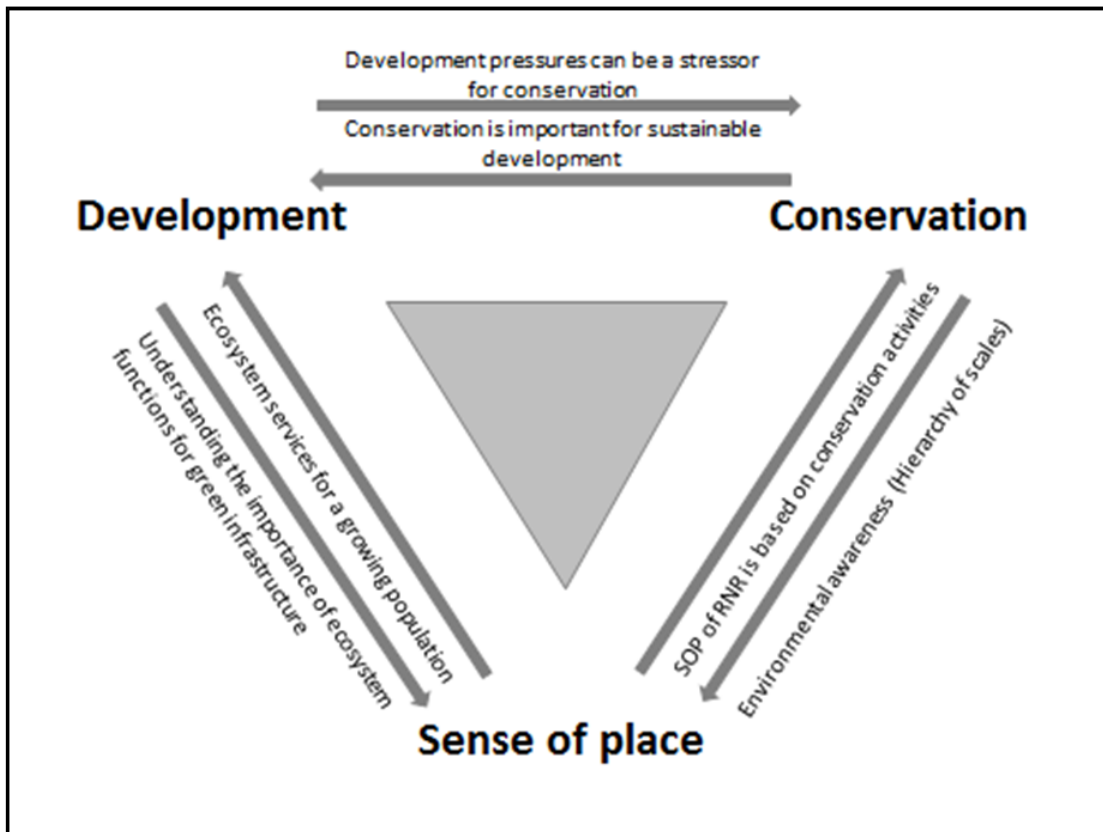


Figure 6.2: The researcher's interpretation of the interplay between urban development, conservation and sense of place for the Rietvlei Nature Reserve

Conservation activities and environmental awareness are closely linked to sense of place (Figure 6.2). Worldwide, development is changing the biosphere and the ecological life-support systems, such as clean water, fertile soils and biodiversity on which humans depend (Kremer *et al*, 2016; Diaz *et al*, 2006). However, this is also true of the character of particular places on the local level that people are connected to and care for, as is the case with the Rietvlei Nature Reserve and the interest groups and visitors associated with it.

6.3.1 Implications and challenges of urban development

The first objective of this thesis was addressed in Chapter 4. An attempt was made in this chapter to map and assess the implications and challenges of urban growth and development and the ongoing changes to the surrounding land-use mosaic for the conservation of the Rietvlei Nature Reserve as a prominent urban greenspace within the Tshwane Metropolitan Area.

It was argued that urban development and land-use changes have placed and will continue to place development pressures on this defined urban greenspace and present it with serious challenges. The Reserve used to be outside of the city, but ongoing urban encroachment trends are placing it under threat from these escalating development pressures. This is not only in terms of the spatial pattern of the growing cities of Tshwane and Ekurhuleni and the infrastructural development in the surrounding area. It is also in terms of the expectations of the Tshwane Metropolitan Municipality and residents, and the demands made on the the Reserve in providing water to the Tshwane Metropolitan Municipality.

In fact, the City of Tshwane has prioritised the improvement of service levels to the growing population. An example in point would be its formalisation of the rapidly-growing informal settlements and the improvements that it has implemented in, amongst others, allowing households access to water and sanitation connections, which have been listed as high-level priorities in Tshwane's Integrated Development Plan (IDP) (City of Tshwane Metropolitan Municipality, 2019).

The importance of protecting wetlands for the sustainable supply of water to the city has also been acknowledged by the Tshwane Metropolitan Council in Strategic

Pillar 3 of the IDP where the stated objective is: '[t]o deliver excellent services and protect the environment' (City of Tshwane Metropolitan Municipality, 2019:71). It can therefore be concluded that environmental conservation, as in the case of the Rietvlei Nature Reserve, is in support of improved service delivery to the residents of Tshwane, rather than in opposition to it.

Urban spatial development is directed by the Municipality via a hierarchy of spatial development planning frameworks. Some of the implications of the measures stipulated in these frameworks, as indicated in Chapter 4, have been the development of roads, as well as infrastructures for the provisioning of water, sanitation and electricity.

Yet another aspect of urban development that the Municipality has to deal with and that significantly affects the Rietvlei Reserve is the question of urban sprawl. As a result of the availability of open space on the periphery of Tshwane - in this case in the area adjacent to the Reserve - itself on the urban fringe - there has been an upsurge in opportunities to exploit the space, thus resulting in urban sprawl. This is an ongoing phenomenon, intensifying over time, and in tandem with development pressure. This aspect, if not efficiently managed, could become a potential stressor for the conservation area and sense-of-place experiences offered by the Reserve.

6.3.2 Implications and challenges of conservation and sense of place of the Rietvlei Nature Reserve

In the Rietvlei Nature Reserve, sense of place, in terms of form (e.g. buildings, camp sites, fences, bird hides, water treatment plant, grasslands and wetlands), activity and function (e.g. recreational activities, nature conservation) and image

(sense of place, perceptions and experiences) as derived from Montgomery (1998), is largely a response to conservation and nature-based experiences. (Colley & Craig, 2019; French, 2010; Vaske *et al*, 2011). In fact, the association between spatial structures, meanings and experiences is important in the context of sense of place (Sebastien, 2020).

Photographers play an important role in supporting the image of Rietvlei as a nature-based destination as they do not often include aspects of human-altered landscapes in their images of wildlife (Goodlet, 2017). This is a deliberate attempt to represent the natural environment despite the changing surrounding landscape. Urban development has already led to visible alterations of the landscape surrounding the Rietvlei Nature Reserve and these could continue to alter the sense-of-place experiences of visitors to the Reserve and interest groups. The public is not allowed into the water purification plant and visitors are not necessarily aware of the increasing importance of the water provisioning function of the Reserve.

The Rietvlei Nature Reserve was proclaimed in 1935 around the Rietvlei Water Scheme in order to support water provisioning to the then city of Pretoria (Marais 2015). As such, the ecosystem functions that it has been rendering over the past decades are clearly reflected in the features of this greenspace. In fact, this greenspace provides a buffer zone around the two dams, the water purification plant, and the fountains, all indicators of its water-provisioning function. Furthermore, because it was proclaimed a Nature Reserve, it reflects all of the properties and regulations associated with a protected conservation area.

The conservation area covers 4 000 Ha (40 km²) and consists mainly of grasslands and wetlands, with a limited area occupied by peatland (Marais, 2015; Marais, 2004). In fact, Rietvlei is one of only a few conservation areas that protects the Bankenveld Grassland biome (Fisher, 2017; Sieben *et al*, 2017; Nkambule *et al*, 2016; Carbutt & Martindale, 2014; SANBI, 2013; Marais, 2004).

The green infrastructural role of wetlands, peatlands and grasslands for water provisioning is widely acknowledged (McKay *et al*, 2018; Dickens *et al*, 2003). Therefore, owing to their potential role in supporting the water purification process before the water enters the Rietvlei Dam, the peatlands on Witkoppies Farm were restored and incorporated into the Rietvlei Nature Reserve in the 1980s (Gründling, 2004). (Chapter 4: Section 4.3; Figure 4.2)

The interplay between development, conservation and sense of place is evident in the electricity network running through a section of the Rietvlei Nature Reserve. From a development perspective, the servitude function is important as it supports the provision of electricity to the growing population living in the surrounding urban areas. The electricity network running through the Reserve thus benefits residents of the Tshwane Metropolitan Area who may never visit the Reserve or use its recreational facilities. However, the presence of electricity lines through the conservation area was indicated by some visitors as lacking in aesthetics and as having a severely negative visual impact for those wishing to escape from the city. The electricity network is a highly visible feature on the landscape of the Reserve and very little can be done to mitigate the negative impact that this network is having on the sense-of-place experiences of visitors to the Reserve (Figure 6.3).



Figure 6.3: The interplay between development, conservation and sense of place illustrated in the image of buffalo below power lines in Rietvlei Nature Reserve (Tshwane)

Johann Perie 2019 (reproduced with permission)

Another negative factor related to the power lines running through the Reserve is the danger that they pose to the wildlife. A rhino and her calf, and a zebra, were electrocuted in the Rietvlei Nature Reserve on Friday, 15 November, 2019, when an electricity pylon collapsed (Maromo, 2019). One of the legs of the pylon had been damaged, most probably in a veld fire that had occurred two weeks prior to this incident, and nobody had realised the extent of the damage. Since the tragedy, the wires have been repaired and all of the pylons in the Reserve have been inspected for further damage. In addition to the inspection and monitoring work normally done by Eskom, a service number was subsequently provided for members of the public to phone in to report such damage to this network. Thus,

continuous monitoring and maintenance of the electricity network is important for sustained electricity provisioning to the City of Tshwane and to prevent any incidents that would harm the endangered animals in the Reserve. This incident again stressed the importance of proper management and conservation efforts to maintain a sustainable interplay between development, conservation and sense of place.

Another problem facing the Rietvlei Nature Reserve is of an administrative and legal nature. The Reserve was proclaimed as a conservation area at the Gauteng provincial level and is, as such, acknowledged in the Gauteng Conservation Plan (Gauteng Department of Agriculture and Rural Development, 2014). However, the fact that the largest portion of the catchment of the Rietvlei Dam falls within the Ekurhuleni Metropolitan Municipality's area of jurisdiction, but that the Rietvlei Nature Reserve belongs to the Tshwane Metropolitan Municipality, does indeed have important implications for the sustainable management of this urban greenspace. Greater and more appropriate coordination between the Tshwane Metropolitan Municipality and the Ekurhuleni Metropolitan Municipality is therefore a critical factor.

This issue was again highlighted by the different forums that were approached and interviewed. Thus, the implementation of the conservation strategies for this greenspace should be treated as a joint responsibility of government, management at the Reserve, stakeholders, such as Friends of Rietvlei (WESSA), Honorary Rangers (SANParks), Birders and Photographers, and participants in the Hennops Catchment Forum. Better coordination across the respective subnational planning

levels of government, as well as with various stakeholders, is therefore important (Grunewald *et al*, 2018).

When the Reserve is considered as a conservation area, and a greenspace with humans interacting with the environment, sense of place and environmental awareness come to the fore as relevant aspects since both have to do with how people “see” or perceive the environment. These two aspects play an important role then when it comes to encouraging the authorities to engage in programmes to enhance the benefits and functions of the Reserve, but also to take cognisance of factors, known as potential stressors, that might negatively impact on its functioning and to then take action to remedy the situation.

In the following sub section the functions, services and benefits, as well as the risks and stressors prevailing at the Rietvlei Nature Reserve are evaluated in order to feed them into the proposed Greenspace Stress Model for the Reserve.

6.4 Evaluation of the critical greenspace functions and services of the Rietvlei Nature Reserve

For the purposes of this research, the ecosystem services and functions of the Rietvlei Nature Reserve were evaluated in order to inform the development of an adapted Greenspace Stress Model of Urban Impact. The Ecological Management Plan for Rietvlei Nature Reserve (Marais, 2015) and the functions of the Reserve were therefore linked to the ecosystem services of urban greenspace that are required to promote human quality of life in the city (Haase *et al*, 2019; Kremer *et al*, 2016). This was done by triangulating data on the functions and benefits of the Rietvlei Nature Reserve that were gleaned from multiple sources, including observational notes, responses to interviews, and information that emerged from

focus group discussions conducted with interest groups. The themes identified through the group discussions were confirmed from the researcher's own personal observations and from face-to-face interviews with the selected respondents.

The objectives specified in the official Ecological Management Plan of the Rietvlei Nature Reserve (Marais, 2015) were evaluated through semi-structured interviews with 16 selected key informants individually. Key informants from development, conservation and sense-of-place perspectives were interviewed to ensure adequate representation from the three different perspectives. The benefits of the Rietvlei Nature Reserve were also identified in these semi-structured interviews, as well as again in the on-site interviews with visitors to the Reserve and also in the research group discussions (Chapter 5).

The outcome of the ranking of the objectives by the key informants of the Rietvlei Nature Reserve, as specified in the EMP (Marais, 2015), emphasised the importance of the water-provisioning function of the Reserve. In fact, it was ranked as the most important objective for the management of the Reserve.

Urban development, in tandem with the associated increase in the demand for water implies that all water sources should be protected and managed in order to remain reliable. The conservation of the green infrastructure that supports water provisioning in the Rietvlei Nature Reserve is therefore important. In fact, this function was ranked as most important in the semi-structured interviews, and its importance was again confirmed in the discussions with the interest groups. On the other hand, however, it is important to note that visitors to the Reserve were

not necessarily aware of the importance of the water-provisioning function of the Rietvlei Nature Reserve.

Not all of the functions of the Rietvlei Nature Reserve were included in the objectives of the EMP (Marais, 2015). The servitude for electricity provision, for example, was not indicated as an objective. Nor, according to the responses to the semi-structured interviews, was this perceived as an important function of the Reserve (Chapter 5). However, according to the researcher's observations, the Reserve does in fact perform an important function in providing energy to a growing urban population and a rapidly expanding urban region.

The second ranked objective was to protect and conserve a fragment of the natural environment around the city, and thereby keep it in a relatively pristine state. This is an important objective within the broader environmental concerns and the sustainability context of this urban greenspace. The objectives to conserve genetic diversity and curb the loss of species (the fifth ranked objective) and to make game available for relocation (the sixth ranked objective), were thus grouped together as the conservation function of the Reserve. Thus, by conserving a fragment of the natural environment, it is possible to concomitantly promote the conservation of genetic diversity and to curb the loss of species (Pearson, 2016).

As reported in Chapter 5, on-site face-to-face interviews were conducted with 181 visitors to the Rietvlei Nature Reserve. During the face-to-face interviews, it was established that many of the visitors do not have any emotional connection with the Rietvlei Nature Reserve. Different perceptions of the Reserve were established

from the responses of the visitors to the conservation area as opposed to those of visitors to the camping and fishing and the Pretoria Sailing Club areas.

Since certain interest groups were also identified in the interviews, a decision was made to conduct focused group discussions, as reported in Chapter 5, with representatives from the Honorary Rangers, Friends of Rietvlei, Birders and Photographers in order to obtain specific information on their respective activities in the Reserve. It was therefore during the fieldwork phase of the research that different approaches that clearly reflected on the theoretical debates on why this particular urban greenspace should be conserved were identified (Pearson, 2016; Piccolo, 2017).

Recreation is an important function of the Rietvlei Nature Reserve. This is not only because it offers a possible source of income to the City of Tshwane, but also because it promotes the physical and psychological health of humans in an urban context (Li, 2020; Mayer-Grandbastien *et al*, 2020; de Crom & Nealer, 2017). The opportunity to escape from the city to an area in close proximity to it was mentioned as a benefit in all of the groups interviewed.

The Rietvlei Nature Reserve provides a setting for nature-based activities, and different areas in the Reserve offer different types of facilities, depending on the specific functions that it performs. The clubhouse and facilities of the Pretoria Sailing Club were designed and built according to the requirements of the aquatic activities here. The strip along the eastern shore of the Rietvlei Dam is the only area in the Reserve where camping is allowed, so that the facilities and amenities there were developed for this purpose. The ablution blocks at the picnic areas, as

well as the overnight hiking hut and Jakkalsden, were designed with thatched roofs in a style similar to that of the rondawels in the rest camps of the Kruger National Park (Barendse *et al*, 2016; Reader's Digest, 1990). This aspect is important for the nature-based recreation and tourism destination image and sense of place experience of the conservation area (Hausman *et al*, 2015; Stobbelaar & Pedroli, 2011; Farnum *et al*, 2005; Stedman, 2003).

Holistically speaking, the functions and characteristics of this conservation-focused greenspace have in fact influenced the evaluation of its accessibility. Had the Rietvlei Nature Reserve been classified as a neighbourhood park, this greenspace would not have been considered accessible. According to the neighbourhood planning and design guidelines (Department of Human Settlements, 2019), a neighbourhood park should be within walking distance of a community. However, visitors to the Rietvlei Nature Reserve cannot access the birding hides, camping and fishing or picnic areas on foot, and yet accessibility was rated as a benefit associated with this greenspace. The availability of a large conservation area with a variety of game species in proximity to the city makes it accessible to people who would otherwise not have been able to visit wildlife areas such as the Pilanesberg or the Kruger National Park for a wilderness-type of experience (Reader's Digest, 1990). Proximity to the city was also indicated as a benefit in the training of the Honorary Rangers and nature conservation students who need to accumulate a specified number of service hours over a work-integrated learning period for the practical component of their qualification.

The specific characteristics and functions of the Rietvlei Nature Reserve collectively contribute to the psychological benefits experienced by visitors to the

Reserve (Wood *et al.*, 2018). Social connections were identified between the Friends of Rietvlei, as well as between the Honorary Rangers, Birders, Photographers, and members of the Pretoria Sailing Club. These groups are not mutually exclusive but perform specific functions within the Reserve and they and the general public visiting the park derive certain benefits from their activities here (Friends of Rietvlei, 2017; Pretoria Sailing Club, 2017; Pretoria Sailing Club 2013). The Reserve also functions amongst others as a meeting place for people with common interests, not least of all in that it provides platforms for social interaction through the *ad hoc* social gatherings that are held at the Rietvlei Coffee Shop and the Facebook groups.

The Birders and Photographers are not closed membership groups like the Pretoria Sailing Club, but rather constitute informal groupings that share a common interest. The Birders are attracted because the Rietvlei Nature Reserve has been acknowledged as a birding hotspot in Gauteng (Marais & Peacock, 2016). Furthermore, the wetlands favour habitat and nesting conditions, which definitely impact on the variety of bird species present (McKay *et al.*, 2018; Callaghan *et al.*, 2018).

The facilities and amenities offered by the Reserve are very important to the Pretoria Sailing Club. There are very few aquatic recreational areas available in Tshwane, and the Rietvlei Dam is a relatively clean dam for paddling and sailing.

On the other hand, the Honorary Rangers who participated in the discussions did not regard the facilities and amenities as a very important benefit of the Reserve

as they indicated that the condition of the animals and veld was a far more important issue than the facilities for humans.

The features of the landscape were mentioned as a benefit of the Reserve by Friends of Rietvlei, Birders and Photographers, and the Pretoria Sailing Club, but not by the Honorary Rangers. As indicated in Chapter 5, the Honorary Rangers are committed to a broader environmental concern for nature conservation and not merely the specific features of the Rietvlei Nature Reserve. The sentiment that the conservation of the rhinos should not be used as a vehicle for making money was also expressed by an honorary ranger in a semi-structured interview. This response reflects on an approach that nature conservation should be practised for the purpose of protecting biodiversity rather than for the benefit of people. Thus, the question posed by Marvier and Kareiva (2014: 281) that "...if it is a moral dilemma to allow [the] extinction of species, why do we motivate conservation for the benefit of people?" was also endorsed by some stakeholders in the Rietvlei Nature Reserve.

Green infrastructure, drainage and flood mitigation were identified as benefits of the Rietvlei Nature Reserve during Friends of Rietvlei and Pretoria Sailing Club discussions. These groups showed awareness of the supporting ecosystem functions which are not part of the recreational product offered by the Reserve. On the other hand, visitors tend to be more aware of the provisioning and cultural ecosystem services of the Rietvlei Nature Reserve as they are visible and directly linked to human needs. Furthermore, the research confirmed that visitors from the general public do not necessarily have any background knowledge on the relative

scarcity of peatlands; environmental processes and their importance for sustainability (Gründling *et al*, 2017).

Some of the value attached to an urban greenspace is indirect, not related to its use and also not revenue-specific. According to the literature, the holding of different perceptions in terms of the value of ecosystem services has proved to be challenging, especially in the global South (Osorio Guzmán *et al*, 2020; du Toit *et al*, 2018). These are important considerations when it comes to making decisions on the future of conservation areas as urban greenspaces. Furthermore, there have also been differences in the evaluation of the importance of an urban conservation area in that it could also be considered to be a stressor (e.g. a drain on the municipal budget, as in the case of the Rietvlei Nature Reserve).

Employment was rated as a very important ecosystem benefit by the employees at the Rietvlei Nature Reserve. However, the research showed that there were generally only limited opportunities for work in the Reserve. Moreover, the specialised type of employment opportunity is beneficial to a specific niche market in conservation, environmental education, recreation, maintenance and water provisioning. Much of the work carried out in the Reserve is actually done by interns and volunteers rather than by those in formal employment. This clarifies the low ranking of employment as benefit in the Reserve (Table 6.1). The formation of partnerships should therefore be a very important issue in promoting the sustainable functions of the Rietvlei Nature Reserve.

The previous chapter confirmed that connections and linkages are important benefits emanating from the conservation programme in practice at the Rietvlei

Nature Reserve. The Endangered Wildlife Trust's cheetah-breeding project is such an example. It bears testimony to the international role that the Rietvlei Nature Reserve has played in conservation and in enlarging the gene pool of the cheetah (Buk *et al* 2018). Furthermore, the availability of blesbuck in the Reserve has also been an important factor in the success of this project as these animals provide an adequate source of food for the cheetahs to hunt. This project is supporting tourism and enhancing opportunities for environmental education, research and monitoring. The presence of cheetahs in the Rietvlei Nature Reserve has also positively influenced the sense-of-place experience and has therefore enhanced the tourism-destination image of the Reserve (Chapter 5).

The identified benefits based on conservation are related to the experience of visitors to the Reserve and their use of the facilities at hand. However, the collective benefits of the green infrastructure in terms of drainage and flood mitigation, water provisioning, its servitude for electricity, as well as the economic opportunities that it offers, are rather beneficial to the growing urban population which does not necessarily make use of or access the Reserve.

The fact that a final meeting of the focus group members evaluated the identified benefits of the Reserve as critical factors emanating from this conservation area, justified their inclusion as inputs into the Greenspace Stress Model of Urban Impact for the Rietvlei Nature Reserve, which is discussed in the next section.

6.5 Building a Greenspace Stress Model of Urban Impact for the Rietvlei Nature Reserve

Throughout this thesis, reference has been made to a variety of components from four models developed specifically for the global North, but which have had the

potential of being harnessed to assist the researcher in developing a Greenspace Stress Model of Urban Impact for the Rietvlei Nature Reserve. These adapted models would then have an added advantage in that they could be applied to other urban greenspaces in the global South.

In summary, the aspects of these models that were considered relevant to the Greenspace Stress Model and therefore to be incorporated into it, are listed below:

- The Stress Model of Urban Impact (Pacione, 2001) served to inform the outline of the Greenspace Stress Model of Urban Impact. Pacione emphasised the importance of environmental perception and the relevant strategies to cope with environmental stressors in an urban context. For the purposes of this thesis, the study object was urban greenspace and the human perceptions pertaining to the associated benefits and stressors issuing from it.
- The model devised by Montgomery (1998) covers the components of a place and sense of place, which were found to be relevant in the Rietvlei Nature Reserve, since sense of place is linked to the environment, perceptions of the environment and conservation initiatives. As such, aspects of Montgomery's model were adapted and incorporated into the Greenspace Model of Urban Impact, which also includes environment as an important aspect of sense of place.
- Haase and Rink's model (2014) presents the nexus between urban shrinkage, ecosystem services and quality of life. For the purposes of this research, this model was adapted to the global South, where urban change involves growth and development rather than shrinkage, and as such, elements of it could be incorporated in the Greenspace Model of Urban Impact (Section 6.5.1)

- The various stressors identified in the context of the Rietvlei Nature Reserve could influence its sustainability. It was therefore important to link the life cycle model of Butler (1980) to the Greenspace Stress Model of Urban Impact in order to demonstrate how management decisions could influence different scenarios in the balance between development, conservation and sense of place.

6.5.1 The link between urban change, ecosystem functions and quality of life as applied to the Rietvlei Nature Reserve

Haase and Rink (2014) established the link between urban shrinkage, ecosystem functions and quality of life. The ecosystem services of fresh air, biodiversity, the cooling of the urban heat island effect, water filtration, carbon sequestration, recreation and aesthetic values are all beneficial ecosystem functions relevant to urban greenspaces in different urban contexts (MEA, 2015), generally adding to the quality of human life. However, the ecosystem services required for improving human quality of life can be sustainable only when critical ecosystem functions are protected or restored (du Plessis, 2019; Haase & Rink, 2014). These range from the global scale down to the local scale (in this context, the Rietvlei Nature Reserve, where they were found to be significant components that could be incorporated into the Greenspace Model of Urban Impact).

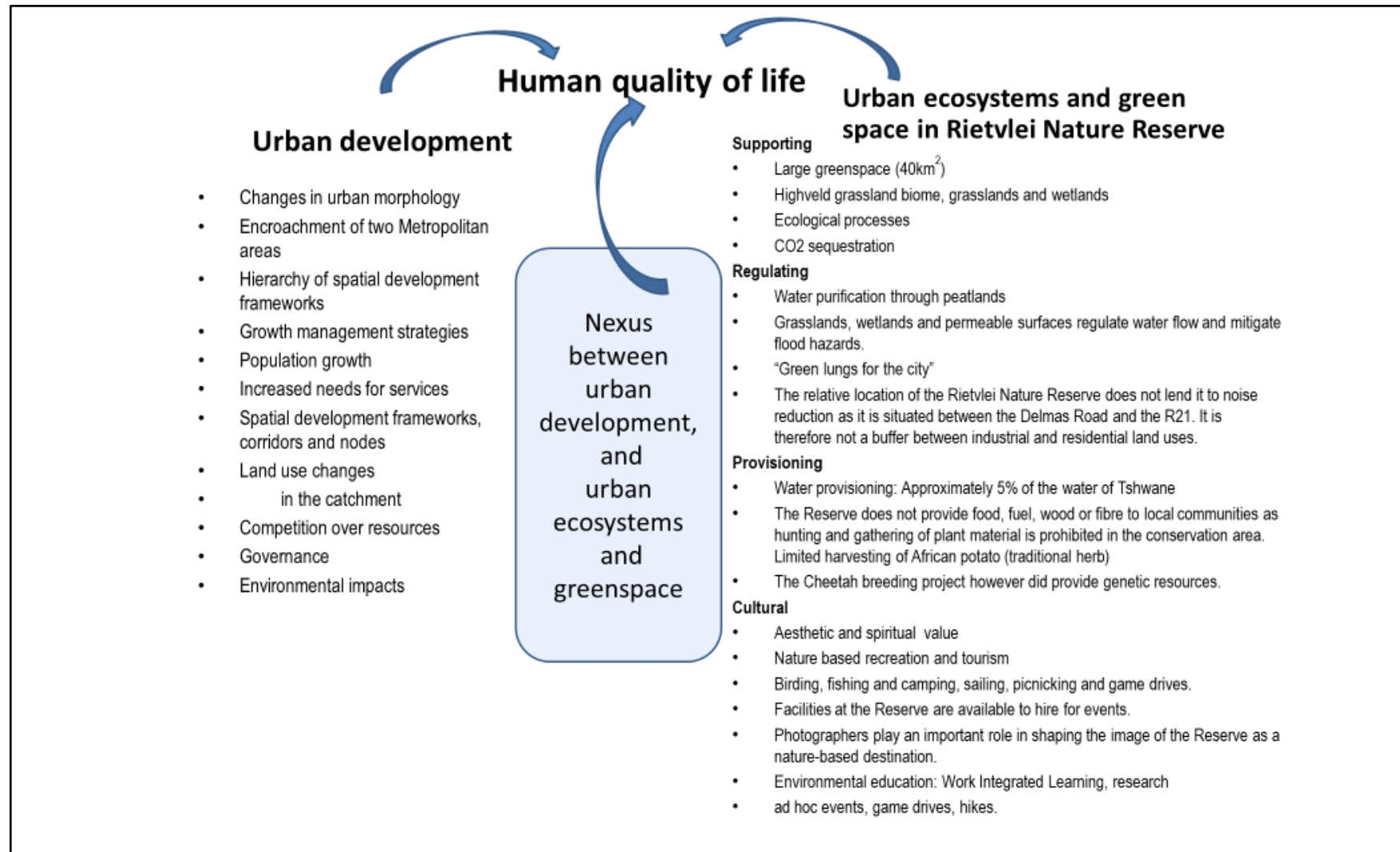
It became clear from this research study that the protection and restoration of ecosystem functions, which are required for ecosystem services are as important in a context of urban growth (e.g. the case in the global South) as in a context of urban shrinkage and degradation (e.g. the case in the global North). Based on the information presented in Chapters 4 and 5, the model presented by Haase and

Rink (2014) was therefore adapted within the context of a global South greenspace perspective (Figure 6.4).

In the context of the global South, and on the local level, in respect of the Rietvlei Nature Reserve, continuous *urban growth and development*, resulting from amongst others population growth and rural-urban migration, have led to changing landscapes, formal and informal settlements, and increased demands for a variety of services (Hamann *et al*, 2018; City of Tshwane, 2018/2019). The environmental impacts of these changes have in their turn placed pressure on the Rietvlei Nature Reserve, *a conservation area* with its own unique physical characteristics and *ecosystem functions* (the objective view) that have in their turn influenced people's *perceptions* and responses to the environment (subjective view – *sense of place*) and expectations from the urban greenspace to meet their needs (ecosystem services). The links between urban development, ecosystem services and human quality of life are presented in Figure 6.4³. This figure was adapted from Haase and Rink (2014) who showed the nexus between urban shrinkage, ecosystem services and quality of life in the global North. In the context of Rietvlei Nature Reserve urban change is growth development rather than shrinkage.

This nexus was further adapted to show the interplay between development, conservation and sense of place (Figure 6.5). This was evident because the conservation of ecosystem functions is important for ecosystem services.

³ The links between urban change (growth or shrinkage), ecosystem services (functions/benefits) and human quality of life are relevant in both the global North and global South scenarios.



**Figure 6.4: The nexus between urban change ecosystem services from Rietvlei Nature Reserve and quality of life
Adapted from Haase and Rink (2014) and Figure 2.2**

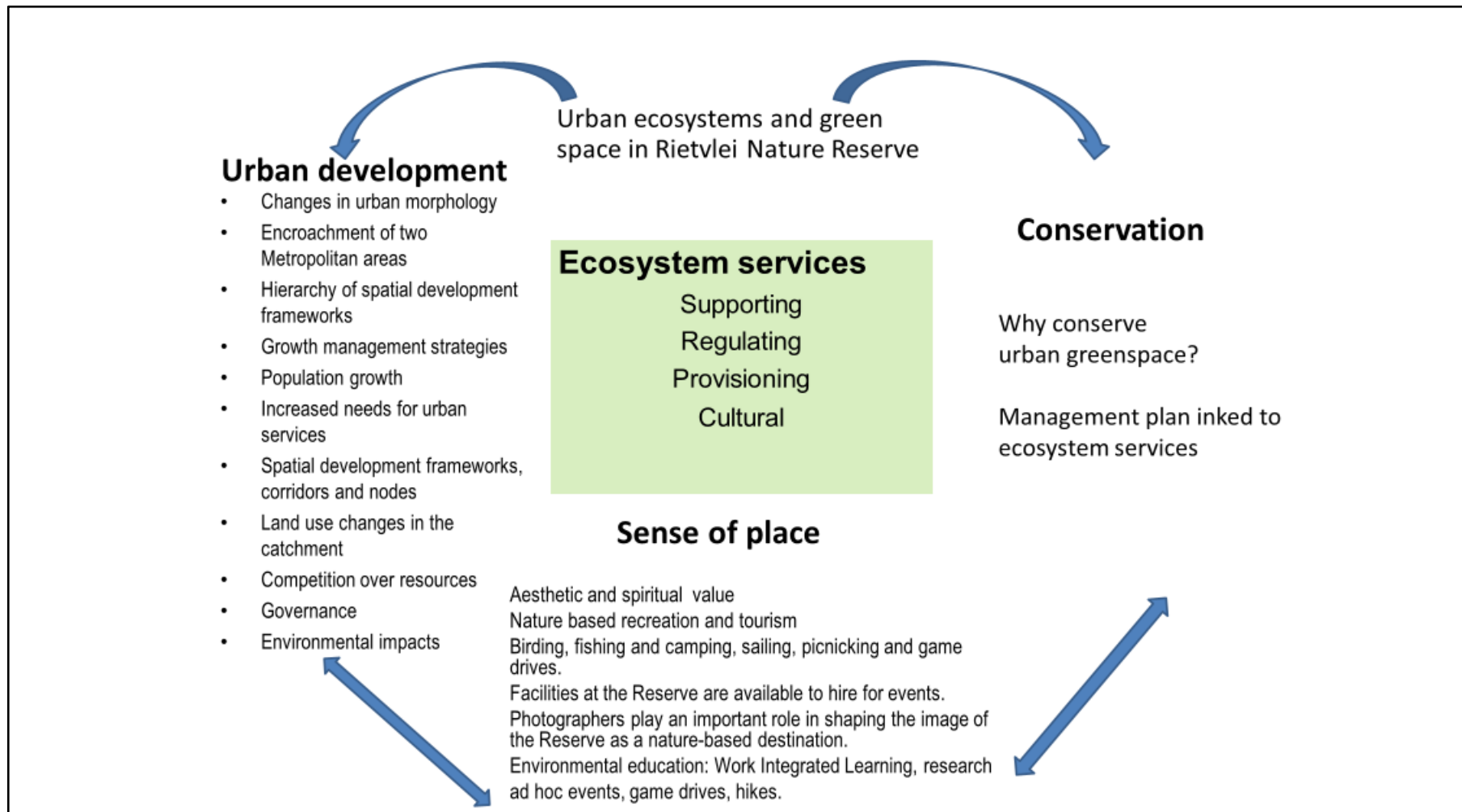


Figure 6.5: Ecosystem services in the interplay between urban growth and development, conservation and sense of place
(Source: Author 2020)

Urban development leads to increased demands for ecosystem services such as water provisioning and at the same time trigger land use changes which may negatively impact on ecosystem functions. Conservation and protecting ecosystem functions are therefore important. Knowledge and environmental awareness of ecosystem services are therefore central in the interplay between development, conservation and sense of place.

Whenever the balance between development, conservation and sense of place is disturbed, the environmental stressors that would then emerge would negatively impact on the functioning of the Reserve. In the case of the Rietvlei Nature Reserve, water provisioning to the City of Tshwane, was identified as an important benefit of the Reserve (Figures 6.4 and 6.5), while the ecosystem functions of the wetlands and groundwater aquifers were found to be necessary components in the natural water purification process.

Currently, the functions which the Rietvlei ecosystem performs are in fact essential to its water-provisioning system. Already, changes to the land use and land cover in the catchment area of the Reserve have led to critical changes in water flow and quality and the situation should be carefully monitored (Environmental Impact Management Services (Pty) Ltd, 2019).

In the light of the above-mentioned facts, environmental awareness and appropriate environmental management practices are therefore important for the protection of the sustainable water-provisioning services and ecosystem functions that the Rietvlei Nature Reserve renders. Because decisions on development and conservation are influenced by the way in which ecosystem services are

understood and the sense-of-place experience of the greenspace in question, it is important that the public is informed about these issues.

6.5.2 Components of sense of place in the Rietvlei Nature Reserve

According to Montgomery (1998), sense of place and the strategies of place making are built around form, activities and image. The form component includes the physical characteristics of the Rietvlei Nature Reserve within the context of urban growth (Chapter 4). The spatial development and encroachment taking place in the urban areas adjacent to the Reserve, influences the form component of sense of place within the Reserve. The objectives of the Rietvlei Nature Reserve, as formulated in the Ecological Management Plan for the Reserve (Marais, 2015), promote the activity or functional component of sense of place. In fact, the activities in the Rietvlei Nature Reserve are mostly around recreation and conservation.

Although the research revealed that visitors to the Reserve experience different ways of connecting to the Reserve and also different levels of awareness of the environment and of the associated benefits and stressors experienced, the stressors identified in this research study were most often related to the specific activities and experiences of the visitor or interest groups (Figure 5.4). According to the findings presented in Chapter 5, the activities in the Rietvlei Nature Reserve are associated mainly with conservation. Figure 6.6 on page shows that the component, activity (function) is linked to conservation.

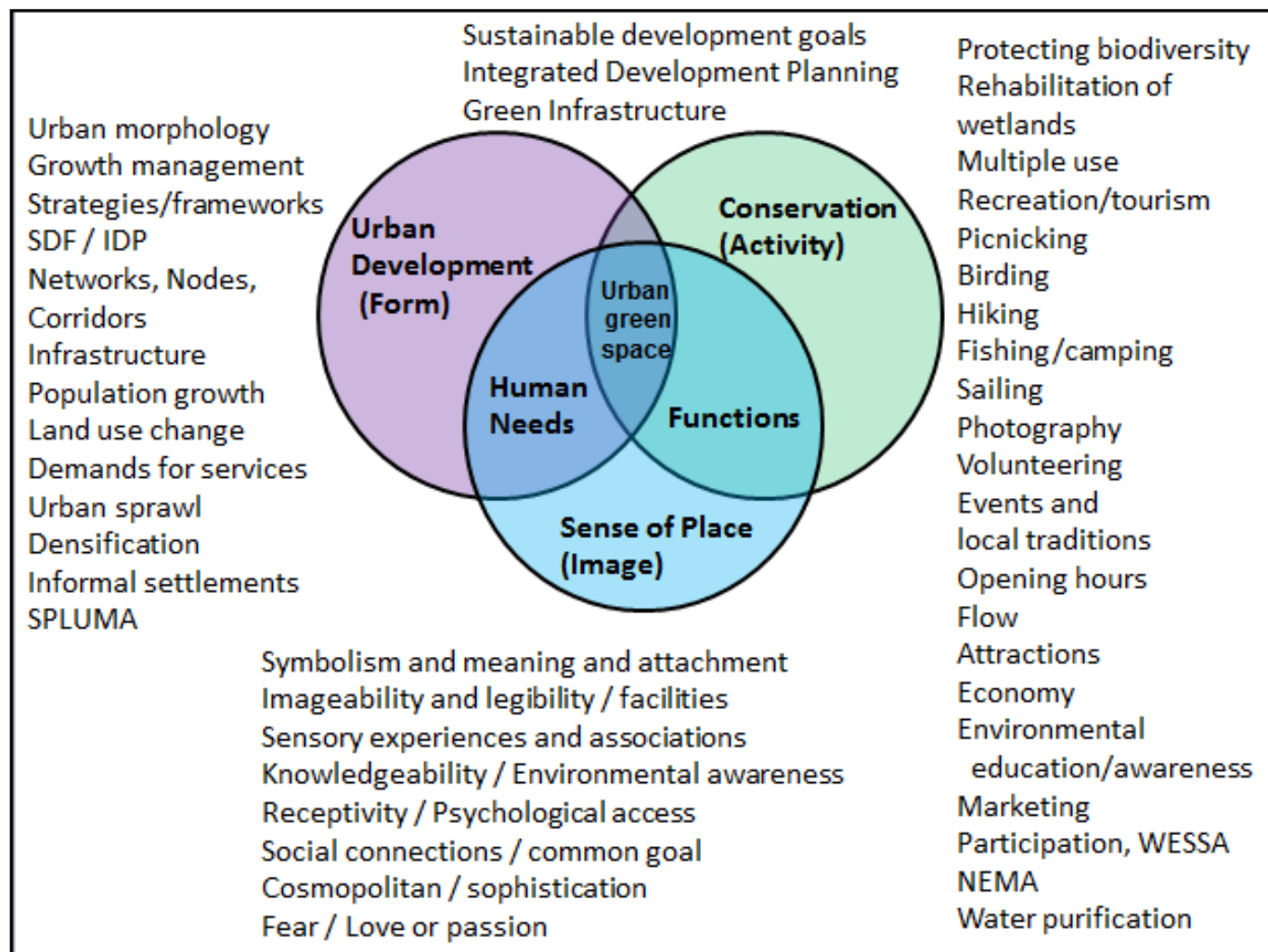


Figure 6.6: Sense of place in Rietvlei Nature Reserve as applied to an adapted model of Montgomery (1998)

Source: Adapted from Montgomery (1998)

Sense of place is related to the significance (meaning) attached to a place (Masterson *et al*, 2017) and since individuals tend to experience a situation differently and there may be errors in the identification and explanation of sources of stress, it need not be the same for everybody. As such, measures of perceived stress may be inaccurate. It is therefore important to evaluate not only the objective benchmarks of the environmental conditions that could cause stress (or pleasure, whatever the case may be), but also their perceived impacts (Pacione, 2009).

The association between physical or spatial structures (form) and experiences (activities, functions and perceptions) is important for sense of place (Sebastien, 2020; Montgomery, 1998). The image component of the Reserve as a conservation area and nature-based recreation destination is supported by not only photographs of birds and animals on social media, the design of the bird hides and fences, but also the signage in the Reserve and the climbing equipment in the children's play area at the Coffee Shop (form).

The social benefits associated with the Rietvlei Nature Reserve are closely aligned with activities (function), and were especially mentioned in the research group discussions with representatives from the Friends of Rietvlei, the Pretoria Sailing Club and the Birders and Wildlife Photographers, all of whom operate in social networks and cherish specific common goals.

Apart from the important aspects of form, function and image, as proffered by Montgomery (1998) in his concept of sense of place and place making, recent trends in the literature have shown an increasing focus on the environmental component of sense of place and place making (Ghavampour & Vale, 2019;

Ghoomi, 2015). In his adaptation of Montgomery's model, Ghoomi (2015) added an environmental component to form, activity and image that feeds into sense of place and place making.

As the environmental component was also considered to be important in the Rietvlei case study, it was also included in the adapted model presented in Figure 6.7. The activities (function) and sense of place associated with the Rietvlei Nature Reserve are especially focused around conservation and human-environment interactions.

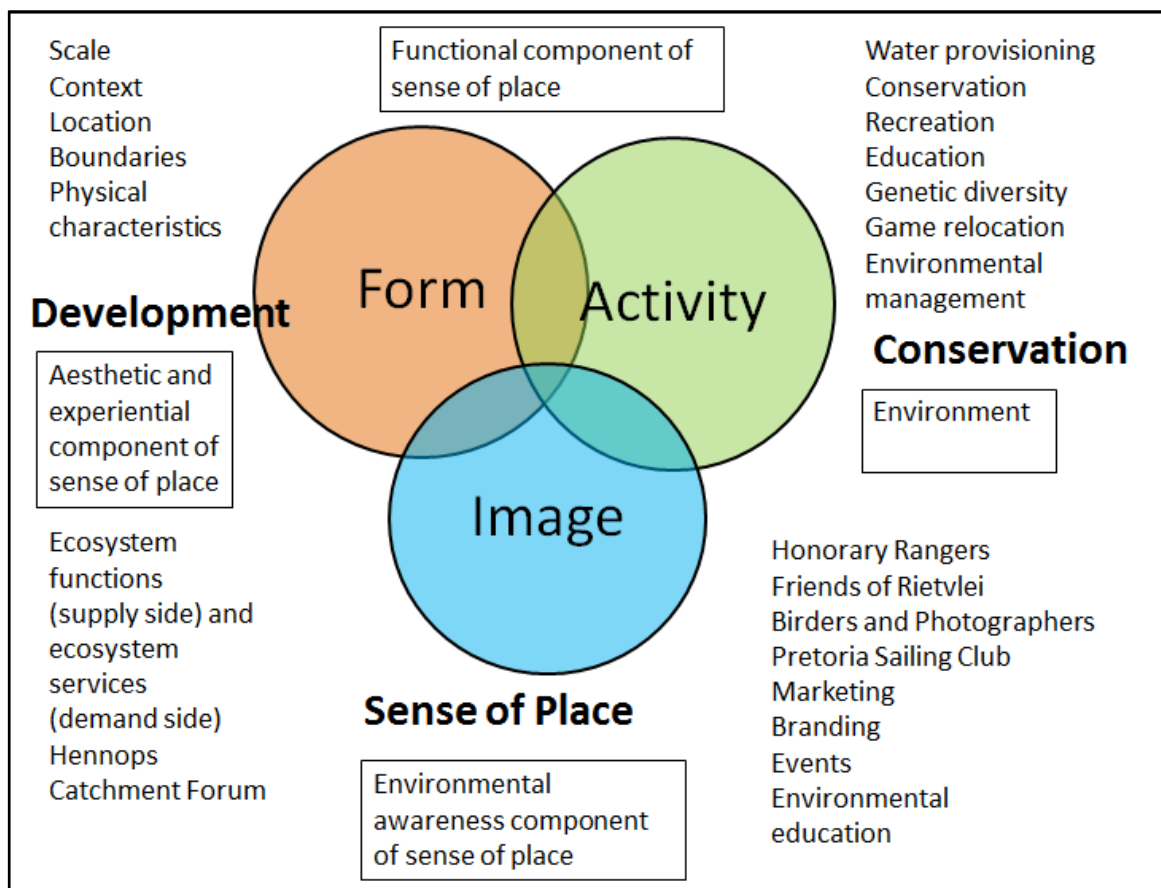


Figure 6.7: Sense of place in the Rietvlei Nature Reserve
(Adapted from Montgomery, 1998 and Ghoomi, 2015)

In order to retain the interplay between development, conservation and sense of place in the adapted model for the Rietvlei Nature Reserve, the order to the placing of the spheres was rotated and Urban Development was placed in the top left-hand corner of Figure 6.7. In its turn, Urban Development was linked to the Form component (Figure 6.7). On the other hand, Conservation was linked to the Ecosystem and Activity (Function) components, while Sense of Place was linked to the Ecosystem and Image components.

As mentioned before, whenever the balance between the three components, Development, Conservation and Sense of Place, is disturbed, environmental stressors could then negatively impact on the functioning of the greenspace and thus lead to environmental degradation, which could eventually also lead to changing perspectives among visitors or changes in their sense-of-place experiences of the Reserve (Figure 6.5).

6.5.3 Re-interpretation of the Tourist Area Life Cycle Model as management tool with reference to capacity and sustainability

The notion of a destination life cycle (Butler, 1980), albeit within a tourist area's life cycle (TALC), also informed the Greenspace Stress Model of Urban Impact as similar principles can be applied in urban green spaces. Adapted to the specific case study of the Rietvlei Reserve, the Butler (1980) model can be applied in the sense that demands on the Reserve and its exploitation could change the characteristics of the Reserve to a level that it is no longer functional. In the Rietvlei case, it is not the variable, visitor numbers, but rather the variable, expected ecosystem services to be gained from an urban greenspace, that is illustrated in the model (Figure 6.8).

In compliance with Butler's model, the degradation in the Reserve should be checked as long as the mitigation and restoration strategies are successful. If not, environmental degradation could lead to the collapse of the current functions of the site ("destination" in Butler's terms). The implementation of relevant strategies is therefore important to protect the functions of the Reserve, as well as the quality of the environment.

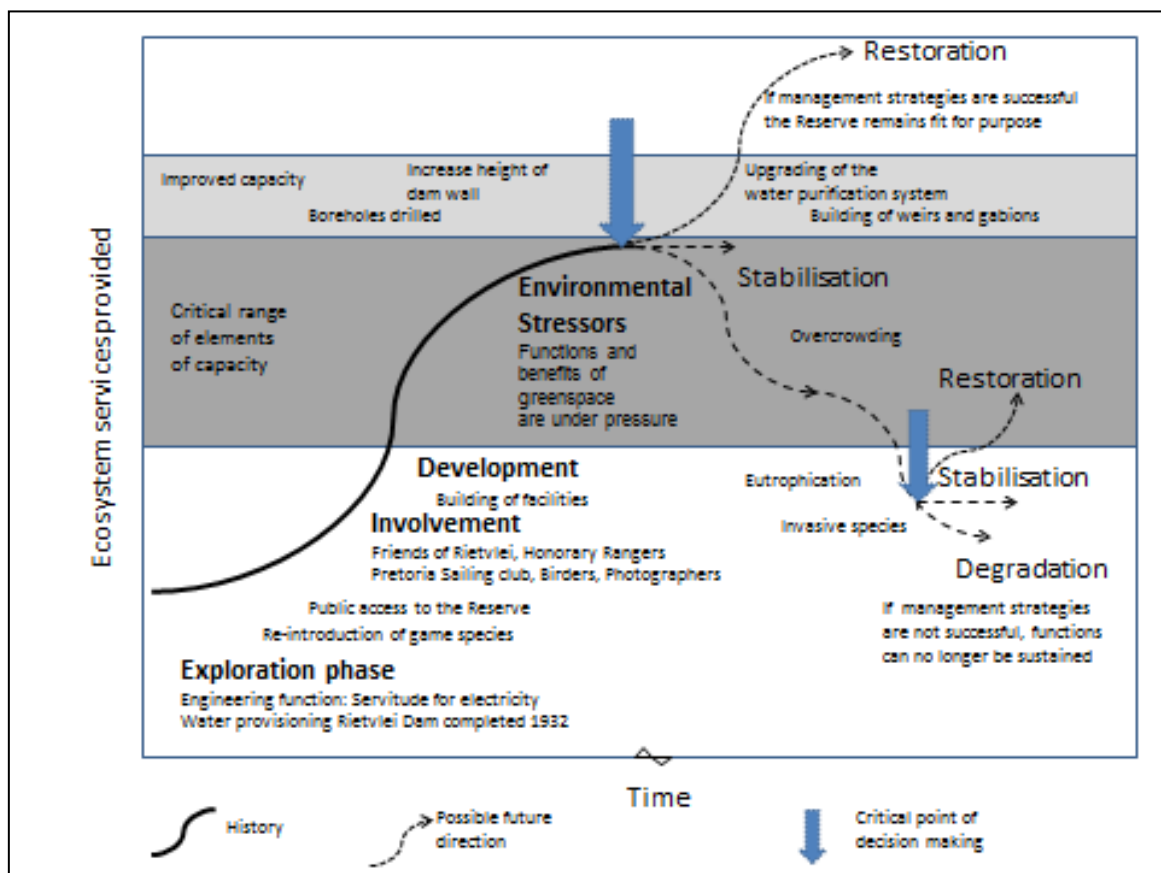


Figure 6.8: An adapted life cycle of ecosystem services from an urban greenspace, as applied to the Rietvlei Nature Reserve
Source: Adapted from Butler (1980)

The concept of carrying capacity and the importance of the successful implementation of appropriate mitigation strategies for each of the identified stressors in the Reserve remain relevant to the GSMUI as a management tool. In

the case of the Rietvlei Nature Reserve, environmental stressors would lead to a situation where the Reserve is no longer fit for its designated purpose, with negative implications for its sustainability. This would not only lead to a decline in the sense of place experience and conservation features of the Reserve, but also negatively impact on the ecosystem services, and more specifically water provisioning to the population of the City of Tshwane, biodiversity, and carbon sequestration in the peatlands of the Reserve.

In line with the TALC model (Butler, 1980), various scenarios, based on the evaluation of stressors and the success of the implementation of mitigation strategies, are probable. This model could be further refined for particular ecosystem services as the respective ecosystem services do not necessarily follow the same curve over time. This was not done in the case of the Rietvlei Nature Reserve, but it could be considered in future research.

Section 6.6 below explains how the research in the case of the Rietvlei Nature Reserve, as well as the selected models of Pacione (2001), Haase and Rink (2014), Montgomery (1998) and Butler (1980) feed into the Greenspace Stress Model of Urban Impact (GSMUI), which was developed for the Rietvlei Nature Reserve.

6.6 The Greenspace Stress Model of Urban Impact (GSMUI) for the Rietvlei Nature Reserve

The outcome of the research culminated in an attempt to develop a Greenspace Stress Model of Urban Impact, as represented in Figure 6.9. The general framework was adapted from Pacione (2001) and aspects from the other models were subsequently incorporated into it.

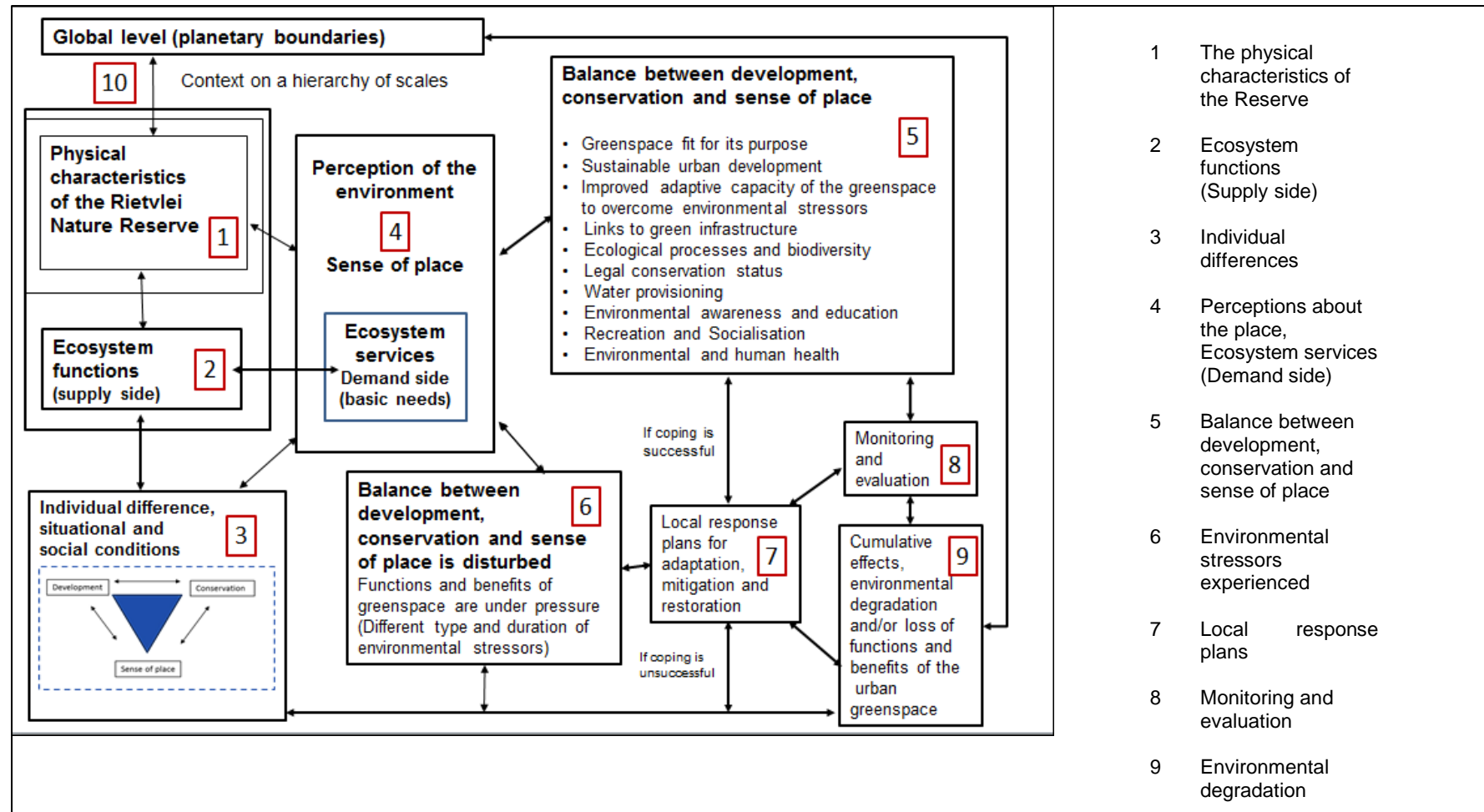


Figure 6.9: The Greenspace Stress Model of Urban Impact developed for the Rietvlei Nature Reserve

For ease of reference, the phases of the model are represented as numbered blocks in the model in Figure 6.9. These numbers are to be used when reference is made to the model in Section 6.6.1.

6.6.1 The physical characteristics of the Rietvlei Nature Reserve

The first phase of the model represents the input, objective physical conditions, feeding into environmental perception. Climate, population and pollution levels were mentioned by Pacione (2001) as such examples. In the case of the Rietvlei Nature Reserve, the demarcated size of the conservation area (40 km²); climate (Highveld, summer rainfall, dry winters with frost); terrain (open grassland with undulating hills); geology and soil (dolomite, lava soils and loam); hydrology (two dams, rivers and wetlands, groundwater); biome (Bankenveld Grassland, small patches of trees with associated fauna and flora); environmental quality; and the defined functions and management of the greenspace all collectively contribute to the physical characteristics of the Rietvlei Nature Reserve (Figure 6.9: Block 1).

As indicated in Chapters 4 and 5, the relative location of the Rietvlei Nature Reserve also has implications for the physical characteristics of the Reserve. The context of the case under investigation is therefore important. The built-up areas of both the cities of Tshwane and Ekurhuleni are expanding towards the Rietvlei Nature Reserve and, as such, the context of its location places increasing development pressure on the Reserve (Chapter 4).

The expansion in the capacity of the infrastructures for water and electricity provisioning, as well as in the road infrastructure, has implications for the Rietvlei Nature Reserve. Increasing demands for municipal service provision for the needs of

the growing population in the urban areas adjacent to the Reserve are generating development pressure (stressors) which is being exerted on the conservation area.

6.6.2 Reciprocal relationships between components

In his study of urban stress in the global North, Pacione (2001) reflects on the influence of the urban environment on the environmental perceptions of the individual in the city – a linkage in one direction (Figure 2.5). In the GSMUI, however, the linkages are representative of reciprocal relationships, as illustrated by the following:

The physical characteristics that influence perceptions of greenspaces reflect a linkage in one direction, but at the same time, the perceptions of the Reserve and sense of place also influence the physical characteristics of the Rietvlei Nature Reserve (Figure 6.9: Blocks 1 and 4f) – reflecting a linkage in the opposite direction.

As is evident from the history of the Rietvlei Nature Reserve (Chapter 4: Section 4.3), perceptions of the environment have over time led to several attempts to change the boundaries of the Reserve.

6.6.3 The importance of ecosystem functions and services

Ecosystem functions are an integral part of the characteristics of the Rietvlei Nature Reserve. They were therefore included in the model, their placing being between the physical characteristics of the Reserve and its societal and social aspects (Figure 6.9: Block 2).

The model of Haase and Rink (2014) informed this section of the model as ecosystem functions and services are linked to environmental perceptions. When this link is understood and it informs sense of place, conservation efforts will probably be

supported. In fact, the ecosystem functions performed by the Rietvlei Nature Reserve are important services required by the urban population.

The research clearly indicates that the Rietvlei Nature Reserve is not only a recreational space for people who can access it, but also important for providing green infrastructural services with the provision of water to the Tshwane Metropolitan Area apparently being of greater importance (Figure 6.9: Blocks 2 and 4).

The nexus between urban change, ecosystem services and quality of life was analysed by Haase and Rink (2014) (Figure 2.2). These authors emphasised the importance of restoring the ecosystem functions of empty urban spaces in order to support ecosystem services in shrinking cities in the global North. The nexus between urban change, ecosystem services and quality of life is also important in the global South, where the change involves urban growth and development rather than shrinking cities.

The ecosystem function is an extension of the physical characteristics of the urban greenspace and part of the supply side of service provision (Figure 6.9: Block 2). Perception of the environment is linked to ecosystem services since only the functions that are recognised as meeting human needs are regarded as ecosystem services (Figure 6.9: link between Block 2 and Block 4). However, despite the importance of ecosystem functions, the significance of a healthy ecosystem is not always understood, and there are different interpretations of the positive ecosystem functions (benefits) that the Rietvlei Nature Reserve offers.

According to Pacione (2001), individual differences, as well as situational and social conditions, influence environmental perceptions and the experiencing of stressors by individuals in the city. In the Greenspace Stress Model of Urban Impact, the influence

of individual experiences on individual perceptions of the urban environment (Pacione 2001) was replaced by the interplay between development, conservation and sense of place (Figure 6.9: Block 4). Thus, different perceptions and priorities emerged in the interplay between development, conservation and sense of place.

Decision makers working from a perspective that places human needs and the goals of urban development over the goals of nature conservation would rather exploit such greenspaces for development. Should the decision maker understand broader environmental concerns, such as global warming, loss of biodiversity, as well as the important role of wetlands for water purification, however, nature conservation could play a larger role in the sense of place experience and decision making on the conservation of the urban greenspace in question.

It was indicated in the previous chapters, that the local context is broader than the boundaries of the Rietvlei Nature Reserve and that there are strong indications that the development pressures facing the Reserve that were referred to in Chapter 4 would intensify in the future.

6.6.4 Different possible scenarios based on the interplay between development, conservation and sense of place

Pacione (2001) indicated that individual differences, situational and social conditions do indeed influence environmental perception and the way in which stressors are experienced (Figure 6.2). The interplay between development, conservation and sense of place was also included in Block 3 of Figure 6.9 as it also impacts on individual differences, situational and social conditions (Figure 6.2, Figure 6.5 and Figure 6.7). This influences the expectations that people have of a greenspace and how their needs are met (Figure 6.9: Blocks 3 and 4). Environmental perceptions and conservation are therefore placed within the broader context of urban development.

Sense of place is more than a tourism destination image (de Jager, 2010; Butler, 1980). An appreciation for and an understanding of the ecosystem functions of urban greenspace is an important motivation for protecting the natural environment. Natural scientists should therefore work together with social scientists in developing the vital attributes of environmental awareness and sense of place.

If there is a balance between development, conservation and sense of place, the greenspace is fit for its purpose (Figure 6.9: Block 5), but if not, environmental stressors emerge that negatively impact on the functions of the urban greenspace (Figure 6.9: Block 6). Thus, through this research, the importance of empirically investigating people's perceptions about the benefits and stressors of the Rietvlei Nature Reserve was realised.

Block 6 in Figure 6.9 can be compared to a tipping point or a critical point in the life cycle of a destination (site) from which different scenarios could develop (Figure 2.4). This part of the model was informed by the destination cycle of Butler (1980). When the balance between development, conservation and sense of place is disturbed, stressors develop as incentives or stimuli to initiate relevant local response plans, which should then be implemented (Figure 6.9: Block 7). The rehabilitation of wetlands in the Reserve, for example, was aimed at restoring water flow, vegetation and biodiversity. This was important in order to support the natural processes of water purification in wetlands (Sieben *et al*, 2017; Gründling, 2004; Venter *et al*, 2003).

An example of a local response plan for improving the quality of the water in the Reserve is the Catchment Management Plan for the Rietvlei Dam (Environmental Impact Management Services (Pty) Ltd, 2019). Sound environmental management

practices, such as the restoration of wetlands, are therefore important for improving the adaptive capacity of the greenspace to overcome stressors (Sieben *et al*, 2017).

There needs to be continuous monitoring and evaluation of the success of local response plans and their implementation, however (Figure 6.9: reciprocal relationships between Blocks 7, 8 and 9). Should the implementation of mitigation strategies for the identified stressors be successful, the balance can be restored and sustainable development is possible. This implies that the greenspace is fit for its purpose, and the objectives of water provisioning, protection of biodiversity in a healthy environment and social benefits from the Reserve can be achieved. Thus, ecological processes and biodiversity are protected and opportunities for environmental education are extended.

On the other hand, should the mitigation strategies to stressors in the Rietvlei Nature Reserve not be successful, environmental degradation and the further loss of ecosystem services might be the end result.

6.6.5 Context on a hierarchy of scales

Management on different scales, not only the Ecological Management Plan of the Rietvlei Nature Reserve (Marais 2015), but also the Catchment Management Plan for the Rietvlei Dam, has implications for the Reserve (Environmental Impact Management Services (Pty) Ltd, 2019). The fact that there is limited spatial co-variation between the administrative municipal boundaries and the catchment boundaries of the Rietvlei Nature Reserve requires that effective management plans be co-ordinated for the different resolution levels involved. The context of the Rietvlei Nature Reserve is hierarchical, with the highest resolution level being the sub-

catchment of the Rietvlei and Swartspruit, and the catchment, the Hennops River; which in its turn is nested in the Upper Crocodile Marico Catchment, the last-mentioned being part of the Limpopo Catchment. There are serious concerns over water quality in these catchment areas (du Plessis, 2019; Department of Water and Sanitation. Republic of South Africa, 2016). Furthermore, challenges expressed in the broader catchment have manifested in the quality of the water in the Rietvlei Nature Reserve - on a lower resolution level (Fisher, 2017; Hart & Mathews, 2018; Booyens *et al*, 2012; Oberholser *et al*, 2008; Toerien & Walmsley, 1979).

Thus, stressors identified in the Rietvlei Nature Reserve are not only relevant to the study area, but are also applicable to regional and even global concerns, such as extensive pollution and alien invasive species that pose threats to the integrity of the regional and global environments (Republic of South Africa. Department of Environmental Affairs, 2015) (Figure 6.9: Block 10).

Different mitigation strategies need to be implemented on different scales (Sutherland *et al*, 2019; Häyhä *et al*, 2016). Thus, Management at the Rietvlei Nature Reserve should consider the objectives of the management plan within the broader context and not only in terms of the site within the boundaries of the demarcated conservation area. Furthermore, the identified stressors could intensify and have implications not only on the local level, but also on the other hierarchical levels. The broader context of the Rietvlei Nature Reserve is therefore not only relevant to the urban planning and development frameworks, as indicated in Chapter 4, but also linked to a broader world-wide environmental concern for the conservation of ecosystems and resources.

6.7 Evaluating the benefits and stressors within the Rietvlei Nature Reserve

The benefits of and the risks to the Rietvlei Nature Reserve that were identified by the researcher through the analysis of data, and reported in Chapters 4 and 5, were presented to 12 key informants during a focus group discussion at the Reserve on 10 July, 2019. These informants represented the three perspectives on which the research was built, namely urban development, conservation and sense of place.

The motivation for setting up this focus group was to validate the benefits and risks identified in the previous section of the research in order to ensure the reliability of the results. The outcome of the discussions of this diversified focus group was to evaluate the benefits and stressors from different perspectives to enable the researcher to find inputs to feed into the Greenspace Stress Model of Urban Impact.

The focus group session started with an introduction to the risks and benefits identified by the researcher. The key respondents were then requested to carry out an individual evaluation of benefits and risks according to the Likert Scale on the instrument supplied (Appendix J: Plate J1: Template for individual evaluation of identified benefits within the urban greenspace).

Based on their expertise in terms of development, conservation, and sense of place, the participants in the focus group were then divided into three groups. Each group was tasked with verifying the benefits; selecting the ten most important or prominent benefits; and ranking them through mutual group consensus. The reason for selecting only ten indicators from the list was to streamline the indicators into a model⁴.

⁴ A similar process was followed to evaluate the stressors to the Rietvlei Nature Reserve.

6.7.1 Analysis of the identified benefits of the greenspace

The twelve participants each received an alphabetical list of benefits to be evaluated on a Likert-type scale, ranging from insignificant ($RV_1=1$); somewhat important ($RV_2=2$); important ($RV_3=3$); very important ($RV_4=4$); or extremely important ($RV_5=5$). The maximum possible Cumulative Rank Value was 60 (calculated as $5 \times 12 = 60$). (Appendix J presents the list of indicators of benefits organised by the researcher according to the participants' Cumulative Likert Scale Values for benefits ($CLSV_B$). The Cumulative Likert Scale Value was then calculated as a ratio to 100 for the Relative Benefit Value ($RBV=CLSV_B/60*100$) (Table 6.1).

The individual evaluation of the benefits by participants in the focus group enabled the researcher to identify the most important benefits of the Rietvlei Nature Reserve. Ecological benefits and the legal protection of the Rietvlei Nature Reserve achieved the highest Cumulative Benefit Value scores. Habitat, drainage and flood mitigation, as well as green infrastructure, also scored relatively high cumulative values.

Biodiversity, environmental awareness and water provisioning scored higher cumulative values than recreation, proximity to the city, facilities and amenities, tourism, education and training, a setting for nature-based activities, partnerships, economic opportunities, employment and servitude for the electricity network.

Table 6.1: Cumulative Likert Scale Value of the benefits of the Rietvlei Nature Reserve

Benefits	CLSV _B	RBV
Ecological processes	54	90
Legal protection of the conservation area (conservation status)	54	90
Provisioning and supporting of habitats	52	87
Drainage and flood mitigation	51	85
Green infrastructure	51	85
Biodiversity	49	82
Environmental awareness	49	82
Water provisioning	49	82
Presence of endangered species	45	75
Recreation (human physical and psychological health)	44	73
Accessibility (proximity to the city)	43	72
Facilities and amenities (e.g. venues, picnic areas, fishing area, sailing club area)	43	72
Tourism	43	72
Education and training	42	70
Setting for nature-based activities	42	70
Partnerships	37	62
Economic opportunities	32	53
Employment	28	47
Servitude for electricity network	22	37

After the individual evaluation, a plenary discussion was held amongst the participants to evaluate the relevance of the benefits, and possibly to add to or merge some of the benefits (e.g. the natural buffer around the dam was added as a benefit of the Reserve). Despite the importance of this aspect, it was not listed separately but rather included as part of the green infrastructure (Table 6.1).

Drainage and flood mitigation were also combined in the green infrastructural component as they were regarded as assumed benefits of the green infrastructure. Worth noting is that the green infrastructure links different types of greenspace to provide habitats, corridors for biodiversity and ecological processes (Schäffler *et al*, 2013; Wolhitz, 2016).

In the discussion, the benefits of the Reserve's conservation status and the legal protection of the conservation area (Table 6.1) were combined as one variable because the conservation status of the Reserve implies that it is entitled to legal

protection from urban developmental initiatives in the vicinity (Chapter 4). To date, the legalised conservation status of the Rietvlei Nature Reserve still protects this greenspace from the consequences of urban development in the vicinity and was tabled as an important benefit for the future existence and sustainability of this greenspace. In terms of the National Environmental Management Act (1998) and the Gauteng Provincial Environmental Management Framework (2018), urban development is not permitted within the proclaimed conservation area (Department of Environmental Affairs, 2018). Protecting the conservation status of the Rietvlei Nature Reserve has thus proved to be an important factor in prohibiting development within and adjacent to the Reserve (Chapter 4).

The conservation of wetlands and buffer zones around the grey infrastructure for water provisioning was also considered by the respondents to be an important benefit (Schäffler *et al*, 2013; Gauteng Department of Agriculture and Rural Development, 2011). The objective specified in the Ecological Management Plan of Rietvlei, namely to protect a fragment of the natural environment in a relatively pristine condition (Marais, 2015) is therefore being supported. In fact, it is based on two of the outcomes of the focus group discussions, namely the identification of the green infrastructural benefits of the Reserve, and the conservation of biodiversity.

As the Rietvlei Nature Reserve is a relatively large urban greenspace, it has the potential capacity to support ecological processes and gene pools (Wolhitz, 2016). Protection of biodiversity was therefore also considered to be an important benefit of the Rietvlei Nature Reserve. Since grasslands and wetlands provide ecosystem services, the protection of these functions is important for the water-provisioning function of the Rietvlei Dam (Zhao *et al*, 2020; Sieben *et al*, 2017; Fisher, 2017). Furthermore, since the conditions of the veld influence the diversity of the bird life

(Callaghan *et al*, 2018), the conservation of the grassland is important and also influences the sense of place associated with the Reserve as a conservation area and birding destination. Positive sense-of-place experiences concerning the ecosystem benefits are also crucial for the effective functioning of the Reserve.

The respective components of biodiversity, environmental awareness and water provisioning presented with similar Cumulative Likert Scale Values. In fact, environmental awareness is a motivation for conserving biodiversity and restoring the provisioning ecosystem functions, especially in terms of water provision (Gründling *et al*, 2017).

In the discussion, the benefits of recreation and tourism were combined as one benefit. Participants expressed the opinion that the distinction between the two concepts was not relevant in this case as both contribute to the physical and psychological health benefits of visitors to the Reserve.

According to the literature, the availability of urban greenspace for recreation contributes to quality of life, especially in the global North (Couts & Hahn, 2015; Byrne & Sipe, 2010), but also in the global South (Osorio Guzmán *et al*, 2020; de Crom & Nealer, 2017). However, according to these authors, the social and recreational benefits of urban conservation areas might not be recognised to the same extent within the context of the global South. Nevertheless, this research study confirmed these two components as benefits emanating from the Rietvlei Nature Reserve, Tshwane, South Africa - in the global South.

Water provisioning was identified as the most important function of the Rietvlei Nature Reserve in the semi-structured interviews with the key informants (Chapter 4). According to the visitor survey, there was however, limited awareness of the

importance of the water-provisioning function of the Reserve. This serves as confirmation of the importance of promoting an ongoing awareness campaign to focus on the importance of supplying water to the City of Tshwane. Surprisingly, water provisioning was placed only in the fifth position for individual ranking of benefits in the focus group. It was placed in the top ten benefits by the development and the conservation groups, but not by the sense-of-place group.

The arguments brought forward in the discussion were that there are also other water sources for the Tshwane Metropolitan Municipality to use besides Rietvlei, and that the recreational functions and the sailing club activities are more important to the visitors and photographers than water provisioning to the City of Tshwane (Chapter 5: Section 5.5.3). However, in the focus group discussion, it was evident that water provisioning was given a high ranking on the individual level.

The Relative Benefit Values and Cumulative Likert Scale Values for employment and economic opportunity were low. Furthermore, these two categories did not feature in the top ten ratings of the respective groups. This is because there are limited employment opportunities in the Rietvlei Nature Reserve, while the income generated from the gate fees and the renting of facilities goes into the budget of the Tshwane Metropolitan Municipality. The day-to-day operation of the Rietvlei Nature Reserve is therefore directly dependent on allocations from the Tshwane Metropolitan Municipality's annual budget. It is further supplemented by individual donations and contributions, and the results of volunteering initiatives.

6.7.2 Comparison of the benefits of the Rietvlei Nature Reserve

The benefits identified for the Rietvlei Nature Reserve were firstly evaluated individually from different perspectives to obtain a deeper understanding of the value of the urban greenspace (Riechers *et al*, 2019). They were then selected according to the RBV list, with only the top ten benefits ranked in order to simplify the comparison. The benefits of ecological processes and the legal protection of the conservation area scored the same RBV value (RBV=90) and were awarded the highest of the identified benefit rankings (Table 6.2; Figure 6.10).

The fact that habitat was listed under the top ten for the conservation and sense-of-place groups, but not for the development group, should be interpreted with caution. The last-mentioned group considered the provisioning and supporting of habitat for a diversity of species and ecological processes as part of the green infrastructural benefit. Green infrastructure not only scored a high individual ranking, but was also placed in the top ten by all of the groups.

The conservation status and legal protection of the Rietvlei Nature Reserve again appeared to be important benefits offered by the Reserve. Legal protection was the benefit that not only scored the highest RBV but was also ranked under the top ten benefits for the three groups (Table 6.2).

Table 6.2: Comparison of the different benefits identified within the Rietvlei Nature Reserve

Benefits	RBV	Individual rank value	Development rank value	Conservation rank value	Sense-of-place rank value
Ecological processes	90	100		100	50
Legal protection of the conservation area	90	100	40	10	100
Provisioning and supporting of habitats	87	80		60	90
Green infrastructure	85	70	100	80	60
Water provisioning	82	60	90	90	
Environmental awareness	82	60	50	20	80
Biodiversity	82	60		70	
Recreation (human physical and psychological health) and tourism	73	30	20	40	30
Accessibility (proximity)	72	20	30	50	20
Facilities and amenities	72	20			10
Education and training	70		60		70
Setting for nature-based activities	70		70		
Partnerships	62		80	30	10
Presence of endangered species	53		10		40
Economic opportunities	53				
Employment	47				
Servitude for electricity network	37				

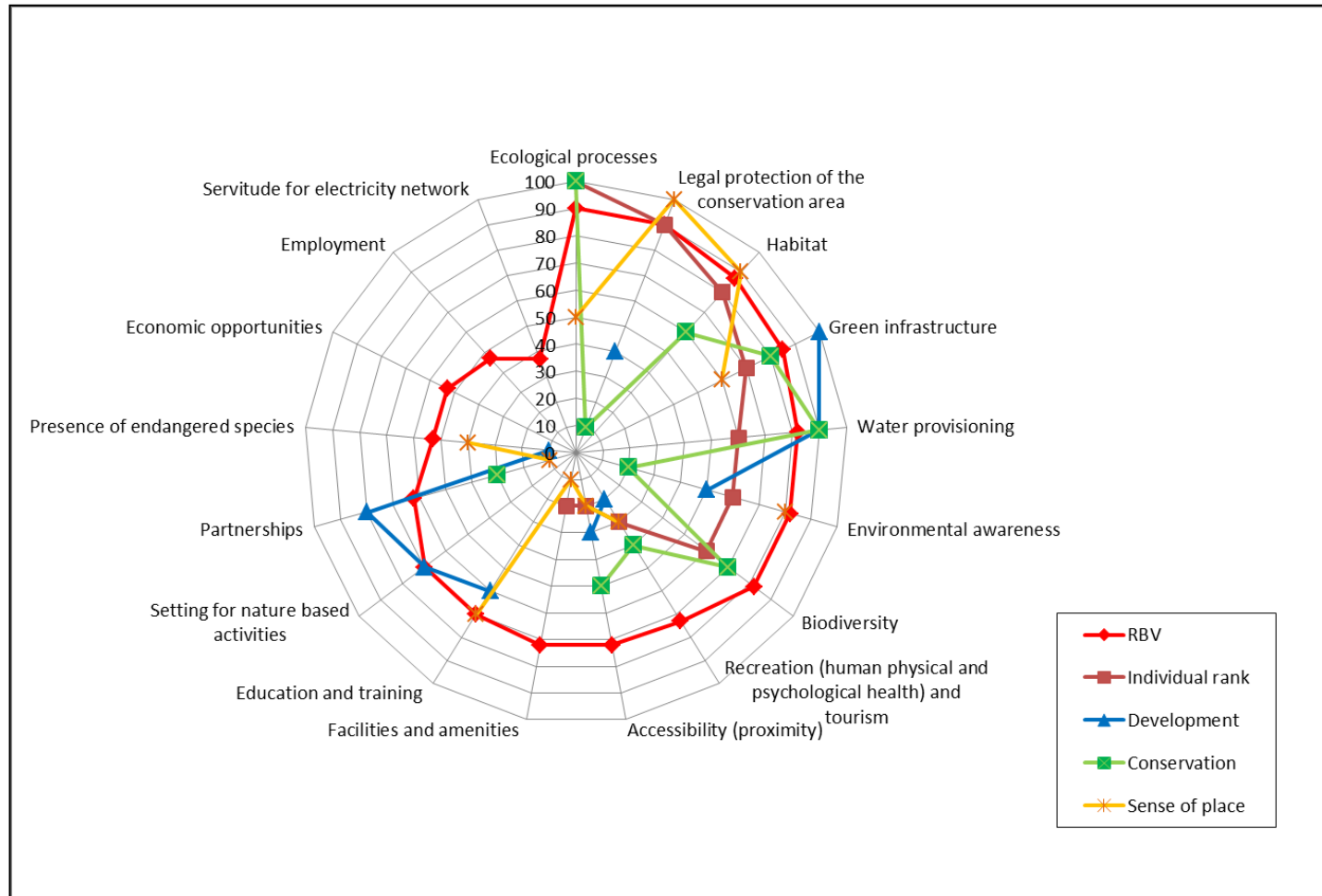


Figure 6.10: Comparison between the Relative Benefit Values and the top ten benefits of the individual rankings and the development, conservation and sense-of-place group rankings

Environmental awareness is an important benefit offered by the Rietvlei Nature Reserve as it is a crucial motivation for promoting nature conservation and sense of place of the Reserve. It was indicated as a category within the top ten in the individual evaluations, as well as in all of the group evaluations (Table 6.2). From the discussion, the consensual response of the conservative group was that even though environmental awareness is an important benefit, it should be further supported and promoted as a lack of environmental awareness could also potentially become a stressor within the Reserve.

During this same discussion, the researcher also highlighted the fact that there were various opportunities for promoting environmental awareness in the Rietvlei Nature Reserve, and indicated that this matter should be capitalised upon by promoting the ecosystem services of the Reserve with the general public and stimulating its awareness of them.

Biodiversity had a high individual overall score, and was in the top ten only for the individual evaluations and the conservation group, but not for the development and sense-of-place groups. This is an indication that the conservation of biodiversity could be considered to be more important as a general concept than as an application in the Rietvlei Nature Reserve specifically.

Recreation (human physical and psychological health) and accessibility (proximity to the city) did not present with very high individual scores, but these two categories were placed under the top ten benefits by all three interest groups. This is an interesting finding and could be linked to the recreational perspective, as identified in Chapter 5.

The Rietvlei Nature Reserve is accessible only on the basis of the specific type of recreation that it offers, as it was compared to the Pilanesberg Nature Reserve in the discussions, but on a smaller scale: No quadbikes or bicycles are allowed in the conservation area and hikes are permitted only when hikers are accompanied by a qualified guide. The fishing and camping sites are also limited in area. Furthermore, sailing is limited to the activities of the club, and no swimming is permitted in the dam.

There are also other greenspaces in the Tshwane Metropolitan Area with a broader range of recreational opportunities than those of the Rietvlei Nature Reserve. For example, the Groenkloof Nature Reserve, which is closer to the CBD, offers more picnic areas and opportunities for hiking and biking. At the Roodeplaat Dam, people can take their own boats and participate in outdoor recreational activities, including camping and fishing.

The Rietvlei Nature Reserve does not have the same facilities as these areas as the focus is more on conservation than recreation. On comparing the relative benefits of the Rietvlei Nature Reserve, however, recreation was placed under the top ten by the development, conservation and sense-of-place groups. Its facilities and amenities, and specifically those offered by the Sailing Club, were also placed under the top ten by the sense-of-place group.

On comparing the classification of the top ten benefits ranked by the selected groups, the importance of green infrastructure and water provisioning was again confirmed (Table 6.3). The development group also included drainage and flood mitigation as benefits in their assessment of the green infrastructure. Surprisingly,

the economic opportunities, employment and the servitude function for the provision of electricity were not placed under the top ten benefits by any of the groups.

During the focus group discussions, the respective groups did not place the same benefit in their top-ten-benefit evaluation. In addition, a discussion was held on the difference between the benefits of the Rietvlei Nature Reserve for people visiting the reserve and the benefits of the Rietvlei Nature Reserve as an urban greenspace. Again, legal protection and the conservation of the urban greenspace were identified as important benefits for the conservation area.

Table 6.3: Top ten benefits ranked by groups

Rank	Benefits: Development	Benefits: Conservation	Benefits: Sense of place
1	Green infrastructure	Ecological processes	Legal protection of the conservation area
2	Water provisioning	Water provisioning	Habitat
3	Partnerships	Green infrastructure	Environmental awareness
4	Setting for nature-based activities	Biodiversity	Education and training
5	Education and training	Habitat	Green infrastructure
6	Environmental awareness	Accessibility (proximity)	Ecological processes
7	Legal protection of the conservation area	Recreation (human physical and psychological health)	Presence of endangered species
8	Accessibility (proximity)	Partnerships	Recreation (human physical and psychological health)
9	Recreation (human physical and psychological health) and tourism	Environmental awareness	Accessibility (proximity)
10	Presence of endangered species	Legal protection of the conservation area	Partnerships

Source: Focus group discussion: 10 July 2019

This evaluation confirmed that the functions and benefits of the Rietvlei Nature Reserve are not primarily limited to the recreational opportunities provided by the Reserve but are also linked to the broader environmental context. Aspects that

benefit the greenspace, for instance, would eventually also benefit ecosystem services to people visiting the Reserve and those living in the adjacent urban areas⁵.

Important to note is the fact that the sense of place of an urban greenspace does not always include an awareness of the associated ecosystem functions and services. The role of environmental awareness that underpins the inherent sense of place associated with an urban greenspace should therefore not be ignored in research.

6.7.3 Evaluation of the stressors of the greenspace

Various sources, such as observation notes, records of interview responses and literature sources were consulted to identify the stressors experienced in the Rietvlei Nature Reserve (Chapters 4 and 5). The potential stressors to the Rietvlei Nature Reserve which were identified are listed in Table 6.4.

Participants in the focus group discussion individually evaluated each of the identified stressors on a Likert-type scale in terms of the following: Daily hassle (1), Ambient stressor (2), Serious stressor (3), Life-changing stressor (4), or Catastrophic stressor (5). The maximum possible value was again 60, which implied that all 12 participants would give the particular indicator a score of five (5).

The stressors were listed according to their cumulative weights in Table 6.4, and the Cumulative Likert Scale Value was represented as a percentage in the last

⁵ In New York City, for example, the importance of ecosystem services was acknowledged, and greenspace was planned within the framework of protecting the ecosystem services of a greenspace and not only the recreational activities (Bernstein, 2017).

column of the table. (If all respondents indicated the stressor as catastrophic, it would be 100%.)

Table 6.4: Cumulative Likert Scale and Relative Stress Values for the stressors within the Rietvlei Nature Reserve, Tshwane

Stressors within the Rietvlei Nature Reserve	CLSV_s	RSV (%)
Environmental degradation	48	80
Water quality	48	80
Pollution	46	77
Catchment conditions	45	75
Security (crime, poaching, vandalism)	44	73
Urban encroachment	41	68
Invasive species	40	67
Fire (accidental or arson)	38	63
Governance challenges	38	63
Ineffective environmental management	38	63
Budget constraints	37	62
Trans-boundary challenges	37	62
Land claims	36	60
Poor service provision in the catchment area	35	58
Limited environmental awareness	35	58
Social exclusion	34	57
Diversity of social needs and demands	33	55
Human-animal interaction	30	50
Image of Rietvlei Nature Reserve	25	42
Visitor behavior	24	40

Stressors related to water quality and environmental degradation received the highest Cumulative Rank Values when these rankings were evaluated. This finding is important, especially in the light of the prominence of water provisioning as a benefit issuing from the Rietvlei Nature Reserve to service the needs of the Tshwane Metropolitan Municipality.

6.7.4 Comparison of stressors in the Rietvlei Nature Reserve

A methodology similar to that concerning the identified benefits (Section 6.5.2.1) was followed to compare the stressors in the Rietvlei Nature Reserve. Through the semi-structured face-to-face interviews with the different informants, it became apparent that what is important to developers is not necessarily important to conservationists, and *vice versa*.

Table 6.5: Evaluation of stressors in the Rietvlei Nature Reserve

Stressors on the functioning of the Rietvlei Nature Reserve	RSV	Individual ratings: top ten	Development group: top ten	Conservation group: top ten	Sense-of-place group: top ten
Water quality	80	100	90	80	60
Environmental degradation	80	100	30	90	40
Catchment conditions	77	70	100	100	20
Pollution	75	80		70	50
Security (crime, poaching, vandalism)	73	60	10	60	
Budget constraints	68		70		100
Invasive species	67	40		50	30
Governance challenges	63	30		30	80
Urban encroachment	63	50	40	10	
Fire (accidental or arson)	63	30	60		10
Ineffective environmental management	62	30			70
Land claims	62		20		90
Social exclusion	60		80		
Trans-boundary challenges	58			40	
Diversity of social needs and demands	58		50		
Limited environmental awareness	57			20	
Poor service provision	55				
Human-animal interaction	50				
Image of the Rietvlei Nature Reserve	42				
Visitor behaviour	40				

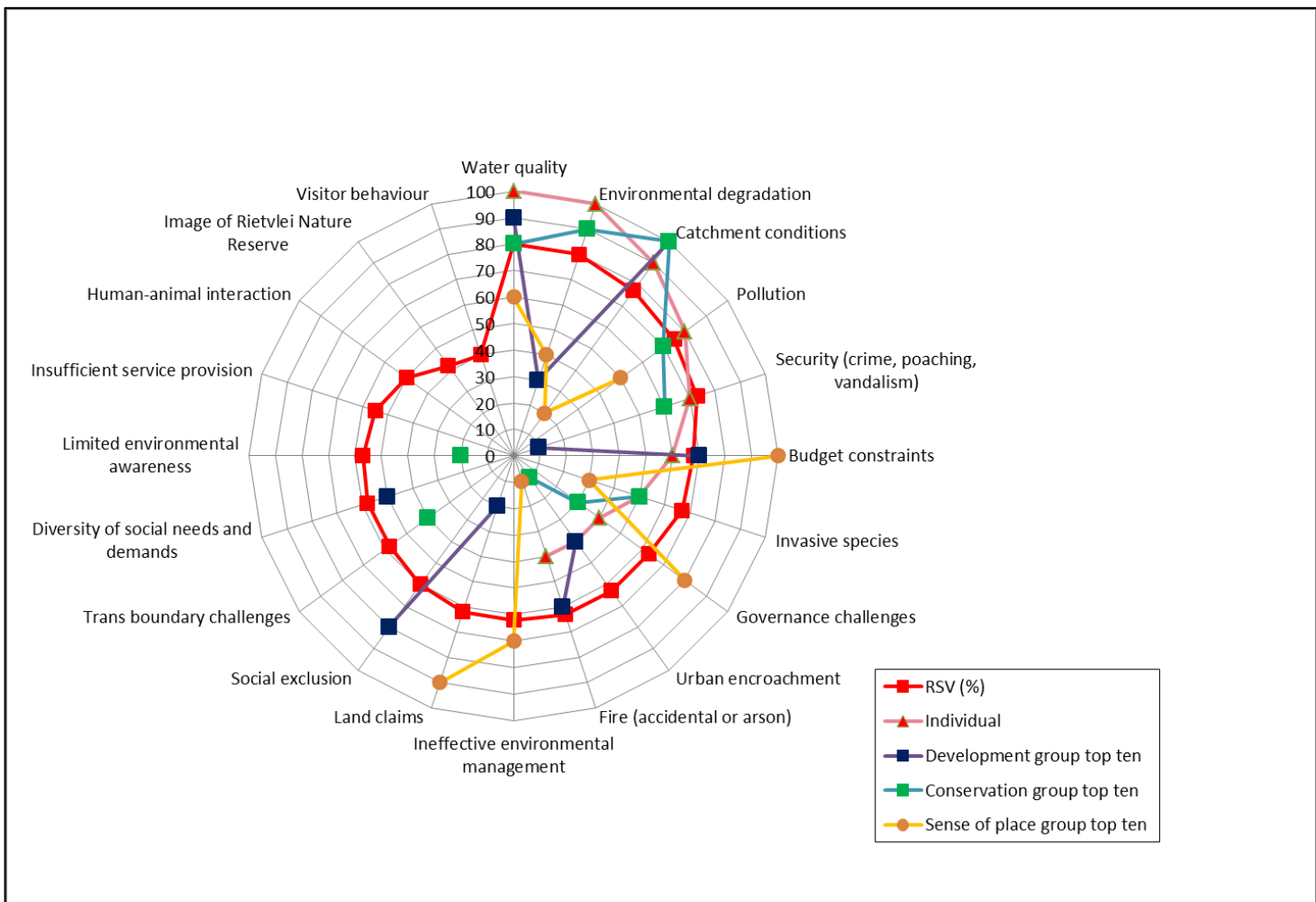


Figure 6.11: Comparison of the Relative Stress Values to the ranking values of the stressors

The concerns raised by the respondents regarding the stressors associated with the Rietvlei Nature Reserve were analysed and are presented in Tables 6.4 and 6.5. Figure 6.11 on the other hand compares the respective rankings of the Relative Stress Values for the stressors by the development, conservation and sense-of-place groups with those specified through the individual evaluations.

While the rankings in Table 6.4 in terms of the Cumulative Likert Scale and Relative Stress Values were based on the focus group's feedback and consensus reached among the participants, Table 6.6 presents a comparison of the top ten indicators of stressors as selected individually and by the three respective focus groups.

Table 6.6: Comparisons of the rankings of the stressors by the three groups

Rank	Development group	Conservation group	Sense-of-place group
1	Catchment conditions	Catchment conditions	Budget constraints
2	Water quality	Environmental degradation	Land claims
3	Social exclusion	Water quality	Governance challenges
4	Budget constraints	Pollution	Ineffective environmental management
5	Fire (accidental or arson)	Security (crime, poaching, vandalism)	Water quality
6	Diversity of social needs and demands	Invasive species	Pollution
7	Urban encroachment	Trans-boundary challenges	Environmental degradation
8	Environmental degradation	Governance challenges	Invasive species
9	Land claims	Limited environmental awareness	Catchment conditions
10	Security (crime, poaching, vandalism)	Urban encroachment	Fire (accidental or arson)

In Table 6.6, the rankings of the top ten stressors by the development, conservation and sense-of-place groups are compared. Only ten stressors were selected to allow for a more effective comparison.

Similar stressors were ranked in the top ten for both the individual evaluations and the development, conservation and sense-of-place groups, even though their stressor positions in the top ten ranking differed (Figure 6.5).

In an attempt to illustrate the interplay between development, conservation and sense of place, the stressors, although not exclusive to any one of these categories, were classified into the respective categories as follows:

Stressors associated with development are those relating to governance, budget constraints, land-use changes, land claims, diversity of social needs and demands in the urban area where the Reserve is located, social exclusion and poor service delivery in the catchment area of the Rietvlei Dam. These stressors originate mainly outside of the boundaries of the conservation area even though their impacts are experienced within the Reserve.

Conservation stressors include environmental degradation, poor water quality, pollution, invasive species, and unsatisfactory human-animal interactions. Conservation stressors in the case of the Rietvlei Nature Reserve are classified in terms of the stress experienced not only by humans, but also within the greenspace. Stressors related to conservation could be linked to human ecology, which was also included by Pacione (2001) in his Stress Model of Urban Impact.

Stressors associated with sense of place, include security; limited environmental awareness; the image of the Reserve as a conservation area; and inappropriate visitor behaviour. These stressors can be compared to stressors associated with environmental load and behavioural constraints in a particular urban behavioural setting (Pacione, 2001).

In the following section the ranking of the identified stressors is discussed from different perspectives.

6.7.5 Discussion

Table 6.6 shows a comparison of the rankings of the top ten stressors by the development, conservation and sense-of-place groups. Only ten stressors were selected to allow for a more effective comparison.

The following stressors are discussed below, namely catchment conditions, water quality, environmental degradation, urban encroachment, budget constraints, invasive species, veld management and the carrying capacity of the Reserve.

6.7.5.1 Catchment conditions

Catchment conditions were placed in the number one position for the development and sense-of-place groups, while budget constraints featured more prominently in the sense-of-place group. The development group placed a higher priority on stressors coming from outside the Reserve, while the sense-of-place group placed stressors within the Reserve as a higher priority, the examples given being budget constraints; governance challenges; poor water quality; pollution; and invasive species. Land claims was the only potential stressor from outside the Reserve that was placed in a high-rank order by the sense-of-place group.

The catchment area of the Rietvlei Dam is larger than the primary catchment area protected by the Rietvlei Nature Reserve (Chapter 4: Section 4.4). Catchment conditions and pollution scored the third- and fourth-highest cumulative values respectively. From the discussions in the focus group, it was evident that pollution and catchment conditions could be combined as a single stressor. The conditions

of the catchment area include land cover, land use, sources of pollution, the lack of service provision, urban encroachment, as well as the limited coordination between the different levels of government, and poor governance.

The land-use functions and conditions of the catchment area influence the quality of the water in the Rietvlei Nature Reserve as pollution originates from industrial, agricultural, as well as residential areas in the catchment of the dam. Issues such as the development of formal and informal settlements; illegal sand mining; agriculture being practised in the riparian zones; as well as agricultural activities generally, were explored in the focus group discussions.

Consensus was reached amongst the groups that there needs to be better communication and improved coordination in terms of urban development at the catchment level in order to protect the uniqueness of the Rietvlei Nature Reserve. The research confirmed that changing land-use functions in the catchment area do indeed influence the source and type of pollution entering the hydrological system (Jordaan *et al*, 2016; Oberholzer *et al*, 2008).

The focus group discussion did not, however, cover concerns over a proposed mine in the catchment area of the Rietvlei Dam. This again illustrates the importance of environmental knowledge when perceptions about potential risks are researched and stressors are identified.

The cumulative effects of the urban development in the catchment of the Rietvlei Dam to the south of the Rietvlei Nature Reserve appear to have more significant implications for water quality and habitats in the Reserve than a mere visual impact would indicate (Figure 6.12).



Figure 6.12: Urban development in the background of the vlei where the Rietvlei River and Grootspruit converge

Photograph: Alicia Williams (17 October 2016): reproduced with permission

Currently, the quality of runoff into the green infrastructure is being influenced by the low level of service delivery and of socio-economic development in the catchment area.

6.7.5.2 Water quality

Water quality was found to be the stressor with the highest cumulative value in the assessments. It also featured in the top ten rankings of the individual evaluations, as well as in those of the development, conservation and sense-of-place groups (Table 6.6). As water provision was identified as the most important benefit, it is a matter for concern that water quality is also apparently the most important stressor associated with the Reserve.

The Rietvlei Nature Reserve is an important source of water for the City of Tshwane (Water Research Commission (WRC), 2018). Unfortunately, there are concerns over the quality of the water.

Owing to conditions in the catchment area of the Rietvlei Dam, anthropological eutrophication has occurred and is clearly evident here (Mbiza, 2014; van Ginkel, 2011; Oberholser *et al*, 2008).

One of the indicators of eutrophication is the occurrence of algal blooms which the Rietvlei Dam has been experiencing since the early 1970s (Toerien & Walmsley, 1979; Harding & Hart, 2013). The large area of high-quality agricultural land in the catchment area of the dam has been partly responsible for this problem (Chapter 4). Even though at the time of the research not much formal development was taking place in the catchment area of the dam, concerns were already then being raised over the high volumes of agricultural chemicals released into the rivers and groundwater upstream of the Rietvlei Dam as a result of farming operations (Oberholser *et al*, 2008).

The high levels of nutrient concentration and mineral loading found in the drainage system leading into the Rietvlei Dam is a further reason for the high level of eutrophication and the poor quality of the water. These high levels can be attributed to discharges from the Hartebeesfontein Wastewater Purification Plant and ERWAT, located in the Swartspruit, upstream of the Reserve (Foppen & Kansime, 2009; Oberholser *et al*, 2008; Toerien & Walmsley, 1979). The increase in discharge from the wastewater plant, as well as its incapacity to manage the volume of wastewater and sewage runoff, have further exacerbated the

proliferation of the algal blooms, the indicators of eutrophication (Booyens *et al*, 2012).

Furthermore, even before the start of this research, there was an upsurge in the growth of informal settlements in the catchment area which, even at this stage, are not linked to formal service provision systems, and also a rise in second dwellings (Hamann *et al*, 2018). Together, the shacks and dwellings place additional pressure on the ineffectual sanitation or sewerage system, and could possibly further intensify the eutrophication process and augment the algal blooms (Figure 6.13).

Thus, the growth in human settlements, in tandem with poor service delivery; the lack of capacity in the water purification systems; agricultural runoff into the Hennops River catchment area and its principal tributaries; and runoff from industrial areas, collectively contribute to pollution in the Rietvlei Nature Reserve (Oberholser *et al*, 2008) and to concerns regarding the quality of the water.

Concerns specifically related to the quality of the water entering the Tshwane Metropolitan Municipality from the Ekurhuleni Metropolitan Municipality were confirmed in meetings of the Hennops Catchment Management Forum. Conditions in the catchment area, specifically the lack of services and the associated risk of increased eutrophication, were discussed.

Another reason why the quality of the water at the Rietvlei Nature Reserve was evaluated as high up on the list of top ten stressors was that it is widely acknowledged in the conservation context that a decline in the quality of the water

leads to a decline in the number and variety of animal and plant species, a benefit that attracts many visitors and interested parties to the Reserve.

Since environmental impacts go beyond political and administrative boundaries, trans-boundary cooperation is critically important in supporting conservation goals, one of them being water quality. This explains why the Catchment Management Plan for the Rietvlei Dam extends across municipal boundaries (Environmental Impact Management Services (Pty) Ltd, 2019).



Figure 6.13: Algal blooms in the Rietvleispruit, visible from the Otter Bridge
Source: Author (14 October 2017)

When it comes to measures to improve the quality of the water and thus to ensure a sustainable supply of it, an important task in the context of the Rietvlei Nature Reserve is to monitor it. Various tools, including chemical analysis (Armitage *et al*,

2014) and biological monitoring (Oberholser *et al*, 2008) have been used in the Rietvlei area to evaluate the quality of the water. The monitoring of the time of hatching of bullfrog eggs, for example, serves as an early warning system before other evidence of environmental degradation becomes noticeable. In this instance, this allows for other interventions to be made timeously in order to mitigate the occurrence of algal blooms (Figure 6.13).

Another remedial action that was taken at the Rietvlei Dam to improve the quality of the water was the implementation of a number of floating solar-powered, long-distance circulation pump systems (Solar Bees), which were placed on the surface to destroy the algal habitat (Booyens *et al*, 2012; van Vuuren, 2012). The currents that are created by the pumps cause the cooler water from below to mix with the warmer surface water, thus allowing the oxygen to blend with the water. Although this supplementary purification method was not successful in eradicating the high nitrogen levels in the Rietvlei Dam, it has assisted in better managing the eutrophication problem and in improving the quality of the raw water flowing into the purification plant.

6.7.5.3 Environmental degradation

Environmental degradation scored the second-highest cumulative value in the stressor assessments. It was also ranked in the top ten of the individual rankings, as well as in those of the development, conservation and sense-of-place groups respectively. Environmental degradation was also identified as a stressor in the semi-structured interviews and again confirmed in the discussions with the Honorary Rangers, Friends of Rietvlei, and the Pretoria Sailing Club members.

Environmental degradation is a stressor that stands in opposition to the beneficial functions of protecting genetic and biodiversity⁶ and acting against the loss of species. In cases where environmental degradation has taken place, conservation programmes and good environmental management practices to protect and sustain these aspects are necessary to restore the environment to its former equilibrium and effective functioning (homeostasis).

Effective environmental management practices that should be implemented in the Reserve to counter the environmental degradation in this instance include the restoration of wetlands, the management of the different species⁷ to ensure a balance in the food web, as well as veld management and the management of the number of animals in terms of the carrying capacity of the veld (Marais, 2015; Venter *et al*, 2003).

An important point to note is that environmental degradation is often linked to ineffectual environmental management. Environmental managers should therefore implement effective plans to mitigate the negative effects of the deteriorating environmental conditions and to deal with the stressors identified in the Reserve.

⁶ In fact, the diversity of species is internationally used as a bio-indicator of the health of the planet, and early warnings may alert scientists of potential environmental health stressors and environmental degradation.

⁷ In order to minimise environmental degradation, for example, the number of buffalo and rhinos need to be carefully monitored in terms of the carrying capacity of the Reserve.

6.7.5.4 Urban encroachment

Urban encroachment has intensified the development pressures on the Rietvlei Nature Reserve. When the researcher visited the Rietvlei Nature Reserve for the first time in 1990, its location was perceived to be far outside the city boundaries. The relative location of the Rietvlei Nature Reserve on the dynamic urban fringe between the growing cities of Tshwane and Ekurhuleni was seen at that stage already to be placing the Reserve in an untenable position with regard to development pressures. Its appearance as a feature on planning frameworks, maps and satellite images and its location relative to the development corridors between the Tshwane CBD and the industrial areas in Ekurhuleni (Chapter 4), was subsequently seen as an additional factor causing its vulnerability in terms of urban encroachment.

The implications of the Reserve's relative location were confirmed in the semi-structured interviews with key informants. Development pressure was also acknowledged as a stressor in the focus group discussions with the Friends of Rietvlei, the Honorary Rangers, and Birders and Photographers.

Development pressures will be increased through upgrades of the road infrastructure which will increase traffic flow and the linkages to the development corridors (Chapter 4). This will unlock the surrounding area for development with the effect of increased development pressure on the Rietvlei Nature Reserve. Furthermore, environmental impacts in terms of changes to traffic and hydrological flow patterns would of necessity be expected to be more widespread than those merely at site level, and to extend to the adjacent urban areas where development is currently taking place.

As it is of now, the traffic on the Delmas Road, as well as light pollution, are negatively impacting on the sense of tranquillity in the camping and fishing areas. Even though the upgrade of the Dam Road is essential for supporting urban spatial development, it would most probably further negatively influence the sense-of-place experiences of visitors to the section of the conservation area adjacent to the road, as well as to the fishing and camping sites.

Evidence of the encroachment of the urban areas on the Reserve environment is clearly evident in the visual impact of the changing environment surrounding the Reserve with new buildings being erected in the vicinity, and the increasing volume of traffic on especially the Rietvlei Dam Road and the Delmas Road.

Urban encroachment has also led to signs of moderate light pollution in the Reserve. This means that it is no longer really dark in the Reserve at night.

Furthermore, according to members of the Honorary Rangers group (Personal communication. 17 November 2016), light pollution also negatively impacts on the wilderness experience of night drives. However, much more serious than spoiling recreational wilderness experiences and its effect on the sense-of-place experiences of visitors to the Reserve, is the deleterious effect of light pollution on natural ecosystems and the behaviour of nocturnal animals.

Artificial light also affects animal breeding and hunting behaviour. According to the Director of Tshwane Nature Conservation (Personal communication. 22 August 2016), cheetahs would normally hunt during the daytime, but owing to the artificial light, they also hunt at night.

When it comes to human-wildlife interactions as potential stressors, it is important to note that human-wildlife conflict on the interface between human settlements and conservation areas is not uncommon. The boundaries of the Rietvlei Nature Reserve are fenced off, which limits the risk of wild animals escaping into the surrounding suburbs. The animals may not be sufficiently protected, however, owing to the higher risk of a single fence being vandalised.

Different opinions on the fencing of the Nature Reserve were encountered during the fieldwork phase of this research. A suggestion was made by visitors that a double fence should be erected between the Rietvlei Nature Reserve and the Delmas Road, as well as between the Reserve and the Rietvlei Dam Road. Such a fence would not only protect the game from potential poachers, but would also protect the surrounding urban communities from the risk of game entering the developed areas.

In spite of the fences between the Reserve and the agricultural and residential areas, some residents adjacent to the Rietvlei Nature Reserve observe game from their gardens. Game can also be observed from vehicles passing the Reserve on the Delmas Road and Rietvlei Dam Road.

The physical appearance of fences could contribute to the image of the Reserve as a conservation area and positively influence the sense of place within the Reserve (Montgomery, 1998). Such improvements would be welcomed as the research revealed that currently the type of fencing in use is not in keeping with the image of a conservation area.

Human-animal interaction was mentioned as a potential risk by the manager of the Rietvlei Nature Reserve, and also in the discussion with the Pretoria Sailing Club. The presence of dangerous animals such as hippos, not only in the Marais Dam, but also in the Rietvlei Dam, limits the variety of watersports activities that can be offered at the Rietvlei Nature Reserve. Furthermore, owing to the presence of dangerous animals, hiking is permitted only when the party is accompanied by a qualified guide, and visitors may exit their vehicles only at designated areas in the Reserve.

Human-animal interaction is not limited to the risk of harm to people by dangerous animals, such as hippos or buffalo, but also applies to the risk of the spread of diseases from animals to humans. The health of animals in the Reserve should therefore be carefully monitored in order to prevent the spread of disease through human-animal interaction.

A final point worth noting is that the group participating in the final focus group discussion did not regard human-animal interaction as an important stressor to the Rietvlei Nature Reserve.

6.7.5.5 Security

Security was evaluated as the stressor with the fifth-highest cumulative value in the assessments. Incidents of rhino poaching in 2016, as well as the poisoning of lions in 2017, received widespread media coverage. Honorary Rangers and staff at the Rietvlei Nature Reserve, as well as representatives from Friends of Rietvlei, confirmed these incidents and also expressed concern over the poaching of other

game species, crime, vandalism and other forms of inappropriate visitor behaviour (Leung *et al*, 2018).

Rhino poaching is a serious problem internationally, as well as locally. On 26 May, 2016, two rhinos were killed and dehorned in the Rietvlei Nature Reserve, and in the week of 7 July, 2017, one was killed and one wounded by poachers there.

During the semi-structured interviews, respondents were asked whether they were of the opinion that poaching had influenced the management or operations of the Rietvlei Nature Reserve in any way. Common themes in their responses were increased awareness of the security risks, and the necessity of revisiting the priorities of the Reserve by management. Before the poaching incident of 26 May, 2016, there were indications that the rhino-dehorning project at the Rietvlei Nature Reserve was behind schedule. However, the media coverage of the poaching increased public awareness of the work done at the Reserve.

6.7.5.6 Budget constraints

Budget constraints were awarded sixth place in the hierarchy of stressors evaluated by the focus group. They were also identified in the semi-structured interviews with key informants and again confirmed in the focus group discussions with Friends of Rietvlei, Honorary Rangers, Birders and Photographers, as well as by the Pretoria Sailing Club.

The Rietvlei Nature Reserve is not managed as an economically self-sustaining unit. Money generated by the Reserve is pooled into the municipal budget. The activities and maintenance of the Reserve therefore compete with other demands

for monetary allocations. There is a risk that the operating costs of the Reserve could be perceived as a burden to the local government.

Furthermore, there are strong indications of fiscal stress in the context of developmental needs in the City of Tshwane. In the winter of 2016, for instance, there was insufficient funding available from the local government to feed the game in the Reserve, but contributions from individual donors and Friends of Rietvlei enabled volunteers and staff to do so. Some of the required maintenance for the bird-hides was also carried out by Friends of Rietvlei, a non-profit organisation of volunteers.

From 2015 to 2018, the chalets in the Reserve were not made available for overnight stays, thus leading to a loss of this potential source of income. Different reasons for this situation were mentioned during the semi-structured interviews. There were indications that vandalism, political conflict, challenges with obtaining tenders, as well as detailed procurement processes, had exacerbated the situation. The renovation of the chalets may offer an opportunity for public-private partnership agreements that could be concluded to improve overall service provision at and financial returns to the Rietvlei Nature Reserve.

6.7.5.7 Invasive species and veld management

The impact of invasive species on the carrying capacity of the veld was identified as a stressor within the Rietvlei Nature Reserve. This stressor was not only identified in the literature (van der Westhuizen, 2019; Strobach, 2018; McConnachie *et al*, 2011), but also confirmed through observations and interviews with selected groups.

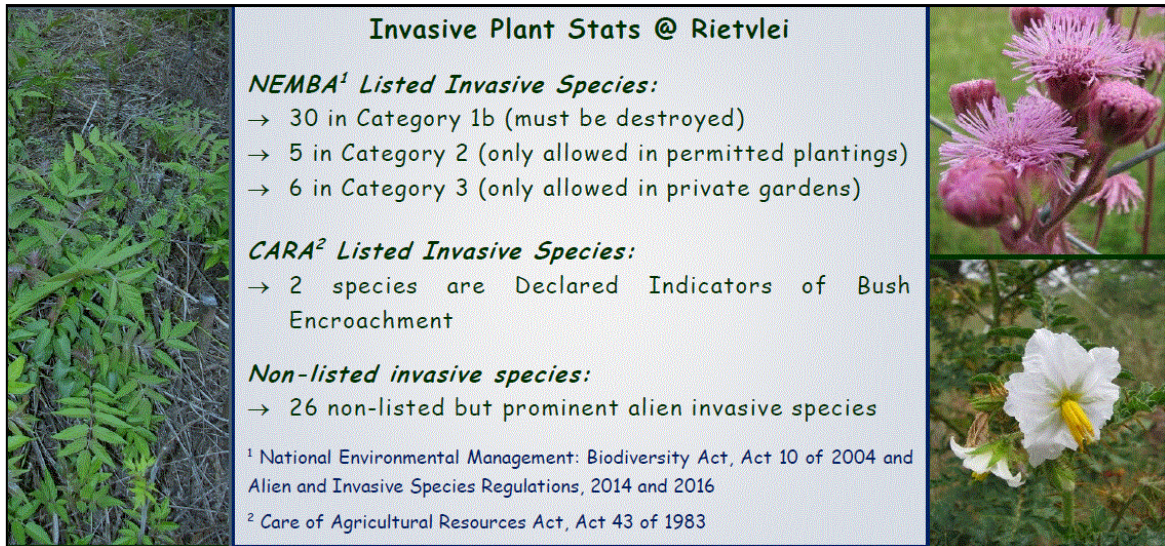


Figure 6.14: Excerpt from the Friends of Rietvlei Newsletter of May 2018 indicating the extent of invasive plant species in the Reserve
 (Source: Strobach 2018:6)

The data in Figure 6.14 provide an indication of the extent and the variety of invasive plant species present in the Rietvlei Nature Reserve (Strobach, 2018). Invasive species have implications for habitats and could adversely influence biodiversity (Witt *et al*, 2017; Mavimbela *et al*, 2018). Species such as the black wattle negatively impact on the water table and increase the risk of fire (Marais, 2004; McConnachie *et al*, 2011).

Fire was indicated as an environmental stressor in the cumulative value hierarchy through the individual evaluations, as well as by the sense-of-place group. The risk of fire was included in the bad environmental management category by the conservation group and therefore not included in their list of top ten stressors.



Figure 6.15: Pom-pom weed at Rietvlei Nature Reserve
Photograph: Author (23 February 2019)

Despite various strategies implemented to eradicate the pink pom-pom weed in Rietvlei (McConarchie *et al*, 2011; van der Westhuizen, 2019), it was still a problem in 2020 and as such identified as a stressor to the Reserve (Figure 6.15).

Proper veld management was identified as a serious concern, not only to protect the carrying capacity for grazing, but also to protect wetlands, ecosystems, habitats and biodiversity, and to limit soil erosion. Invasive species are a threat to biodiversity, as they take over the veld, reduce the carrying capacity for grazing, and heighten the risk of fire. As monoculture, which arises from the afore mentioned, makes the veld less resilient, it is important for the Tshwane

Metropolitan Municipality to have a long-term veld management system in place to eradicate invasive species.

This concern was also acknowledged as a priority for management in a face-to-face on-site interview with the manager of the Rietvlei Nature Reserve (Marais, 2016). The importance of improving the condition of the veld was also stressed during a Friends-of-Rietvlei group meeting (4 May 2017). A low level of public awareness of the consequences of invasive species was also identified as a potential stressor by Friends of Rietvlei. The Friends of Rietvlei group is concerned about this stressor and remains active in the eradication of invasive alien plants, such as the pompom weed.

The conservation of biodiversity requires an understanding of animal management principles; the sensitivity of the food web; and the habitats of species. The *damaliscus pygargus phillipsi* (blesbuck) and *antidorcas marsupialis* population (springbuck), for example, have come under pressure, as the ewes are prey to *acinonyx jubatus* (cheetah), and the calves to *canis mesomelas* (jackal). Furthermore, the ram-ewe balance of the blesbuck needs to be monitored. Should this be disturbed, the percentage of lambs might decrease (Wolhitz, 2016). In fact, the number of jackals in the Reserve had to be reduced in 2016, and again in 2017 (Friends of Rietvlei, 2017).

As fishing is not allowed in the Marais Dam, and visitors feed the *clarius gariepinus* (barbers), the increases in the number and size of the barbers have led to a decline in the number of small birds (Friends of Rietvlei, 2017).

6.7.5.8 Carrying capacity of the Reserve

Carrying capacity is not only relevant to game, but also to visitors to the conservation area, because crowding could be a stressor to the experience of tranquillity and escape from the city.

At the time of the study, there were limitations to accessing the sailing club area and the number of boats on the dam, but there were no limitations on the number of visitors entering the Rietvlei Nature Reserve at a particular time. Crowding over weekends and the inappropriate behaviour of visitors were mentioned as potential hazards during the group discussion with Friends of Rietvlei (4 May 2017). Reckless behaviour, such as drinking and driving, exceeding the speed limit, and getting out of vehicles in areas that are not designated viewing or picnicking spots, was also observed by the researcher while visiting the Rietvlei Nature Reserve.

It is recommended that a threshold needs to be determined for managing the number of visitors to the reserve in order to protect the conservation function and the recreational experience. The tourism capacity of the recreational area is related to visitors' experiences of crowding, as well as the potential environmental impacts arising from their activities. Inappropriate behaviour, crime, vandalism and poaching⁸ are all related to negative tourism impacts. The carrying capacity for the recreational function of urban greenspace also needs to be monitored and managed for a sustained recreational experience (Arnberger, 2012; Butler, 1980).

⁸ Besides the well-published rhino poaching incidents, there have also been known incidents of visitors poaching game and removing plants (Friends of Rietvlei, 2017). This trend was confirmed in face-to-face interviews with visitors and managers, when they were asked about their concerns.

The above-mentioned problems associated with pressure being placed on the carrying capacity of the Reserve could be mitigated through communication – by disseminating information on environmental awareness and what is regarded as appropriate behaviour for visitors to the Reserve, as well as for safety tips and information about animal behaviour.

6.7.6 Perceptions about the Rietvlei Nature Reserve

Limited environmental awareness featured on the top ten ranking for only the conservation group, while diversity of social demands featured on the top ten ranking for only the development group. Land claims were named among the top ten stressors for the development group and the sense-of-place group. Governance challenges featured on the top ten ranking for individual assessments and on the top ten ranking for the conservation group. This is most probably because the conservation group was directly involved in the day-to-day management of the Reserve.

The perception of social exclusion and access to the facilities of the Reserve came to the fore in the focus group discussions with the Honorary Rangers and the Pretoria Sailing Club. Both these groups have active programmes to include a broader social spectrum of different sectors of the South African society in their activities.

6.8 Conclusion and the way forward

The Greenspace Stress Model of Urban Impact was developed specifically for the Rietvlei Nature Reserve. The characteristics of the Rietvlei Nature Reserve were found to be influenced by its context. The relative location to urban development

corridors in Gauteng and the position between two growing metropolitan areas impact on the development pressures experienced in the Reserve. Furthermore, the re-demarcation of municipal boundaries up to 2011 has had implications for the governance of the Reserve, especially as the Witkoppies section of the Reserve falls within the Ekurhuleni area of jurisdiction. Despite being relatively early in the larger Marico catchment management area, impacts of the catchment are already visible from a relatively short distance up the course of the Rietvlei River and the Grootfontein River feeding into the Hennops River. Furthermore, the land-use functions practised in the catchment area of the Rietvlei Dam were found to influence the type of pollutants entering the dam, and the prevalence of anthropological eutrophication, both factors seriously affecting the quality of the water in the dam.

These issues again highlight the need for better inter-metropolitan cooperation to monitor the impact of polluted water within the larger catchment area. It is therefore important to continuously monitor the level of effectiveness of the implementation of this aspect of the Catchment Management Plan for the Rietvlei Dam at each of the respective phases in its evolution. This is in line with the requirements of the National Water Act of 1998, that requires participation and catchment level management of water resources.

By analysing this aspect, it became clear that different priority levels of attention have been awarded to the respective stressors experienced in the Rietvlei Nature Reserve. The priorities, as well as the awareness of the participants about the potential impacts of particular stressors, might influence people's perceptions of the Reserve, as well as the environmental image of the Reserve. However, much

more needs to be done to promote the image of the Rietvlei Nature Reserve as a conservation area and to create an awareness of the beneficial functions thereof.

Serious attention also needs to be given to the concept, sense of place, in the context of the Reserve since it is an important factor in the decision-making processes that underlie the actual formulation of conservation programmes and management plans. As such, sense of place plays an important and essential role in supporting conservation.

Chapter 6 (Sections 6.6 and 6.7) focused on the application of the Greenspace Stress Model of Urban Impact to the Rietvlei Nature Reserve. Since this model also promises a wider, more universal application for conservation areas in urban greenspaces within similar geographical contexts, Chapter 7, which now follows, focuses on recommendations for generic guidelines for applying the Greenspace Stress Model of Urban Impact to similar geographical areas.

Chapter 7: Guidelines for the implementation of the Greenspace Stress Model of Urban Impact

7.1 Introduction

The case study of the Rietvlei Nature Reserve, Tshwane (South Africa), was the basis on which a Greenspace Stress Model of Urban Impact was developed to be tested and applied not only in terms of the Reserve itself, but also in terms of other similar greenspace areas. Inputs from observations made, relevant literature sources and the opinions of stakeholders and experts were used to inform the Greenspace Stress Model of Urban Impact. As such, this model was able to detail how geographical interplay and the interdependencies of components (e.g. urban development, conservation and sense of place) could be linked in order to obtain a comprehensive understanding of the intricacies that challenge urban greenspace areas in their quest to be sustainable. Thus, the guidelines for the implementation of the Greenspace Stress Model of Urban Impact have been based on the outcomes of the research; reported experiences at the Rietvlei Nature Reserve; as well as citations to research in other parts of the world.

Although the Greenspace Stress Model of Urban Impact was developed for the Rietvlei Nature Reserve in Tshwane (South Africa), the three most important components of the model are also typical of greenspace on the fringes of any other metropolitan area and could thus be applied to other but similar geographical spaces.

In line with this assumption, this chapter addresses the fourth objective of the thesis, namely to develop generic guidelines for the implementation of the

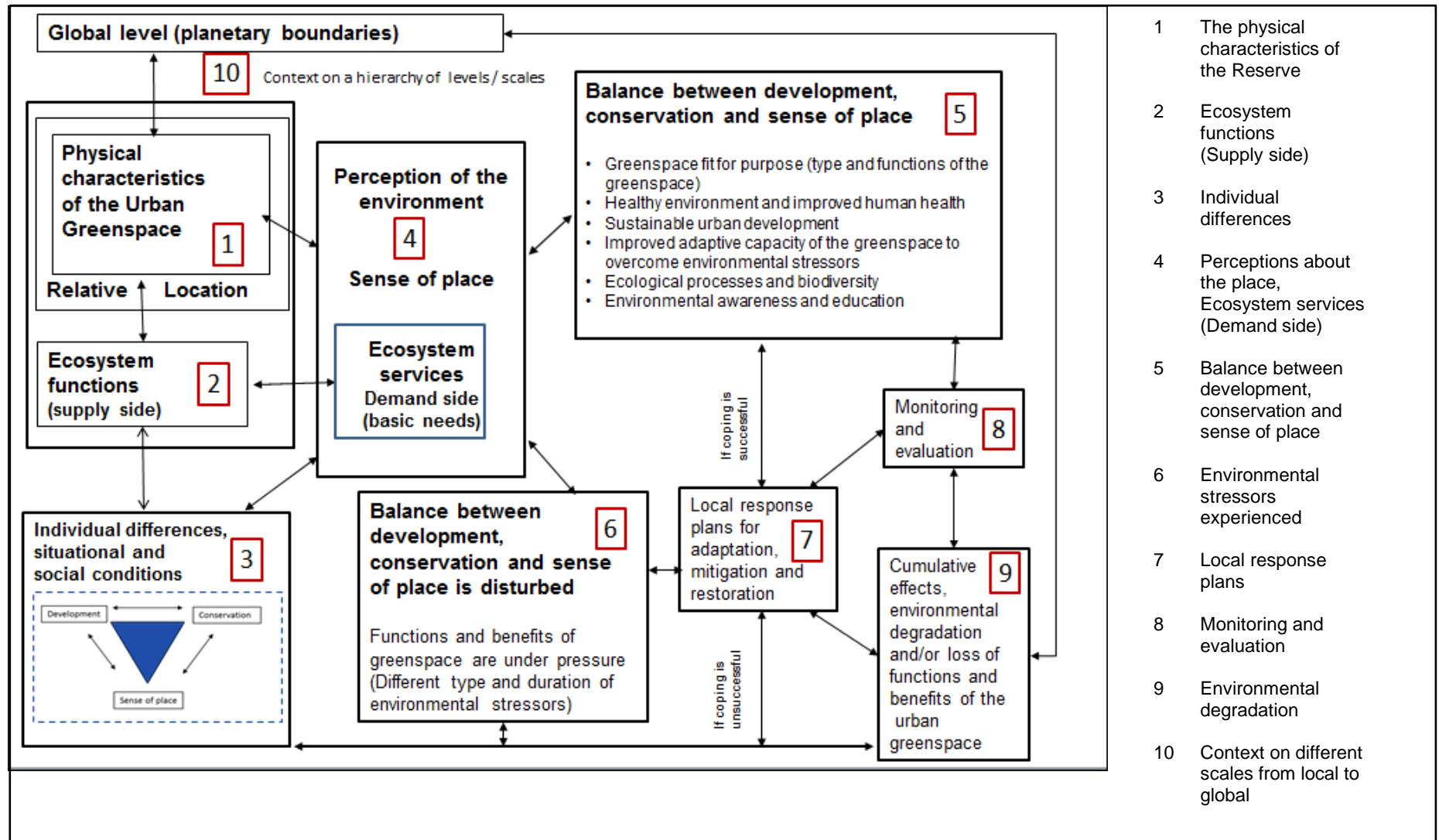
Greenspace Stress Model of Urban Impact. However, it can be assumed that these guidelines would have to be adapted to accommodate the specific origin, location and characteristics of the particular greenspace to be researched.

7.2 Guidelines for implementing the Greenspace Stress Model of Urban Impact

The Greenspace Stress Model of Urban Impact was developed specifically for the Rietvlei Nature Reserve (Figure 6.9). A more generic representation of this model (Figure 7.1) can be used when applying the SGMUI in other metropolitan areas.

Figure 7.1 should be read together with Table 7.1, in which the generic implementation guidelines are summarised. While Figure 7.1 and Table 7.1 are detailed in this section, an important consideration in applying the model and the accompanying guidelines is that due consideration should be given to local strategies and stressors particular to the geographical area of the greenspace in which the model will be applied.

The specific characteristics and functions of a greenspace may influence the prominence of particular legislation. In conservation areas managed through an ecological management plan, the relevant legislation is updated and considered in the development of local management strategies, plans and procedures. In Figure 7.1 policies linked to the National Environmental Management Act of 1998 would be more prominent in Blocks 1, 2 and 4 and policies related to Spatial Planning and Land Use Management Act of 2013 would be prominent in Block 3 and 4 of the model. These acts are, however, not exclusive to any particular blocks of the model.



- 1 The physical characteristics of the Reserve
- 2 Ecosystem functions (Supply side)
- 3 Individual differences
- 4 Perceptions about the place, Ecosystem services (Demand side)
- 5 Balance between development, conservation and sense of place
- 6 Environmental stressors experienced
- 7 Local response plans
- 8 Monitoring and evaluation
- 9 Environmental degradation
- 10 Context on different scales from local to global

Figure 7.1: The generic Greenspace Stress Model of Urban Impact (GSMUI)

Table 7.1: Guidelines for applying the Greenspace Stress Model of Urban Impact

	Activities	Key questions	Methods and Tools
1	Explore the context and physical characteristics of the urban greenspace (Focus on Form.)	What are the physical characteristics of the greenspace? (Appendix J1, Plate J1) Where is this greenspace? How does this greenspace fit into a broader context? What are the implications of administrative boundaries on different resolution levels for the management of the greenspace? How is the surrounding urban environment changing? What are the implications of these changes for this greenspace?	Maps and remote sensing images; Consult Local Integrated Development Programme documents, as well as Spatial Development Frameworks on different levels of jurisdiction (Appendix J).
2	Identify what the greenspace has to offer. (Focus on the ecosystem and activity.)	What are the ecosystem functions provided by the greenspace? Why is this greenspace maintained or conserved? What are the management objectives within the greenspace? Is the greenspace fit for its purpose?	Observation and participation; Literature study (including academic articles, reports, species lists, policy and guideline documents); Interviews with key informants; Adapt data capturing tools (Appendix C).
3	Identify stakeholders. (Focus on Activity.)	Who is involved in this greenspace? What is the nature of their involvement?	Literature study and observation; Snowballing for identification of key informants; Semi-structured interviews.
4	Evaluate environmental perceptions and sense of place of different stakeholders. (Focus on image and environmental awareness.)	What is special about this greenspace? What are the benefits of this greenspace? What are the ecosystem services by this greenspace? What do stakeholders expect from the greenspace (ecosystem services) and what are their needs in terms of the urban greenspace?	Observation; Semi-structured interviews; Focus group interviews (Appendices E to J). Allow for participation in line with the IDP, National Water Act of 1998, EIA legislation and social environmental impact analysis.
5	Evaluate the functions and benefits of the urban greenspace with due	How important are the identified benefits for this greenspace? Which benefits are the most important?	Identify environmental benefits from various sources. Evaluate the importance of the identified benefits in a focus group discussion. (Section 6.5) <i>(Table 7.1 continues...)</i>

	Activities	Key questions	Methods and Tools <i>(Table 7.1 continued)</i>
	consideration to the balance between development, conservation and sense of place.	Why has this greenspace not been developed? Are there any changes in the way the greenspace is used?	Create relevant graphic presentations. (Figure 6.7)
6	Identify and evaluate the environmental stressors.	What are the stressors that negatively impact on the functioning of the urban greenspace? How severe are the stressors? Are there different perspectives on the identified stressors? Which aspects of the stressors are within the control of the managers of the greenspace?	Identify environmental stressors from various sources. Evaluate the importance of the identified stressors in a focus group discussion (Section 6.5). Calculate and represent the Relative Stressor Values (Section 6.5; Figure 6.11). Create relevant graphic presentations. (Figure 6.11)
7	Develop local response plans for adaptation, mitigation and restoration.	What can be done in terms of each of the identified stressors for adaptation, mitigation and restoration? How can the response plans be effectively communicated?	Any available scoping, SIA or EIA reports for the particular greenspace or surrounding area should inform the Greenspace Stress Model of Urban Impact. Establish public-private partnerships; memoranda of agreement and collaborations (e.g. between service delivery departments, environmental specialists, local stakeholders, as well as inter-municipal collaborations).
8	Apply continuous monitoring and evaluation of the mitigation plans and strategies and re-design if required	Are all of the identified stressors addressed in the mitigation plans? How effective are the current mitigation plans? How efficient is the implementation of the current management plans? What is working well? Which parts of the management plans need to be adapted?	Collaboration with relevant stakeholders and a multi-disciplinary team of experts; Identify relevant processes and assign responsibilities; Evaluate management plans, policies, strategies and guideline documents.
9	Assess the impacts of the stressors.	What are the implications of the identified stressors to the functions and benefits of the urban greenspace?	Environmental Impact Assessment (EIA); Identify and apply the relevant benchmarks.
10	Link local actions to global implications.	Which international agreements have relevance to the urban greenspace?	Identify international collaborations and agreements. Place the greenspace within a broader context.

The characteristics of a particular greenspace should not be considered in isolation, but rather in relation to the local context of the interplay between development, conservation and sense of place (Toure, 2020). In addition, it should be noted that different perceptions of and the different forms of attachment to a place (sense of place) should be considered within the context of local development and the variety of responses to environmental stressors (Elmendorf, 2020; Russ & Krasny, 2017; Culwick & Bobbinsk, 2016; Ugglá, 2014; French, 2010; Farnum *et al*, 2005). In areas where high levels of competition over land use prevail, and where, owing to poor service provision, human needs are not being met, the evaluation of urban greenspace may differ from evaluations of more affluent areas (Anderson *et al*, 2020; Satgé & Watson, 2018).

While the following sections are detailed in terms of the generic implementation guidelines of the model, it should be noted that the sequence between the phases could be adapted to the particular circumstances of a specific geographical area. It should also be noted that the questions posed and the action required for each phase (Table 7.1) should be adapted to be relevant to the specific greenspace under investigation.

7.2.1 Determine the context and physical characteristics of the urban greenspace

The first and very important action required in the implementation of the model is to determine the various physical characteristics related specifically to the geographical location of the greenspace. To answer questions such as “Where?”, “What?”, “When?” and “How?” is crucial to better understand the greenspace within the context of the surrounding urban area. In fact, these responses could provide

important indicators of possible stressors that might underpin the model to be created for the particular greenspace.

The following important characteristics and the geographical context of the urban greenspace could be established with the support of maps and remote sensing images:

- Absolute and relative location
- Area of the greenspace
- Climate
- Hydrology
- Biome(s)
- Terrain
- Geology and soil.

In addition to these characteristics, the context of the greenspace should be established through the literature and reviews of documents related to local development and spatial development programmes. Some of these may be:

- History of the greenspace
- Changes to the urban area surrounding the greenspace
- General purpose of the greenspace
- Identification of possible stressors.

The literature study should include, *inter alia*, spatial development frameworks, local town planning documentation, documents provided by stakeholders within the greenspace, as well as items from the popular media. Semi-structured interviews with purposively-selected key informants should also inform this component.

For ease of reference, a template (Plate J1) that could be of assistance in implementing this phase of the model is presented in Appendix J.

7.2.2 Identify the ecosystem functions and services of the greenspace

Once the physical characteristics and context of the greenspace have been established, it would be necessary to identify the specific functions and services that the greenspace provides to the surrounding urban areas in terms of its inherent ecosystem (Table 7.1: the question section). Consultations and extensive literature reviews, that could include policies, reports and other documents specifically related to the greenspace, should be conducted with relevant experts (von Schiller *et al*, 2017).

Information gathered through consultation with experts and the perusal of documentation should be verified through observations, including observations by the respondents. During this phase, it is critical to find an answer to the question: “Why is this greenspace maintained or conserved?” Diversity assessments might also provide valuable insights into environmental quality and garner information about possible environmental health stressors in a particular greenspace (Baker & Greenfield, 2019) that could influence the ecosystem services provided by the greenspace. As such, the functions and ecosystem services need to be confirmed through ongoing observations within the study area.

Remote sensing images are useful for exploring the spatial distribution of ecosystem services and for measuring the patch size and extent of fragmentation of the green infrastructure. Landsat images on the other hand are suitable for exploring land-use changes, and Sentinel 2MSI for analysing data on a higher

resolution level (Mogano, 2017) (e.g. the biomass of *phragmites* (reeds)). Where wetlands are included in the urban greenspace, a tool such as the Wetland Classification and Risk Assessment Index (WCRAI) (Oberholser *et al*, 2014) could add value to the analysis.

7.2.3 Identify the stakeholders related to the greenspace

Stakeholders could include the local government; owners and managers of the greenspace; organised groups involved in the greenspace; the users of the greenspace; and people living or working in close proximity to the greenspace. Stakeholders can be identified through observations, the popular media and literature sources, and through snowballing and interviews, and should represent the widest spectrum of perspectives for the identification of the benefits and stressors within the greenspace. In terms of the individual differences among stakeholders, situational and social conditions do in fact influence the dynamics of the interplay between development, conservation and sense of place in these contexts, and these differences should therefore be considered for the particular greenspace to which the Greenspace Stress Model of Urban Impact is to be applied.

7.2.4 Evaluate environmental perceptions and sense of place as experienced by different stakeholders

Sebastien (2020), Russ & Krasny (2017), Culwick & Bobbinsk (2016), Uggla (2014), French (2010) and Farnum *et al* (2005) indicate in their research that human perceptions of the environment differ according to their attachment to a place and thus to the sense of place that they attribute to the place in question.

Sense of place can be enhanced by promoting environmental awareness of the ecosystem services rendered by a particular greenspace. Sense of place is influenced by the objective characteristics of the physical landscape, but also, and more so, by individual perceptions, knowledge and attitudes in respect of the place.

The research clearly revealed that environmental perceptions and sense of place do indeed influence decision-making concerning the important function of conserving urban greenspace. It is, therefore, necessary upfront to foster a shared understanding of the functions and benefits of the greenspace for different stakeholders (Elmendorf, 2020).

In order to establish the sense of place and the perceptions stakeholders may hold of a particular greenspace, it is necessary to pose a number of questions (Table 7.1) to establish the following attributes of the greenspace:

- Uniqueness
- Benefits
- Expectations related to it.

These questions could be answered through direct observation, and by conducting semi-structured and focus interviews involving the relevant stakeholders.

It is recommended that the importance of the ecosystem functions and services provided by a particular urban greenspace (Haase & Rink, 2014; Schäffler *et al*, 2013) should be considered by public and private decision-makers who need to increase the service delivery footprint and quality of life of the urban residents in the area.

7.2.5 Evaluate the functions and benefits of the greenspace within the context of the interplay between development, conservation and sense of place

Greenspaces on the urban periphery often fulfil an important role in enhancing the quality of life of the city dweller (Žlender & Gemin, 2020; Chen *et al*, 2020; Kondo *et al*, 2018; Bernstein, 2017; de Crom & Nealer, 2017; Coutts & Hahn, 2015; de Young, 2013). At the same time, these spaces may offer important ecosystem functions and services that could be directly linked to development, conservation and sense of place.

The attributes of the greenspace, the use to which it could be put, the objectives put in place by management and the associated benefits of the greenspace could be identified through observation, by consulting literature sources, and through interviews. Based on the answers to open-ended questions, themes can be identified to indicate the benefits of a particular greenspace. The reliability of the identified benefits can then be confirmed and evaluated in focus group discussions with purposively-selected key informants or participants.

Within the context of land-use competition in the city, it is important to establish why a particular greenspace has not been developed. In the case of the Rietvlei Nature Reserve, the *raison d'être* is water provisioning, and the support of other ecosystem functions.

Yet another point to note is that ecosystem functions or services are central to the interplay between development, conservation and sense of place (Figure 7.2), with sense of place being linked to the functions and use of a particular greenspace and especially relevant to cultural ecosystem functions and services. In this context

then, knowledge and an appreciation of the supporting, regulating and provisioning ecosystem services could also inform sense-of-place experiences.

As proposed in Figure 7.2, a template can be used to capture the identified benefits of a particular greenspace within the respective development, conservation and sense-of-place perspectives for that particular greenspace. As clearly revealed by the research, Figure 6.5, in conjunction with Section 6.5.1 in Chapter 6, highlights the importance of ecosystem services in the interplay between urban development, conservation and sense of place within the Rietvlei Nature Reserve.

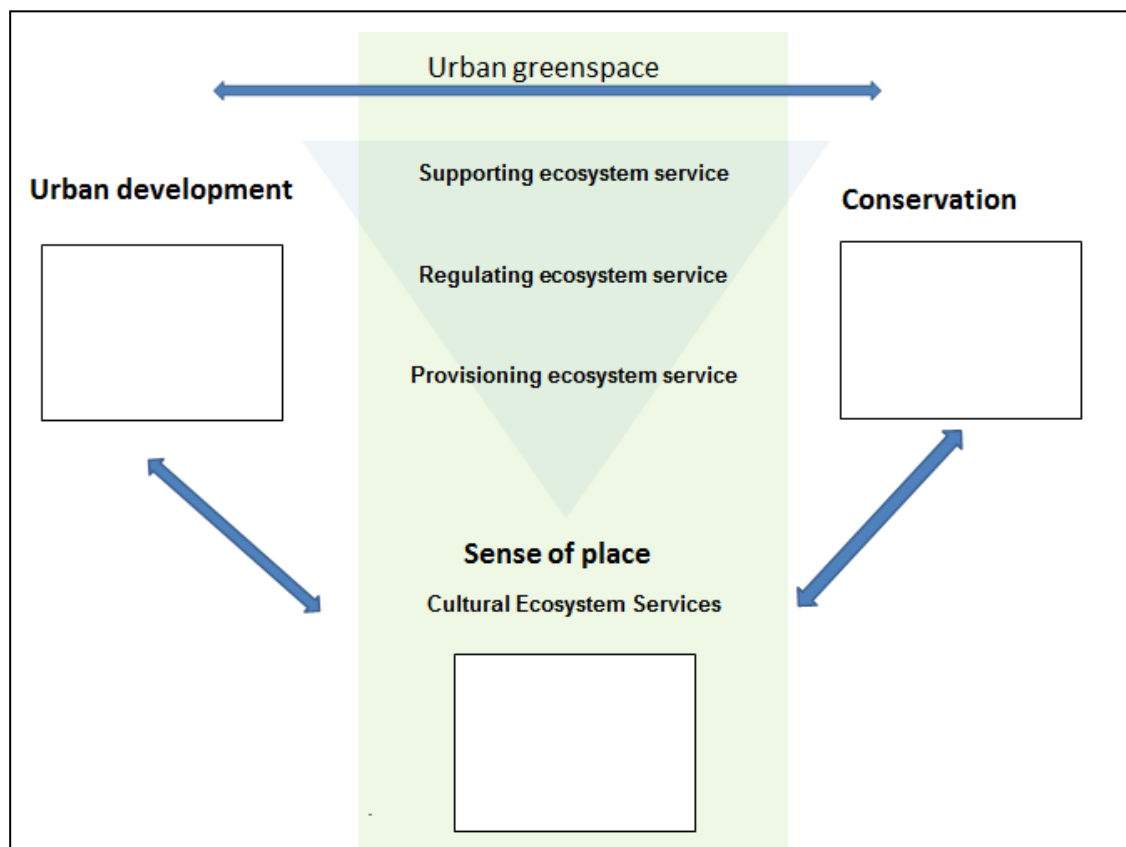


Figure 7.2: Template to be completed when evaluating benefits of a particular greenspace from development, conservation and sense-of-place perspectives

It is important to ensure that informants representing development, conservation and sense-of-place perspectives are included in focus group discussions where the associated services or benefits are to be evaluated. As a first step, the identified benefits should be individually evaluated in terms of a Likert Scale-type assessment.

The template used for the Rietvlei case study could be adapted to the particular greenspace to which the model could be applied (Appendix J: Plate J1: Template for individual evaluation of identified benefits within the urban greenspace).

The second step in the evaluation of the benefits would be the calculation of the Cumulative Likert Scale Values for each benefit (CLSV). The maximum possible value on the Cumulative Likert Scale is 60 when 12 participants all select the benefit as extremely important and award it a score of 5 ($5 \times 12 = 60$). The benefits are then listed according to the CLSV values, and based on individual evaluations, the top ten benefits - in this case, quoted as an example within the Rietvlei Nature Reserve - are identified and presented in Table 6.1.

After the individual evaluation process, the participants of the focus group would then be grouped according to their development, conservation and sense-of-place perspectives. In each of the groups, the benefits should be discussed and ranked. It would be helpful to create cards for each of the benefits so that participants can physically move them around while discussing their ranking.

An adapted version of the Plate J2 Template was used to capture the consensus ranking of benefits (Appendix J). As such, three versions of Plate J2 could be completed, one each for the development, conservation and sense-of-place groups

respectively. The top ten ranked benefits from these plates would then be used to inform the calculation of the Relative Benefit Value (Appendix J, Plate J4) and also in the comparison of benefits (Appendix J, Plate J5).

The template in Appendix J4 could be adapted to be used in the context where the model is to be applied (Chapter 6: Table 6.2: Comparison of the benefits of the Rietvlei Nature Reserve, Tshwane). This could be done according to the number of benefits included in the evaluation. In order to enhance the reliability of the findings, the interpretation of Table 7.1 should be informed and supported by observations made in the study area.

The radar chart (spider diagram) appears to be a suitable type of graphic presentation to compare the benefits from the different perspectives (Chapter 6: Figure 6.7). As the benefits were sorted in an Excel spreadsheet from the highest to the lowest, the radar chart (spider diagram) creates a continuous line (the red line in Figures 6.7 and 7.3). Furthermore, the radar chart provides for a visual comparison between the variables and presents the importance attached to the different benefits from the respective perspectives.

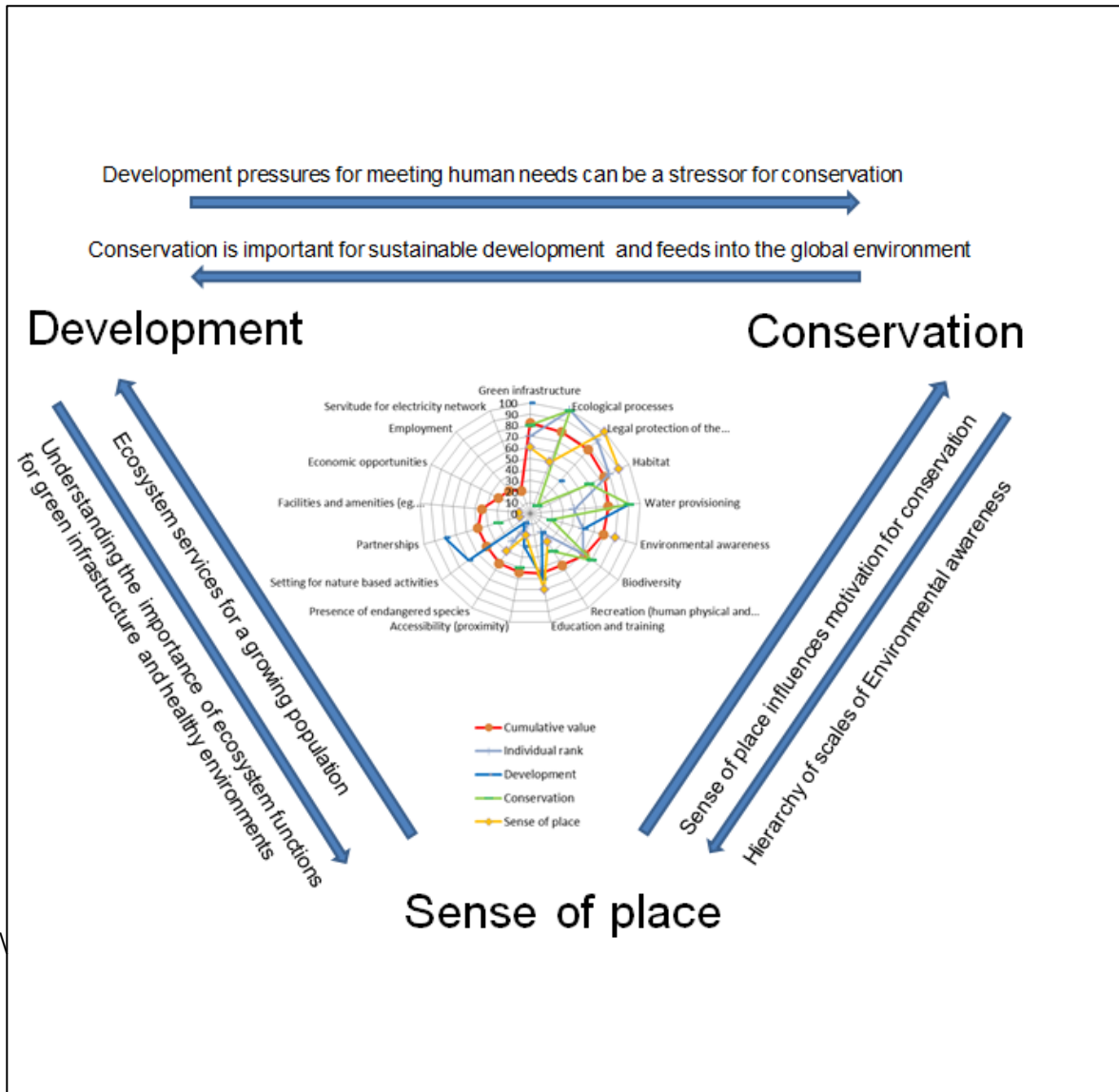


Figure 7.3: Comparison of the benefits of an urban greenspace from development, conservation and sense-of-place perspectives

Figure 7.3 places the evaluation of the benefits of a greenspace within the interplay between development, conservation and sense of place. The specific benefits recorded in Figure 7.3 were identified for the Rietvlei Nature Reserve and could as such be adapted for the urban greenspace to which the model is to be applied.

Should the Greenspace Stress Model of Urban Impact be applied to another greenspace, it should be assumed that the benefits, as well as the relative importance attached to them by the stakeholders, will differ from those of the Rietvlei Nature Reserve. Thus, based on the benefits and functions identified for the urban greenspace, the model should be adapted to the context in which it is to be applied. Relevant response plans should be developed for supporting each of the identified benefits.

As explained in this section, the methodology for evaluating the benefits of a greenspace could also be applied to evaluate any environmental stressors (e.g. Chapter 6: Section 6.5.2.3) captured during the research process.

7.2.6 Identify and evaluate environmental stressors within the urban greenspace

Urban greenspaces are vulnerable to stressors from the physical and socio-cultural environment (Pacione, 2009; Tzoulas *et al*, 2007; Nagar, 2006). Field observations, as well as remote sensing images, GIS and environmental management frameworks, are all especially suited to the identification of possibly sensitive areas that are under development pressure (Republic of South Africa, Department of Environmental Affairs. 2015). Observation notes, literature sources and semi-structured interviews should also provide valuable information for identifying stressors from the socio-cultural and natural environment. The stressors should then be listed in a table adapted from the one created for the Rietvlei Nature Reserve (Appendix J, Plate J6). After the stressors have been identified from a variety of sources, they need to be evaluated and endorsed in a focus group discussion.

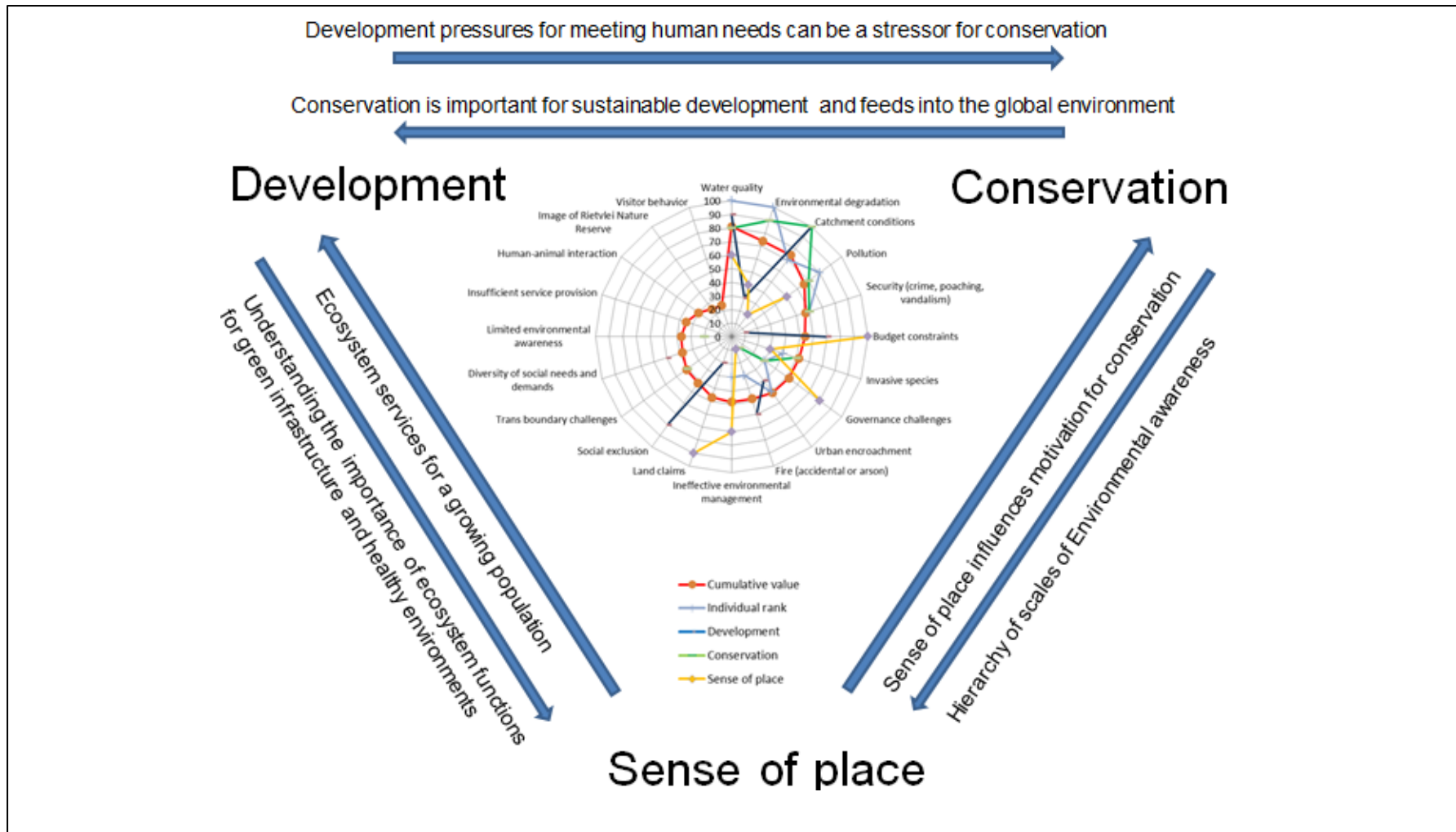


Figure 7.4: Comparison of stressors within an urban greenspace from development, conservation and sense-of-place perspectives

The stressors identified in Chapter 6 (Figure 6.8) are included in Figure 7.4, which presents a comparison of stressors within an urban greenspace from the different perspectives. After the template has been completed individually by all of the participants in the focus group, the Cumulative Likert Scale Value should be calculated again for each of the stressors indicated in the template. The stressors should then be discussed in a plenary session in which the same stressors would be adapted or confirmed. The Relative Stressor Values would then be calculated in a manner similar to that which was applied in the case of the benefits.

The templates provided in Appendix J should be adapted to include the stressors identified in the particular greenspace where the model is to be applied. Appendix J, Plate J8 provides an example of the evaluation of stressors within the Rietvlei Nature Reserve, while Plate J9 is an example of the comparison between the different stressors.

The stressors identified through this process should then be used to inform management of the challenges within the urban greenspace. Local response strategies should therefore include scoping reports, as well as specific plans and procedures, to timeously deal with the identified stressors.

7.2.7 Develop relevant local response strategies for each of the stressors identified within the greenspace

The practical part of the implementation strategy is to develop local response plans for the adaptation, mitigation and restoration of each of the identified stressors in order to build on a long-term vision for sustainability. Thus, it is important to include inputs from specialists and stakeholders in the development, implementation and evaluation of appropriate local response plans for each of the identified stressors.

It might also be necessary to make dynamic changes in order to maintain the functional homeostasis of the urban greenspace (Schulte *et al*, 2014). As such, relevant local response plans need to be developed for each of the stressors identified.

The Greenspace Stress Model of Urban Impact supports the principle of integrating sustainability into strategic decision-making. Any available scoping, SIA or EIA reports relevant to the particular greenspace or the area surrounding the greenspace to which the model is to be applied, should therefore be consulted. Strategic Environmental Assessments (Department of Environmental Affairs and Tourism, 2004) should inform mitigation strategies for each of the stressors identified in the greenspace under investigation.

Decision makers need to take cognisance of the importance to harmonise the relevant spatial development frameworks and plans at local authority level in order to effectively address the complex interplay between the three identified components. In the case study researched, the need for the two metropolitan authorities of Tshwane and Ekurhuleni to better align their respective spatial development frameworks and local development initiatives proved to be essential. In this exercise, they attempted to minimise the stressors experienced within the Reserve, and at the same time to optimise the benefits of the Reserve.

Sustainability and environmental protection are important components in the interplay between development, conservation and sense of place. Both play an important role in the dynamic Greenspace Stress Model of Urban Impact in which participation from different perspectives is encouraged. The model is strategic in

the sense that the stressors need to be identified and relevant local response strategies developed to address each of the stressors (Rapport *et al*, 2018). The principles of precaution and continuous improvement are also important in the implementation of the Greenspace Stress Model of Urban Impact, because risks should be timeously identified and mitigated before they become stressors that negatively impact on the functioning of the greenspace.

The notion that environmental stressors can be mitigated, thus leading to a restored balance between development, conservation and sense of place, is linked to the destination cycle (Butler, 1980). According to Butler (1980), a tourist destination that is over-developed can either be restored or left to deteriorate. In the case of the Rietvlei Nature Reserve, the urban greenspace is more than a tourist destination; however, the ecosystem services are as vulnerable to over-use as those of a tourist destination (Butler, 1980). It is therefore important to implement relevant strategies to protect the urban greenspace.

Early and sustained support from the community is an important success factor for the protection of urban greenspace. Community support is important in the context formal urban spatial planning processes of the global North (Elmendorf, 2020; Towne, 1998), as well as in the global South where informal development and lack of maintenance is evident within a context of competing needs (Yang *et al*, 2015; Mensah, 2014; Takon *et al*, 2013).

The local response strategies to deal with stressors should include an environmental communication plan to disseminate information about the stressors, as well as the mitigation measures. Potential stakeholders need to be made aware

of the stressors and opportunities for participation in the development and implementation of mitigation measures for each of the identified stressors. Public-private partnerships, memoranda of agreement and collaborations (e.g. between service delivery departments, environmental specialists, local stakeholders), as well as inter-municipal collaborations, are important in supporting the development and implementation of strategies.

The guidelines for evaluating the environmental stressors considered in the Greenspace Model of Urban Impact could contribute to the content covered by the Strategic Environmental Assessments (DEAT, 2004) and could thus be used to make recommendations for evidence-based implementation strategies (Rapport *et al*, 2018). Furthermore, strategic environmental management plans need to include communication plans in which environmental awareness is promoted.

A complicating factor in considering environmental stressors (and benefits) in an urban greenspace is that the combination of conservation and recreational activities within that space does not necessarily support the ecosystem services offered within the greenspace. Recreational experiences and tourism activities therefore need to be orchestrated into a balanced situation with provision being made for conservation and environmental protection initiatives (Hudson & Miller, 2005). As such, potential risks, threats and impacts that are evident in the conservation area should be included in a communication plan for environmental awareness. Such a plan should inform internal, as well as external stakeholders, about events and programmes in the greenspace.

7.2.8 Monitor the effectiveness and implementation of local response plans

The context of urban greenspace is dynamic. As such, it is important to continuously monitor not only the management plans, but also their implementation. Specific processes need to be formulated and tasks and responsibilities to be assigned. The agreements and partnerships forged in the formulation of the response strategies should also be monitored and evaluated, and new initiatives put in place.

During this phase, the critical questions to be posed would include the following:

- Are all of the identified stressors addressed in the mitigation plans?
- How effective are the current mitigation plans?
- How efficient is the process of implementing the current management plans?
- Who are the stakeholders and what can each of the multi-disciplinary teams of experts contribute to the protection of the urban greenspace?
- What is working well, and which portions of the management plans, policies, strategies and guideline documents need to be adapted?

The specific environmental stressors posing challenges to management, as well as the level of awareness in respect of the local response strategies change over time. Thus, management plans need to be regularly updated in response to the potential stressors which have been identified or experienced. The same applies to the local response strategies, many of which are focused on environmental awareness, which is largely promoted by sense of place and place making, both of which also vary over time (Ghavampour & Vale, 2019). Thus, the source, nature,

severity and duration of stressors, as well as the characteristics, relative location, functions and management of the greenspace need to be considered in the development of local response plans and strategies to mitigate stressors.

7.2.9 Assess the impacts of the stressors experienced within the urban greenspace

The stressors experienced in a particular urban greenspace should be assessed in order to devise suitable response strategies. Because the focus of the Greenspace Stress Model of Urban Impact should be of a particular greenspace within an urban context, the Strategic Environmental Assessments are typically conducted on a lower resolution level. As such, they are invaluable at this level as they are able to inform day-to-day management decisions and local response strategies within a particular urban greenspace (Department of Environmental Affairs and Tourism , 2004). A literature search and interpretations of the relevant remote sensing images should be conducted to assess the impact of the stressors that have been identified. This should be done in conjunction with fieldwork observations made on visits to the greenspace in question.

It should be noted that different strategies should be followed for the investigations into the respective classes of the identified stressors, and that it is important to assess the *status quo*, as well as the risks that could become stressors if not appropriately managed.

7.2.10 Link local actions to global implications

There are increasing concerns over planetary boundaries and environmental processes (Lombard, 2020; Prescott & Bland, 2020; United Nations, 2018; 2015; Sinnet *et al*, 2015; Brown, 2015; Schäffler *et al*, 2013; Carson, 1962). International

agreements need to be implemented on a local level. It is therefore important that an urban greenspace should not be evaluated in isolation, but that the stressors should be linked to global concerns.

Urbanisation is a world-wide phenomenon. In the global South, accelerated urbanisation is projected for the next decade (Population Reference Bureau, 2018). Thus, the implications of population increase and the interplay between development, conservation and sense of place are not limited to the local context, but also evident on a hierarchy of resolution levels (Sutherland *et al*, 2019; Baker & Greenfield, 2019). International agreements related to climate change and sustainability and recommended best practices should therefore be considered when evaluating stressors on a local level.

7.3 Conclusion

This chapter provided guidelines for implementing the Greenspace Stress Model of Urban Impact. Urban growth and development and the associated increase in human needs continue to exert increasing pressure on urban greenspaces. Under such conditions, all of the variables (e.g. benefits and stressors) might differ for different places, and also for the same place, but at another point in time. These changing circumstances require that the Greenspace Stress Model of Urban Impact should be a dynamic model. Furthermore, the specific greenspace to which the Greenspace Stress Model of Urban Impact is to be applied would also determine the specific benefits and stressors, which should be clearly evident, as well as the specific response plans required.

The legislative context is dynamic and when applying the GSMUI, the latest environmental legislation, spatial development frameworks and policy documents on different levels of resolution should be considered (refer to Section 4.4.1).

The following chapter, the final one in this thesis, provides a synthesis, recommendations and conclusions concerning the findings of the research case study of the Rietvlei Nature Reserve, Tshwane (South Africa). This case study should be assessed against the outcomes of the objective setting, the methodology applied, the research results accumulated and addressed, as well as the development of the Greenspace Stress Model of Urban Impact.

Chapter 8: Synthesis, recommendations and conclusion

8.1 Introduction

Urbanisation is a worldwide phenomenon with a significant impact on not only the level and rate of urbanisation, but also on the present and future landscape dynamics and patterns of urban places. It further implies continuous challenges that must be met in terms of urban infrastructures and service provision to satisfy the population's increasing needs.

A geographical perspective and a case-study research design were therefore applied in this research to assess the importance of the Rietvlei Nature Reserve, Tshwane (South Africa) as a critical green infrastructural component of the Tshwane Metropolitan Area. Furthermore, it also set out to assess the impact of the geographical interplay between urban development, conservation and sense of place.

Environmental stressors from the contexts of development, conservation and sense of place were identified and then integrated into the Greenspace Stress Model of Urban Impact. The model developed for this geographical location could potentially be applied to other urban greenspaces for the purpose of evaluating the geographical interplay between urban development, conservation and sense of place in such situations. It was, therefore, necessary to identify opportunities and threats to urban greenspace emanating from urban growth and development, together with the associated increasing human needs - including the need for the sustainable conservation of dedicated urban greenspace.

The Greenspace Stress Model of Urban Impact that was developed for the Rietvlei Nature Reserve is based on the Stress Model of Urban Impact developed by Pacione (2001). It also incorporates the nexus between urban change, ecosystem services and human quality of life, as postulated by Haase and Rink (2014). In the case of the Rietvlei Nature Reserve, however, urban change does not represent shrinkage, as modelled by Haase and Rink (2014), but rather urban growth and the spatial manifestation of urban land-use functions.

The concept of a destination cycle (Butler, 1980) informed the Greenspace Stress Model of Urban Impact as the notion that a destination (site) which is under stress can be restored, if relevant changes are implemented; or decline, if the mitigation measures are not successful. However, in the Greenspace Stress Model of Urban Impact developed for the Reserve, this notion is relevant not only to tourist destinations, as in the case of Butler's model (1980), but also to other multi-functional urban spaces.

Sense of place has also been included in the Greenspace Stress Model of Urban Impact through the incorporation of an adapted version of the model by Montgomery (1998). Although the selected models were updated with later applications, the original models were used and referred to in the Rietvlei research study.

The geographical perspective applied in this research focused on the implications of the location of the Rietvlei Nature Reserve within its metropolitan context, as well as on the perspectives that selected stakeholders noted of this space. The first objective of the study was the focus of Chapter 4. It was to map and assess the

implications and challenges of urban growth and development and the ongoing changing land-use functions and infrastructure of the surrounding areas on the conservation of the Rietvlei Nature Reserve as a prominent urban greenspace within the Tshwane Metropolitan Area.

The second objective, namely to analyse and assess the importance of the critical greenspace functions of the Rietvlei Nature Reserve for conservation and sense of place, was explored in Chapter 5. This chapter focused on the conservation activities in the Reserve and the sense of place that the Reserve holds for many that appreciate this particular greenspace within an urban environment.

The third objective was to develop a model that could be used as a possible management tool to sustain the future of the Rietvlei Nature Reserve as a sustainable urban greenspace. The Greenspace Stress Model of Urban Impact was introduced in Chapter 6, where it illustrates how different components can be linked to demonstrate the interplay between urban development, conservation and sense of place.

The fourth objective, namely to develop strategic implementation guidelines for the Greenspace Stress Model of Urban Impact in a South African metropolitan context, was the focus of Chapter 7.

Chapter 8 is the final chapter of the thesis and attempts to provide a summary of the findings and recommendations of this research study, as well as a conclusion summing up the outcomes of the research.

8.2 Findings regarding the implications of urban development for the Rietvlei Nature Reserve

The City of Tshwane was the metropolitan area in Gauteng with the highest population increase (12,1%) recorded between 2011 (the South African Census) and 2016 (the Population Household Survey). On the other hand, the City of Ekurhuleni presented with an increase of 6,3% during the same five-year period (StatsSA, 2018) (Chapter 1: Table 1.1).

The research revealed rapid urban growth and development taking place in the area surrounding the Rietvlei Nature Reserve. These processes involved ongoing land-use changes and development pressures on the Reserve (Chapter 4: Section 4.4), as well as an increasing demand for service provision (Chapter 4: Section 4.5).

When the Reserve was proclaimed in 1935, its *raison d'être* was to provide water to the growing population of Pretoria. As such, it was important for the provisioning function that the Rietvlei Nature Reserve should be legally protected from urban development pressure, which did in fact transpire with the promulgation of legislation in this respect. Furthermore, the issue of its legal protection is also acknowledged in the spatial planning frameworks at both the Gauteng provincial level and at the local level, by both the Tshwane and the Ekurhuleni metropolitan municipalities.

However, on account of the declining availability of space in the city, greenspaces have had the tendency of becoming multi-functional (van der Wateren, 2012). This was found to be the case with the Rietvlei Nature Reserve, which provides space for bulk electricity and water infrastructural networks and recreational spaces. It

also supports healthy ecosystems, thus protecting the biodiversity of the area, and natural processes such as carbon sequestration and water purification.

Proclaimed township development, and retail and light industrial development in the area surrounding the Reserve, have collectively led to increased pressure on the already congested road infrastructure bordering the Reserve. Thus, the relative location of the Rietvlei Nature Reserve alongside proclaimed corridors for urban development and transport could contribute to long-term development pressures on the Reserve as a conservation area (Pelser, 2019).

Based on the analysis in Chapter 4, it is evident that urban-type land-use functions, as well as pivot irrigation, are increasing in the catchment area of the dam. This trend will most probably increase the risk of anthropological eutrophication from urban discharge and agricultural runoff. Of particular note is the fact that land-use and urban developments in the catchment area of the dam are having a larger impact on the Reserve than the visual impact of the housing developments in close proximity to the dam. Thus, developers involved in promoting the areas adjacent to the Reserve for development need to become sensitive to the ecology and the prevailing water drainage patterns of the Reserve.

As the research revealed limited spatial co-variation between the natural and current administrative boundaries, some of the stressors within the Rietvlei Nature Reserve have originated from areas falling outside the jurisdiction of the Reserve management and even that of the Tshwane Metropolitan Municipality. Furthermore, the rapid development of formal and informal settlements in the catchment area of the Rietvlei Nature Reserve is posing serious challenges for the

capacity of the ERWAT waste treatment facility. Informal settlements that are typically associated with a lack of basic service delivery in the catchment area of the Reserve, are, therefore, placing increasing pressure on the quality of the water entering the Reserve.

Water quality was identified as an important stressor within the Rietvlei Nature Reserve (Hart & Matthews, 2018; Fisher, 2017; Department of Water and Sanitation, 2017; Booyens *et al*, 2012; Oberholser *et al*, 2008; Toerien & Walmsley, 1979). This is significant because the environmental quality of the catchment area, as well as the pollution of the groundwater sources, could influence the water-provisioning capacity of the Rietvlei Dam.

This is not unique to the case study as most South African cities and towns are experiencing major challenges with limited water resources to meet the demands of their growing populations (Knappe, 2011). Not only is the volume of water a problem, but pollution and the degradation of the catchment area are contributing to its declining quality (Environmental Impact Management Services (Pty) Ltd, 2019; van Ginkel, 2011; Oberholser *et al*, 2008). It is therefore becoming increasingly important to protect the systems that support the sources of water provisioning.

It is expected that over the next 40 years, water provisioning from the Rietvlei Nature Reserve will be increased from just over 40 000 mega-litres per day to more than 200 000 mega-litres per day (City of Tshwane, 2016 (b)). This will require engineering excellence and better collaboration with environmental

specialists and the relevant stakeholders involved within the Reserve and in areas adjacent to it.

The natural purification capacity of the peatlands in the Reserve also needs to be protected and potential impacts carefully managed. Greater in-depth knowledge of the geology and hydrology of the Reserve also needs to be prioritised as an important pre-requisite to the essential upgrading of the infrastructure (Chapter 4: Section 4.5).

Apart from the findings made in terms of the stressors mentioned above, the research also uncovered positive aspects associated with the Reserve. The most important beneficial functions are water provisioning, conservation and recreation. Based on the semi-structured interviews with key informants, the most frequently mentioned theme around the Reserve's benefits was water provisioning.

Environmental awareness is a potential benefit for the conservation area, and opportunities for creating environmental awareness were identified as important pre-requisites for establishing this benefit, which pertains to sense of place within the Reserve. The presence of flora, fauna and natural habitats, provision of water and green lungs for the city were also mentioned as beneficial aspects associated with the Reserve. These are related to the ecosystem services of urban greenspace, which in itself is also linked to opportunities for human interactions with nature.

Proximity to the conservation area was also considered to be a positive externality for property prices, even though the research indicated that the access to the major routes had a greater influence on property prices than proximity to the Rietvlei

Nature Reserve. In fact, owing to the ease of access to this particular type of greenspace via major routes between O.R. Tambo Airport and the Pretoria CBD, accessibility can be considered to be an important benefit of the Reserve.

Clearly, from the perspective of the effects of urban development on the Reserve, the research revealed the complexity and challenges resulting from the perceived interplay between development, conservation and sense of place. These aspects can be attributed to the fact that there is a lack of spatial co-variance between the natural and administrative boundaries in the context of the Rietvlei urban greenspace; and furthermore, that there is no measure of effective co-ordination in the spatial development programmes between the neighbouring metropolitan municipalities of Tshwane and Ekurhuleni.

8.3 Findings regarding the implications of conservation and sense of place for the Rietvlei Nature Reserve

The Rietvlei Nature Reserve was proclaimed as a conservation area in 1935 (Marais 2015) and comprises of about 25% of the protected land area in Tshwane. With an area of 4 000 hectares (40km²), it is a large urban greenspace which renders a variety of ecosystem services (Wolhitz, 2016). The Reserve is a multifunctional greenspace which provides not only recreational space, but also conserves the natural environment and supports electricity and water provisioning to a growing urban population.

Because legislation prohibits development in a sensitive environment, the legal protection of this conservation area was prioritised as an important benefit in respect of the Rietvlei Nature Reserve as a greenspace. (In fact, environmental awareness was awarded the same level of acknowledgement as legal protection.)

The other benefits within the Rietvlei Nature Reserve that were rated as more important include the green infrastructure, ecological processes, water provisioning, and the protection of biodiversity, as well as improved opportunities for recreation.

Wetland awareness and education remain important components in the interplay between urban development, conservation and sense of place. Yet, the research showed an apparent lack of public awareness as to the importance of the conservation of the wetlands for water provisioning. In fact, the wetlands are apparently being sacrificed to urban developments in the area surrounding the Rietvlei Nature Reserve. Moreover, the developers are not all necessarily aware of the impact of urban developments on stream flow and their potential effect on wetlands (Sieben *et al*, 2017).

Furthermore, stormwater management plans and the construction of weirs are sometimes seen by the developers as unnecessary costs to be incurred in an urban development project. Under such conditions, it is, however, important to realise that rather than infiltrating slowly into wetlands, rainwater is often channelled at high speeds into the stormwater systems or rivers, thus impacting negatively on the water-provisioning capacity of the aquifers.

Regardless of the sense of place and environmental perceptions of visitors or stakeholders to the Rietvlei Nature Reserve, if a situation should occur where the water source becomes degraded to the level that there are deficiencies in terms of its quality and quantity and in its ability to provide for the needs of a growing population, this stressor could have catastrophic repercussions. It is therefore

essential to regularly disseminate information regarding the benefits and stressors pertaining to urban greenspaces to the relevant officials and audiences in order to inform policies, practices and local mitigation strategies.

In cases where sensitive environments such as the Rietvlei Nature Reserve need to be protected, environmental awareness and strategies to deal with the particular environmental stressors should be brought to the attention of management and the local authorities. In a nutshell, the induced perception or image of the initial greenspace should be adapted accordingly (Hudson & Miller, 2005).

Water provisioning was identified by the key informants in the semi-structured interviews as the most important function of the Rietvlei Nature Reserve. This evaluation was based on the ranking of the objectives of the Rietvlei Nature Reserve as formulated in the Ecological Management Plan (Marais, 2015). Surprisingly, owing to the limited range of ecosystem-provisioning services provided by the Reserve, the provisioning function did not feature prominently in the Gauteng Biodiversity Assessment (Marais, 2015). In fact, the research revealed a limited awareness of the importance of water provisioning by the visitors who were interviewed.

Other aspects of the Ecological Management Plan for the Rietvlei Nature Reserve that came to light in this case study are that it appears to be a dynamic management tool and that it is continuously being adapted according to the current situation at any point in time (Marais, 2015). Its specific role in maintaining the balance between the jackal population and the young blesbuck, for example, relies on the careful monitoring of the two specie populations, which it recommends, and

continual adaptations being made in this respect. Yet another example of its adaptability is that it recommended that the cheetahs be relocated from the Reserve in 2019 when the declining number of mature blesbuck on which they prey, became noticeable. The other reason for this drastic move was to protect the carrying capacity of the Reserve.

Further examples of adaptations to changing conditions which were implemented in line with the identified needs at Rietvlei include the strategies for controlling alien plant invasions, wetland restoration, and a controlled fire regime. This research study revealed various dedicated attempts and initiatives to manage the degradation of the Reserve as a result of erosion and encroachments by invasive species.

The eradication of invasive species in the Reserve is linked to the *Working for Wetlands* programme, and was implemented by the Friends of Rietvlei (Friends of Rietvlei, 2017). It involves sustained veld management, an essential practice for dealing with the invasive species and the protection of the wetlands. As such, the City of Tshwane collaborated with the Agricultural Research Council to import the *liothrips tractabilis* (Thrips), an insect which is native to Argentina, as a biological agent to control the pompom weed. The photographs in Chapter 5 (Figure 5.11) show that despite different interventions, the pompom weed was still a challenge in 2019. Improved coordination between interest groups and officials, as well as the regular dissemination of information, could support the initiatives for improved veld management.

Owing to limited funding and manpower, attempts to eradicate invasive species were focused on the dedicated recreational areas in the Reserve, namely Fern Fountain, the Marais Dam picnic area, the Big Lapa and its surroundings, Coots Corner and Jakkalsgat. Furthermore, all green and silver wattles were removed “in a more-or-less 50-metre wide strip along the access roads from Coots Corner all the way to the Big Lapa and also further up to the Jakkalsgat turnoff” (Strobach, 2018: 8). This was in line with a strategy recommended by Witt *et al* (2017) to focus the activities for the eradication of invasive species around tourism facilities and along buffer zones.

Also of importance in designing effective eradication strategies was the mapping of the respective spatial distributions of invasive species (Mavimbela *et al*, 2018). Despite the efforts of the Reserve management and Friends of Rietvlei, in conjunction with the veld management strategy that is applied at the Reserve, invasive species have remained a stressor here. They not only have a negative effect on the carrying capacity of the Reserve, but also pose a continuous threat to biodiversity in the adjacent urban areas (Derkzen *et al*, 2017).

The functions of the Rietvlei Nature Reserve tend to be beneficial to the Tshwane Metropolitan Municipality in that it provides the city with water. On the other hand, the natural water purification capacity of the dam, a cost-saving attribute of the Reserve, is a further asset. Furthermore, the physical and psychological benefits of interaction with nature are well-documented positive greenspace attributes (Meyer-Grandbastien *et al*, 2020; Kondo *et al*, 2018; Jennings *et al*, 2017; De Crom & Nealer, 2017; World Health Organisation, 2016; Hall & Page, 2014; Irvine *et al*,

2013; Mayer *et al*, 2009) and are also relevant in the case of the Rietvlei Nature Reserve.

The Rietvlei Nature Reserve presents benefits for biodiversity, including the preservation of the Bankenveld Grassland biome and its associated species. On the other hand, the zoological aspects of the Reserve are also beneficial since they constitute part of the research programme for the National Zoological Gardens, as well as an international breeding programme. In addition, the conservation element provides educational opportunities for students studying Nature Conservation, and at the same time could increase the number of visitors to the Reserve. This, in turn, could supplement the income from the Reserve for the Tshwane Metropolitan Municipality. Thus, the preservation of the biodiversity of the Reserve is clearly of importance to the Tshwane Metropolitan Municipality in that it is one of the sources that provides financial inputs for the municipal budget.

8.4 Recommendations for the Rietvlei Nature Reserve

The interplay between development, conservation and sense of place has important implications for the Rietvlei Nature Reserve. The favourable site and situation, and relative location (context) of the Rietvlei Nature Reserve should thus prompt the Tshwane Metropolitan Council to prioritise the management and conservation plans for it on its agenda (Marais, 2015).

The management plan for the Reserve should therefore not only focus on the area within the boundaries of the Reserve, but also take note of the broader context of its relative location between two growing metropolitan areas and adjacent to spatial development corridors. It is evident that development in the areas adjacent

to it is placing increased pressure on the Reserve which has resulted in different perceptions on the comparative importance of the functions rendered and the benefits offered by this urban greenspace.

The changing land-use functions in the catchment area of the Rietvlei Dam, as well as the challenges regarding service provision to a growing population, do not fall within the jurisdiction of the management of the Reserve. The resultant implications for the Reserve should, however, be considered, and possible mitigation plans and strategies for dealing with the stressors should be implemented. As such, better collaboration between the Reserve Management and the metropolitan municipalities of Tshwane and Ekurhuleni is vital. Representatives from the Rietvlei Nature Reserve should also attend the meetings of the Hennops Catchment Forum in order to gain a broader understanding and knowledge of developments in the catchment of the Rietvlei Dam.

8.4.1 Recommendations for the management of and conservation plans for the Rietvlei Nature Reserve

This analysis showed that the stressors within the Rietvlei Nature Reserve include budget constraints, as well as stressors related to ineffectual environmental management, namely the presence of invasive species, environmental degradation, pollution, unacceptable visitor behaviour, limited environmental awareness and ineffectual security measures. The poaching of rhinos and lions and also smaller game species, as well as crime generally, has had negative implications for conservation efforts and the biodiversity of the Reserve, and for recreation and tourism. Other stressors, also identified, but from outside the Reserve, include unsatisfactory conditions within the catchment area of the dam

(e.g. urban encroachment, land claims, political challenges, the varying social expectations, perceptions and demands in respect of the Rietvlei Nature Reserve, as well as trans-boundary and inter- governance challenges).

Owing to the lack of spatial co-variation between the natural and the administrative boundaries, there is a need for improved co-ordination regarding the intergovernmental and non-governmental organisational intersect within the larger Rietvlei Nature Reserve greenspace. The establishment of an inter-metropolitan Tshwane-Ekurhuleni ecological forum or committee is recommended. This committee should also be involved in the work of the Hennops Catchment Forum in supporting water management issues and the sustainable provision of water.

Furthermore, management based on ecosystem principles is becoming increasingly important and essential in areas in close proximity to high-density urban developments since the effective management and maintenance of greenspace at the catchment level contribute to the resilience of an ecosystem (Steenberg *et al*, 2017).

Integrated water resource management has been recommended as a mitigation strategy to sustain the quality of the water in the Reserve (Chapter 6). Because water sources are interlinked in an aquatic system, in this particular case the quality of the water in the wetlands impacts upon the capacity of the Reserve to supply the City of Tshwane with water. Greater collaboration is therefore required with and between the local governments with jurisdiction over the catchment area of the dam.

Furthermore, inputs and guidance from the Hennops Catchment Forum, as well as the implementation of the Rietvlei Dam Catchment Management Plan (Environmental Impact Management Services (Pty) Ltd, 2019) and of recommendations from research (Mouton *et al*, 2015, Dickens *et al*, 2003), should inform local response strategies focusing on the management of the quality of the water.

The Catchment Management Plan for the Rietvlei Dam reaches across municipal boundaries (Environmental Impact Management Services (Pty) Ltd, 2019) and its implementation remains an important consideration for the local planners in their quest to address the associated environmental stressors. Thus, the high priority awarded to research on water quality should be supported on an ongoing basis.

The monitoring of the quality of the water should be conducted not only through chemical analysis but also through biological monitoring (e.g. the identification of signature species in changing wetlands; the monitoring of algae in streams and dams; and the timing of the hatching of bull-frog eggs (Oberholser *et al*, 2008).

The monitoring of water quality on a continuous basis is important in that it supports the water-provisioning function of the Reserve to the City of Tshwane. Furthermore, physical, chemical and biological indicators could also be used to evaluate the health of the ecosystem and the success of the local mitigation strategies. Should early warning signals be recognised, adaptive strategies should be devised timeously so that the stressors do not eventually reach catastrophic proportions.

Owing to the seasonal variation and ecological activities within the Reserve, the timing of interventions is very important (Chishaleshale *et al*, 2015). Seasonal

activities, such as a proper burning regime, with controlled veld fires, the application of herbicides, the removal of weeds before flowering, and the sowing of the correct type of grass for re-growth, should be carried out at the appropriate times.

Other challenges in terms of procurement and administrative bureaucracy are also considered to be stressors in respect of which timeous interventions are essential (Friends of Rietvlei, 2017). It is therefore important for interested parties to realise that if the planned activities are not carried out at the scheduled time and the challenges are not properly addressed, the implications will be dire and would therefore need to be spelled out in the finest detail.

From the research, it became evident that decision makers need to clearly understand the implications of their decisions in respect of the urban greenspace and wetlands (e.g. wetland ecosystems may have thresholds beyond which the risks or negative impacts could emanate to become stressors that have detrimental consequences for their functioning). It is therefore important for both public and private entities to protect the greenspace through well-articulated and practical conservation plans and ongoing awareness programmes.

Public-private participation is often seen as a strategy to improve efficiency and the capacity to extend services to a broader population. Examples of this strategy are evident in both the global North and the global South. In Thousand Oaks (California), for example, a coalition of business people, government representatives, educators and citizens recommended strategies for the preservation of land for open space functions and the protection of wildlife and

ecosystems, and subsequently established a regional trail system (Towne, 1998). Private-public partnerships have also played an enabling role in re-establishing greenspace, as in the case of Eden Park in Malawi (Mkula, 2015). On the other hand, on an international level, the WESSA's Environmental Governance Programme promotes partnerships with stakeholders and authorities (Wildlife and Environment Society of South Africa, 2018).

Since budget and governance constraints were identified as stressors in the Rietvlei Nature Reserve, cooperation and agreements for participation between the different agencies are important. This is particularly relevant too to all of the interest groups which were identified to be active in the Rietvlei Nature Reserve. Friends of Rietvlei (WESSA), the South African Hunters and Game Conservation Association, the Pretoria Sailing Club, Honorary Rangers (SANParks), and the group, Elephants, Rhinos and People; as well as various corporate and individual volunteers and champions supporting the goals set for the Rietvlei Nature Reserve are working together with the employees at the Reserve.

This research study further found that the problem of security of the conservation area and the safety of visitors, both of which were identified together as one of the stressors pertaining to the Rietvlei Nature Reserve, are important initiatives that should depend on the forging of public-private partnerships and the implementation of volunteer programmes. Guards are currently on duty at the entrance gates to the Reserve, and are backed up by the Honorary Rangers and the Friends of Rietvlei who are voluntarily involved in, amongst others, supporting the safety and security measures in place in the Reserve. Security has improved

through patrolling (e.g. through the services of the Honorary Rangers, who also monitor and maintain the fences around the Reserve). There are also partnerships with non-government organisations, such as Elephants, Rhinos and People, which support the safety of the rhinos in the Reserve.

Incidents of crime and poaching (e.g. rhino poaching on 26 May 2016 and 7 July 2017); the poisoning of two lions in October, 2017, and the culling of four lions in 2019, precipitated an awareness of the important role that security plays in dealing with this specific stressor. Safety and security should therefore receive more attention in the Ecological Management Plan (Marais, 2015).

The Ecological Management Plan for the Rietvlei Nature Reserve should not only recommend strategies for mitigating stressors, but also include specific recommendations as to how the benefits of the Reserve could be supported and strengthened (Figure 6.6). In fact, ecological processes, habitat and biodiversity have already been addressed in this plan (Marais, 2015). Furthermore, the Ecological Management Plan should also focus more on promoting awareness of the benefits of conserving the grasslands for water purification and the water-provisioning functions of the Reserve (Zhao *et al*, 2020).

8.4.2 Recommendations for the ongoing environmental awareness programmes within the Rietvlei Nature Reserve

A communication plan for the Rietvlei Nature Reserve requires strategies for both internal and external communication. The current initiatives for school visits and the training of teachers should be supported and extended. Improved environmental awareness is not only relevant to environmental education, but also

to capacity building of the staff and stakeholders involved in the Reserve. Thus, not only conservation staff, but also security guards and waiters, should be empowered to answer questions about the Reserve.

Based on the findings of the research, there are indications that visitors are lacking in their awareness of the Reserve's ecosystem benefits. Although Friends of Rietvlei makes use of regular meetings and the social media to communicate with members, the communication plan needs to be extended to also include visitors to the Reserve who are not members of any non-government organisation.

Since public awareness as to the importance of the ecosystem functions of greenspaces is an important aspect in their long-term protection, provision has been made at the Reserve for guided walks (with interpreters) and special events and programmes to promote this objective. However, the environmental awareness programmes which are currently limited to learners and students only, should be extended to the general public (Culwick & Bobbinsk, 2016). Furthermore, the environmental communication strategies in use should present urban environmental data in a format that is convincing and useful to decision makers (Lauer *et al*, 2019). A variety of communication platforms are recommended in the literature (e.g. community radio stations and electronic social media (Hove & Osunkule, 2019), and Friends of Rietvlei, the Pretoria Sailing Club, Birders and Photographers do indeed play an important role in this regard.

The environmental awareness and educational initiatives at the Reserve should be enhanced by forming sound partnerships with educational institutions and by making the facilities at the Reserve available for purposes of environmental

education. Currently, *ad hoc* lectures, guided hikes throughout the Reserve and educational events are presented. Information is also disseminated through the websites for the Reserve and the Friends of Rietvlei, and also through other social media.

Pamphlets could also be distributed at the entrance gates. Furthermore, a marketing and communication plan should be developed for the Reserve. It could be informed by the recommendation by Wilhelm-Rechmann *et al*, (2013) that social marketing concepts should be used to promote the integration of conservation plans into land-use planning.

The interplay between development, conservation and sense of place can therefore be influenced through the dissemination of information, which should include facts about the facilities, amenities and events at the Reserve, but more importantly information about ecosystem services and challenges regarding water provisioning. By improving the environmental awareness of visitors, their sense of place of the Rietvlei Nature Reserve might also be enhanced.

Effective environmental communication is essential to increase awareness of the benefits and stressors within the Rietvlei Nature Reserve. The image of the Rietvlei Nature Reserve as an important nature-based tourism and recreation destination, as well as a conservation area for protecting ecosystem functions and services, should be strengthened. Thus, the marketing plan for promoting the benefits of the greenspace should thus also include the benefits attached to the Reserve's green infrastructural component.

Knowledge translation is more than a marketing plan for sustainable tourism, and should also target an appropriate audience. This implies shared understanding by different stakeholder groups on the benefits and stressors of the Rietvlei Nature Reserve. Furthermore, improved information management is essential if informed decision making is to be supported (Republic of South Africa, Department of Environmental Affairs, 2015). This could include an electronic repository with links to research reports on the Rietvlei Nature Reserve. Posters with environmental interpretations could be placed at strategic points, such as at picnic spots, bird hides and the Coffee Shop to enhance awareness of the importance of wetland conservation and biodiversity on a global level.

It is important to link local issues to global environmental concerns (Roberts, 2008). Non-government organisations, such as WESSA and EWT, which are active in the Rietvlei Nature Reserve, are implementing principles and goals formulated on the international level. What is happening at the Rietvlei Nature Reserve is therefore not only significant on the local level. The City of Tshwane, for example, is developing a climate action plan in terms of the Paris Agreement, while the sustainability office of the Tshwane Metropolitan Municipality has requested inputs concerning stressors that have been experienced first-hand by representatives of various Friends of Urban Greenspace groups, including Friends of Rietvlei.

The Threatened Species Programme (TSP) of the South African National Biodiversity Institute (SANBI) provides opportunities for the general public to monitor plant and animal species (South African National Biodiversity Institute,

2017). As such, interested members of the public, together with scientists, could participate in biodiversity assessment projects by uploading data and photographs onto a national database. Moreover, the checklists that are available on the websites of SANBI and Friends of Rietvlei could be disseminated at the entrance gates of the Reserve to enhance awareness of this project and participation by visitors.

8.5 The Greenspace Stress Model of Urban Impact as a contribution to the discipline of Geography

The multi-disciplinary approach followed in this research placed urban greenspace at the intersections between Urban Geography, Tourism Geography, Sustainability, Environmental Management and Governance (Figure 1.1). The contribution of the thesis is therefore confined to not only one of the traditional Geography sub-disciplines, but rather to a unique combination of models from different fields of study (Figure 8.1).

The geographical perspective applied in this study focused on the implications of the relative location of the Rietvlei Nature Reserve on different scales. This case study could therefore potentially make a contribution to the human-environment interaction branch of Geography.

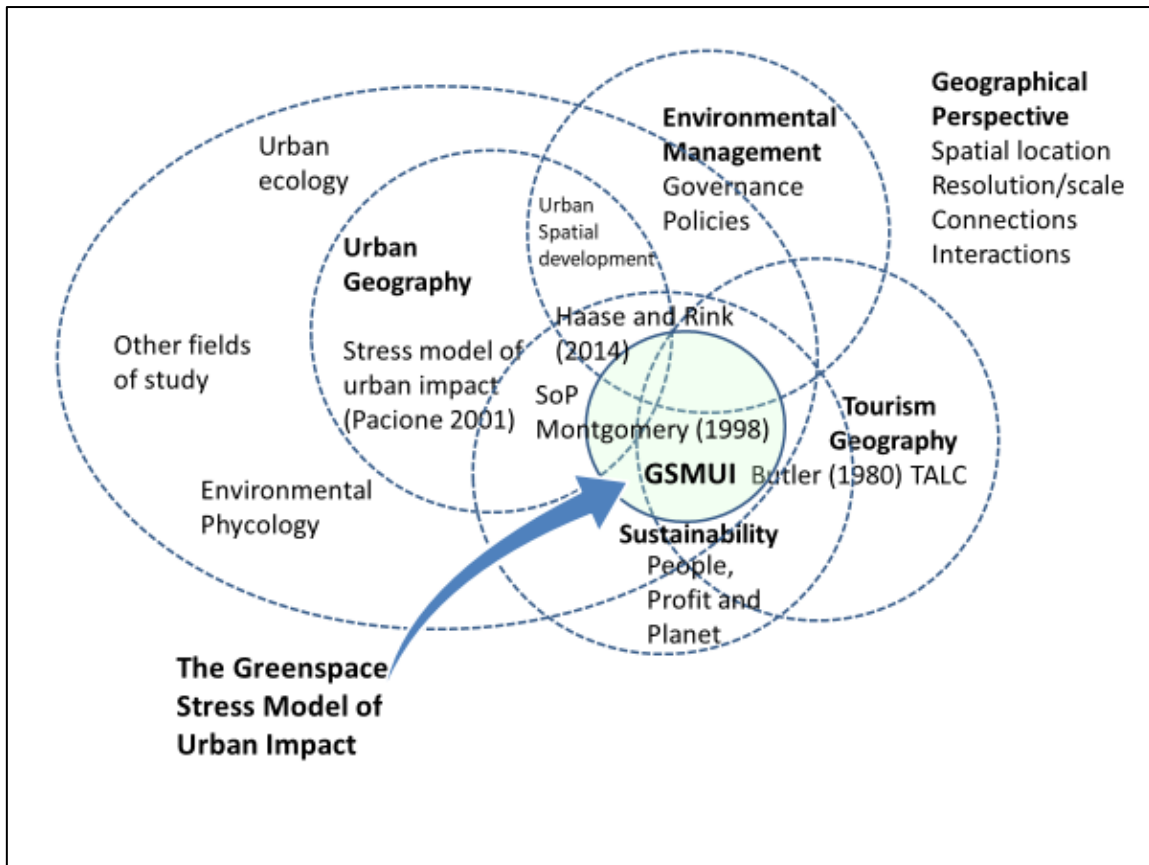


Figure 8.1: The position of the Greenspace Stress Model of Urban Impact within a multi-disciplinary context

A geographical perspective on the interplay between urban development, conservation and sense of place in the case of the Rietvlei Nature Reserve in Tshwane (South Africa) led to the development of the Greenspace Stress Model of Urban Impact (GSMUI), the purpose of which is to foster a better understanding of the characteristics and value of urban greenspace within a specific geographical setting.

Development and population pressures lead to major changes in the human-ecological landscape (Heymans *et al*, 2019). In the Greenspace Stress Model of Urban Impact, sense of place is placed in the triangle between the development

and conservation components, because not only the objective characteristics of a particular greenspace, but also the sense of place (including perceptions people have about the benefits and utility value of that space), influence decisions about development and conservation.

The Stress Model of Urban Impact (Figure 2.4) by Pacione (2001) was used as the basis for the development of the Greenspace Stress Model of Urban Impact (Figure 6.9). Pacione (2001) stressed that individual differences, situational and social conditions influence perceptions of the urban environment. He indicated that relevant objective indicators, as well as the perceptions of individuals in the city, should be used to evaluate the influence of the urban environment on quality of life in a particular context (MacLean & Salama, 2019; Pacione, 2003).

In the Greenspace Stress Model of Urban Impact, not only environmental stressors to human liveability were considered, but also stressors to the natural environment. This was a significant decision because the research revealed that environmental quality influences the sustained water-provisioning capacity of the Rietvlei Dam in servicing a portion of the water needs of the Tshwane Metropolitan Municipality.

A contribution made by the Greenspace Stress Model of Urban Impact is that benefits and stressors within a particular greenspace can be identified and evaluated from different perspectives (Figure 6.9: Block 3; Figures 7.4 and 7.5). In this particular evaluation, a possible representation was suggested to indicate the priority levels awarded to the respective benefits and stressors in a particular greenspace, in this case, the Rietvlei Nature Reserve. This could inform future

decision-making and strategic environmental assessment in respect of the Reserve.

In the GSMUI, sense of place is specifically linked to a better understanding of the ecosystem services provided by a particular greenspace. In this model, sense of place is more than a mere tourism destination image or a token of protection in terms of a particular cultural heritage. Sense of place is to be linked to the components of the urban greenspace to appreciate the importance of a healthy environment for quality of life in the city and the sustainable provision of services to a growing urban population (Li, 2020). The nexus between urban change, ecosystem functions and quality of life (Haase & Rink, 2014) informed this part of the model.

If a greenspace is fit for a particular purpose, there is homeostasis or a balance (Figure 6.9: Block 5), but if not, stressors develop that may negatively impact on the functions and future of the greenspace. This aspect links up with the evolution of the life cycle of a tourism destination (Butler, 1980). Within an urban greenspace, the identified ecosystem functions and services need to be protected to ensure that their functions remain sustainable.

In the Greenspace Stress Model of Urban Impact, there are also different pathways that emerge once the stressors have been identified. These include the restoration of a balance (Figure 6.9: Blocks 7, 8, and 5), or further environmental degradation and loss of ecosystem functions in the urban greenspace (Figure 6.9: Blocks 7 and 9).

The benefits identified within a particular greenspace therefore need to be promoted and strengthened. On the other hand, suitable mitigation strategies should also be applied for each of the identified stressors. The type of stressors, and their intensity, as well as their consequences, should be identified. In its turn, the Reserve Management needs to be given the opportunity to buy-in on the adoption of plans and programmes.

The Greenspace Stress Model of Urban Impact can be applied to evaluate changes in a particular greenspace, such as the Rietvlei Nature Reserve, over time, but it can also be adapted for comparative analyses of other urban greenspaces. The implications of the interplay between development, conservation and sense of place will most probably not be the same in the global North and global South. As such, it is important to analyse a particular greenspace in the context of its relative location, characteristics, and prominent functions.

8.6 The way forward: Recommendations for the application of the Greenspace Stress Model of Urban Impact to other greenspaces

A typical limitation of case-study research is that the findings cannot be generalised. The Greenspace Stress Model of Urban Impact developed through this research could, however, be replicated in other greenspaces within a similar context, namely the urban fringe. Chapter 7 (Figure 7.1; Table 7.1) and Appendix J provide guidelines for the implementation of the model in other greenspace areas.

The context of the location of the greenspace, whether it be global North or global South, as well as the characteristics and features of the particular greenspace, is relevant to the model. Relative location has implications on different resolution

levels, from the geographical features in close proximity to a particular greenspace to the location in terms of broader planning frameworks and green infrastructure.

It is therefore vital to not only evaluate the characteristics of a particular site, but also consider the implications of the context in respect of the expectations regarding the functions and services of the greenspace. Planning documents such as spatial development frameworks on the local and provincial level, as well as SEA and EIA studies for the area where the greenspace is located, should therefore be consulted.

Ecosystem services should be considered when exploring the implications of the interplay between development, conservation and sense of place for a particular urban greenspace. Environmental stressors could affect supporting ecosystem services, as well as the provisioning, regulating and cultural services of ecosystems in urban greenspaces (Millennium Ecosystem Assessment, 2005). The specific benefits and stressors experienced in a particular greenspace may differ from those identified for the Rietvlei Nature Reserve, Tshwane (South Africa). As such, the guidelines provided in Chapter 7 and Appendix J should be adapted according to the context of the location (site; situation; relative location) to which the model is applied.

8.7 Conclusion

In the research for this thesis a geographical perspective was applied to assess the importance of the Rietvlei Nature Reserve as a critical green infrastructural component of the Tshwane Metropolitan Area, and secondly, to demonstrate the

impact of the geographical interplay between urban development, conservation and sense of place on the Rietvlei Nature Reserve.

The research question of this thesis was: Which environmental benefits, risks and stressors that are currently evident in the Rietvlei Nature Reserve might affect the management functions of Rietvlei as a critical urban greenspace?

Within the mixed-method case-study approach followed, a variety of sources were used to identify and rank the associated benefits, functions and stressors. It was found that the particular point in time and the perspective from where the evaluation was conducted influenced the perceived importance of not only the prevailing functions and benefits, but also the stressors within the Rietvlei Nature Reserve. Thus, not only should management plans be dynamic and taken from a conservation perspective, but due consideration should also be given to inputs from the development and sense-of-place perspectives. Inputs from both the natural and human sciences are important when devising management plans and mitigating stressors identified within the greenspace, as well as in the surrounding context.

This thesis contributes to the literature on urban greenspace in the global South. From an urban social geography perspective, we know that individuals in the city may experience stress owing to not only the physical characteristics of the city and the associated environmental conditions, but also their individual social positions and subjective experiences of the setting (Pacione, 2001; Pacione 2003). The type of stressors, as well as the degree of success that the coping mechanisms meet with, influences whether homeostasis is restored or whether the implications of

stress would negatively impact on quality of life. However, in the case of the Rietvlei Nature Reserve, the focus was not on individual quality of life but rather on the functions and benefits of this urban greenspace and the stressors to the Reserve.

The physical characteristics and ecosystem functions, as well as the relative location of a particular urban greenspace have important implications for the ecosystem services expected from any particular greenspace. It is therefore important to consider urban change in the context where the greenspace is located. In the global North, the typical form of urban change is shrinkage, with the associated deserted and degraded open spaces (Haase & Rink 2014). However, in the global South, urban change is related to urban growth and development. In the case of the Rietvlei Nature Reserve, the relative location on the urban fringe between two growing metropolitan areas, namely Tshwane and Ekurhuleni, adds to development pressures on the Reserve. The context in which the greenspace is located is therefore important for its effective functioning and necessitates collaboration between different local governments and tiers of government.

Urban development and land-use changes in the catchment area of the Rietvlei Dam have contributed to anthropological eutrophication, with both urban and rural impacts being evident. Since the remote sensing images indicate increasing areas of land under irrigation, the inflow of pesticides from the agricultural area into the dam, as well as runoff from the ERWAT Water Purification Plant, and insufficient sanitation services in the catchment area, remain important issues to monitor. On the other hand, however, the prospect of continuing to harness the wetlands in their significant role in the natural purification of the water in the catchment area of the

dam remains promising. Thus, these particular ecosystem functions are expected to continue contributing to the natural water purification process.

Environmental quality is important for human quality of life. Ecosystems in urban greenspace therefore need to be restored to support human quality of life in the city (Haase & Rink, 2014). In terms of the functions of a conservation area, it is important to note that when the ecosystem functions of a greenspace in a changing urban environment are restored, the health of that ecosystem is restored and with it the ecosystem services that are beneficial to the urban dwellers in the city bordering on the greenspace (Bernstein, 2017; Li, 2020; Haase & Rink, 2014). The motivation for conservation is based on the priority given to the functions and ecosystem services expected from the greenspace and is therefore linked to sense of place (Montgomery 1998). Various stakeholders consulted in this research study also emphasised the importance of environmental health, specifically in the case of the Rietvlei Nature Reserve.

Typically, findings of case study research cannot be generalised and this is also the case in this study. The Greenspace Stress Model of Urban Impact developed through the Rietvlei Nature Reserve case study should, however, not be regarded as being limited only to the Rietvlei Nature Reserve. The implementation guidelines for the model could be applied to other urban and metropolitan areas, and, in similar vein, linked to broader environmental concerns and on different scales, as stipulated in Chapter 7.

In fact, the environmental stressors that were identified and discussed in this study are also experienced in various other urban greenspaces in different parts of the

world. The application of the GSMUI for the Rietvlei Nature Reserve could therefore potentially make a meaningful contribution elsewhere in the global South, since it could be adapted to and implemented in similar analyses of other urban greenspaces in other geographical areas. It would play an important role in such cases in timeously identifying and evaluating the benefits and stressors in such urban greenspaces and in proposing the necessary local mitigation strategies. This is important as this could influence the possible direction of the life cycle of a particular greenspace (Buttler 1980). Finally, it is hoped that the Greenspace Stress Model of Urban Impact will contribute to a growing awareness of urban greenspaces in the global South, and possibly support contributions towards improved perceptions of these vital components of the natural environment in an urban setting.

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Appendix A: Ethical clearance letter

Ethics number: REF #: 2014/CAES/152; Letter of approval from Ethics Committee dated 10 November 2014



CAES RESEARCH ETHICS REVIEW COMMITTEE

Date: 10/11/2014

Ref #: **2014/CAES/152**
 Name of applicant: **Mrs AE De Jager**
 Student #: **1988514**

Dear Mrs De Jager,

Decision: Ethics Approval

Proposal: Image and value of natural areas for quality of life with reference to Rietvlei Nature Reserve in Pretoria (Tshwane)

Supervisor: Dr JJ Olivier

Qualification: Postgraduate degree

Thank you for the application for research ethics clearance by the CAES Research Ethics Review Committee for the above mentioned research. Final approval is granted for the duration of the project.

Please consider point 4 below for further action.

The application was reviewed in compliance with the Unisa Policy on Research Ethics by the CAES Research Ethics Review Committee on 06 November 2014.

The proposed research may now commence with the proviso that:

- 1) The researcher/s will ensure that the research project adheres to the values and principles expressed in the UNISA Policy on Research Ethics.*
- 2) Any adverse circumstance arising in the undertaking of the research project that is relevant to the ethicality of the study, as well as changes in the methodology, should be communicated in writing to the CAES Research Ethics Review Committee. An amended application could be requested if there are substantial changes from the existing proposal, especially if those changes affect any of the study-related risks for the research participants.*
- 3) The researcher will ensure that the research project adheres to any applicable*



University of South Africa
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www.unisa.ac.za

Appendix B: Letter of approval from Tshwane Metropolitan Municipality



CITY OF TSHWANE
IGN - IMP EXCELLENCE

Tel: (012) 358 1819/1/2 P O Box 1454 Rietvlei Nature Reserve
Fax: 096 516 5799 Pretoria, 0001 Pretoria, 0001
E-mail: Rietvlei@tshwane.gov.za

CITY OF TSHWANE: NATURE CONSERVATION

RIETVLEI NATURE RESERVE

Our ref: 26052017

Enquiries: Silusiso Dlamini
Date: 26/5/2017

To Whom It May Concern:

STUDENT PROJECT PERMIT AT RIETVLEI NATURE RESERVE

This serves as notice to confirm that Anna de Jaegs is allowed to do his/her student project on Rietvlei Nature Reserve of the City of Tshwane. This registered student may gain free access to the reserve during the week and on Saturdays but not on Sundays and public holidays. Student contact details:

Title of study or project: A geographical interpretation of the interplay between urban development, conservation and sense of place in Rietvlei Nature Reserve, Tshwane
The study will start on 26/5/17 and end on 1/6/2017

THEREFORE I UNDERTAKE TO-

1. Accept that the Council has the right to withdraw its consent to use the reserve if I do not comply with the provisions below;
2. See to it that I at all times comply with the provisions of the By-laws relating to Public Order, Public Places, Recreation Grounds and the Nature Reserves' rules and regulations, published under Administrators Notice 55 of 18 January 1984 (as amended);
3. Comply with the provisions of the Nature Conservation Ordinance 1983 (Ordinance 12 of 1983) promulgated under Administrator's Notice 519 of 14 December 1983 (as amended);
4. Enter the reserve during the normal gate times and be out one hour before the gate closes;
5. Work in uniform with the appropriate epaulette (if available);
6. Drive my vehicle responsibly and not drive off any of the roads into the veld (leave vehicle next to road and walk in if necessary);
7. Mark my vehicle with a notice that indicates my name, the study title and student reference number;
8. Hand a copy of the completed report in at the Main Gate;
9. Answer all questions and enquiries from the public; and
10. Complete an indemnity form and use the nature reserve and facilities at own risk.

PLEASE TAKE NOTE THAT STUDENTS NEED TO PROVIDE THEIR OWN PERSONAL PROTECTIVE EQUIPMENT IF NECESSARY.

Since I, the undersigned, (* and the following minor(s)) of whom I am the present and/or guardian wish to undertake a study project in the Rietvlei Nature Reserve at my own request and risk. I, in my personal capacity (*and in my capacity as present and/or guardian of the below mentioned minor(s)), indemnify the City of Tshwane, its employee(s), sponsor(s) or agent(s) against and hold it/them harmless for any claims, actions, causes of actions or lawsuits and claims from motives of fairness, of any nature whatsoever, legal costs or attorney/client scale included, instituted against the said Council) by myself, (*and any of the below mentioned minor(s) or any third party, which may arise from undertaking the foregoing study project, irrespective of whether any such claim may be ascribed to negligent act or omission on the part of the Council, its employee(s), sponsor(s) or agent(s). (*delete that which is not applicable)

City Representative

26/5/2017
Date

.....
Student

.....
Date

Open Rubric
25/5/2017

26/5/2017
Date

Open Rubric

Appendix C: Fact sheet for observations

Name of the conservation area: Location Date of visit
Accessibility <ul style="list-style-type: none"> • Roads • Number of restroom facilities • Accessibility for disabled • Public transport
Signage <ul style="list-style-type: none"> • Signage at the entrance • Park rules • Multiple languages • Visibility
Safety <ul style="list-style-type: none"> • Natural hazards • Lighting • Isolated areas
Attractiveness <ul style="list-style-type: none"> • Maintenance • Landscape features /Scenery
Environmental stressors <ul style="list-style-type: none"> • Which environmental stressors could be observed in the physical and cultural environment? • How did they influence the experiences and activities of the visitors? • How are they managed?
Visitors <ul style="list-style-type: none"> • Number and type of visitors; • Activities: • Special event: • Where did people attending the event come from? • Photographic evidence of activities
Identification of possible participants for semi-structured interviews or focus groups Name: Reason for selection / Comment Email address and Tel. no:

Completed fact sheet for observations

Name of the conservation area: Rietvlei Nature Reserve

Date of visit: 6 August 2016

Location: Rietvlei Nature Reserve, Tshwane Metropolitan Municipality

Roads	Access from the Dam Road to the angling area entrance and from the R21 to the nature conservation area. Visitors do not have access to all of the areas of the reserve owing to the conservation regulations. Vehicles may only travel on the tarred and gravel roads within the reserve. Visitors may not get out of their vehicles outside the designated parking areas.
Restroom facilities	Main entrance: one toilet for male and one for female visitors Angling and camping area: excellent restroom facilities, wash basins, showers and toilets The restroom facilities at the Rietvlei Coffee Shop are in need of maintenance. Restroom facilities at the Marais Dam camping site: three buildings with six toilets each. Good condition. There are toilet facilities at the bird hides. There are restroom facilities at the sailing club.
Accessibility for the disabled	Coffee shop: accessibility for the disabled: There is a route around the small swimming pool where wheelchairs can move quite comfortably from the parking area to the Coffee Shop There is a toilet for the disabled inside the Coffee Shop.
Public transport	There is limited public transport to the reserve. Groups who visit the reserve, however, arrive in designated buses for a bus tour through the reserve. Special arrangements and bookings for a guided tour need to be made to accommodate groups.
Communication	The telephone landline was offline at the time of the visit. Cell phone reception was available. There seem to be fewer staff working at the office than before. There was nobody at the gate to let us out when we returned after our visit to the Reserve.
Signage	Signage boards on the main road and the Dam Road indicating the entrance to the reserve. The name of the reserve is indicated on the stone wall at the entrance boom. Visible signage throughout the Reserve shows place names. Warning signs indicate the presence of dangerous animals.

Park rules	Pamphlets are distributed at the office. Roads that visitors may not use are indicated by “No entry” signs.
Multiple languages	Signage in English and via icons
Safety	Visible patrolling by Honorary Rangers adds to a sense of safety. Visitors may leave their vehicles in only the designated areas. Only guided tours are allowed to the lion camp. Visitors may get out of their vehicles in only the designated areas. The reserve was very quiet at the time of our visit. The speed limit of 30km per hour limits the risk of accidents. The small bridges over the rivers in the reserve may be dangerous in case of flooding. Reports of muggings of visitors to the camping and fishing area are a matter for concern. Secluded spots may be dangerous on a quiet day
Maintenance	There was evidence of various maintenance activities. A new fence has been erected around the Marais Dam picnic area. There are newly-paved paths at the bird hides.
Landscape features or scenery	Even though there are no spectacular waterfalls or cliffs in the Reserve, the winter grassland and hilly landscape has a beauty of its own.
Environmental stressors	Drought poses a risk of fire Erosion in some wetland areas Invasive species Weather
How do the environmental stressors influence the experiences and activities of the visitors?	A recent fire in the lion camp made this area unattractive. However, the short grass increased visibility for the sighting of animals. Owing to the drought, animals were being fed at the Coffee Shop. An eland, a young rhino, and an old buffalo often walk together in the area around the Coffee Shop and have become an attraction to visitors. Owing to the unpleasant weather, visitors were accommodated inside the Coffee Shop.
How are the environmental challenges managed?	The risk of fire is managed through a controlled burning schedule. Animals are fed at specific sites in the Reserve, including the Coffee Shop.
Visitors	The reserve was extremely quiet on the day of the visit. This was most probably due to the cold weather experienced. There were members of the Friends of Rietvlei group who had a meeting with the workers at the Reserve. While waiting for the manager at the main gate, we noticed one other visiting group paying ed for entrance. Our car was the only vehicle at the Marais Dam picnic spot. While we were at the Hippo Hide, two teachers investigating

	<p>the possibility of bringing a group of children for an excursion to Rietvlei joined us.</p> <p>There were no visitors at the other bird hides or at the Panorama Hide.</p> <p>There were three other groups at the Coffee Shop while we were there, namely a photographer, a group of pensioners and international tourists.</p> <p>We went on a game drive and lion tour to the lion enclosure on the eastern side of the Reserve, across the Delmas Road.</p>
<p>Identification of possible participants for semi-structured interviews or focus groups</p>	<p>The owner of the Rietvlei Coffee Shop was identified as a possible informant.</p>



Figure C1: A Buffalo and rhino observed adjacent to the fence of the Coffee Shop

Photograph: Author: 6 August 2016

Appendix D: Consent form for semi-structured interviews



TITLE OF RESEARCH PROJECT

A Geographical interpretation of the interplay between urban development, conservation and sense of place of urban greenspace in Rietvlei Nature Reserve (Tshwane)

Dear Mr/Mrs/Miss/Ms _____

Date...../...../20...

Thank you for your interest in participating as a respondent or key informant in my PhD research in Geography.

NATURE AND PURPOSE OF THE STUDY

The purpose of the study is towards a PhD in Geography. The aim of the study is to apply a geographical perspective to assess the importance of the Rietvlei Nature Reserve as a green infrastructural component and to illustrate the interplay between urban development, sense of place, and conservation of urban greenspace in the Rietvlei Nature Reserve (Tshwane).

RESEARCH PROCESS

1. Literature study and analysis of remote-sensing images and maps;
2. Observations of activities at the Rietvlei Nature Reserve and the collection of photographic evidence;
3. Structured interviews with key respondents;
4. Survey using visitors' inputs;
5. Focus group interviews with interested or affected participants.

NOTIFICATION

Photographic material and recordings will be required for this research project.

Only with consent will photographs be used where individuals are recognisable.

CONFIDENTIALITY

The responses will be used for academic purposes only and will be generalised in order to protect the identity of respondents. Your identity will not be revealed without your approval. Should you wish to have your name, together with your input, acknowledged, you are welcome to request that.

- I would like my name to be published together with my quoted comments:

(please sign)

- I do not mind whether my name is published or not :

(please sign)

- I do **not** want my name to be published together with my quoted comments:

(please sign)

WITHDRAWAL CLAUSE

Should you at any stage no longer wish to participate in the research, you are welcome to say so and to withdraw from the study.

POTENTIAL BENEFITS OF THE STUDY

This study may help to improve our understanding of the use of the Rietvlei Nature Reserve.

DISSEMINATION OF FINDINGS

Would you like to obtain information on the findings of the project?

Not necessarily Yes please

If yes, please provide your email address:

CONTACT INFORMATION

Contact information of PhD student: Mrs A E de Jager; *****@****.**. **

Contact information of supervisors: Dr J J Olivier; **** @****.****

Prof. M D. Nicolau ***@****.**. **

CONSENT

I, the undersigned, (full name), have read the above information relating to the project and have also heard the verbal version, and declare that I understand it. I have been afforded the opportunity to discuss relevant aspects of the project with the project leader, and hereby declare that I agree voluntarily to participate in the project.

I indemnify the university and any employee or student of the university against any liability that I may incur during the course of the project.

I further undertake to make no claim against the university in respect of damages to my person or reputation that may be incurred as a result of the project/trial or through the fault of other participants, unless resulting from negligence on the part of the university, its employees or students.

I have received a signed copy of this consent form.

Signature of participant:

Signed at on

WITNESSES

1

2

Appendix E: Interview schedule for the semi-structured interviews



Interview number	
Date	

QUESTIONS FOR SEMI-STRUCTURED INTERVIEWS WITH KEY INFORMANTS

TITLE OF RESEARCH PROJECT

A Geographical interpretation of the interplay between urban development, conservation and sense of place of urban greenspace in Rietvlei Nature Reserve (Tshwane)

Purpose of the interview: Research towards a PhD in Geography at Unisa

Unisa Ethics Committee Approval Number: REF #: 2014/CAES/152 dated 10/11/2014

Rietvlei Nature Reserve Management Approval REF: 23/07/2014 and 21/04/16/03

A CAPACITY OF THE INTERVIEWEE

Volunteer from visitors interviewed:

Knowledge / Experience:

Involvement / Association:

Position held:

May your name, together with a quotation in the research report, be listed?

Yes No

Would you like to obtain feedback on the results of the research? Yes No

If yes, please provide your email address:

B OBJECTIVES

B1 The following objectives of the Rietvlei Nature Reserve are stated on the official website of the Tshwane Metropolitan Municipality. What would you regard as the three most important objectives of the Rietvlei Nature Reserve? Please rank them, using 1 as the most important objective.

The objectives of the Rietvlei Nature Reserve are:	
	to supply the city with clean drinking water;
	to protect and conserve a fragment of the natural environment around the city, keeping it in a relatively pristine state;
	to conserve genetic diversity and curb the loss of species;
	to make live game available for relocation;
	to give local and foreign visitors the opportunity to visit the Reserve, go into the veld, and participate in activities;
	to supply facilities and opportunities for environmental education, research and monitoring.

B2 How does the Tshwane Metropolitan Municipality promote the above objectives?

B3 Are you aware of any changes in the vision for the conservation of greenspace in general in Tshwane and specifically in the Rietvlei Nature Reserve?

C LEGISLATION AND GUIDELINE DOCUMENTS

C1 Which legislation or guiding documents are relevant to the development of urban space? Would there be any challenges (e.g. local open-space planning) regarding the implementation of such?

C2 Which legislation or guiding documents are relevant to conservation? Would there be any challenges regarding the implementation of such?

(Probing questions: Where does Rietvlei Nature Reserve fit into the green infrastructure / metropolitan open space system?)

D BENEFITS AND RISKS

D1 What are some of the benefits and risks of having a conservation area in the city?

D2 From within your portfolio, does the continued association of the Municipality with Rietvlei Nature Reserve pose benefits or risks? If 'yes', please explain.

	No	Uncertain	Yes	If yes, or uncertain, please explain.
Economic benefits				
Economic risks				
Social / cultural benefits				
Social / cultural risks				
Environmental benefits				
Environmental risks				

D3 What can be done to mitigate the risks you have identified?

D4 What are the biggest challenges in terms of the management of the following aspects in relation to the Rietvlei Nature Reserve? How are they dealt with?

4.1 Water quality and quantity

4.2 Air quality

4.3 Size of the reserve (potential re-zoning and selling of portions of the reserve)

4.4 Field / flora in the reserve (invasive species, wetlands)

4.5 Access to recreational facilities

4.6 Conservation of endangered species. (Do we need rhinos, cheetahs and lions at Rietvlei?)

4.7 Surrounding land use (influence of the developments on the catchment of the Rietvlei Dam and wetlands)

D5 How severe are the following stressors in the Rietvlei Nature Reserve? Indicate X with the option you regard as relevant in each case. (Indicate X under (1)-(5), with (1) as the least important and (5) as the most important option.)

Category	Potential risk / threat	1	2	3	4	5
Social	Capacity of the greenspace					
	Different perceptions on the value of natural areas					
	Diversity of social needs and demands					
	Limited environmental awareness of decision-makers					
	Crime					
	Vandalism					
	Health and safety risks					
	Land invasion					
	Informal settlement					
	Formal housing projects and gated communities					
	Limited resources					
	Lifestyle changes					
	Extinction of interaction with nature owing to cultural changes					
	Externalities such as noise and odours					
Economic	Environmental quality and amenities of open spaces differ according to the socio-economic status of the surrounding areas					
	Nuisance (e.g.: pollution from leaf litter, pods and bird droppings)					
	Costs of environmental management					
	Costs of maintenance					
	Pressures on the budget owing to other needs					
	Temporary employment					
	Access and use					
	Densification					
	Land-use changes					
	Socio-economic structure of the surrounding area					
Environmental	Development pressures					
	Additional security measures required by property owners adjacent to the greenspace					
	Soil pollution / contamination					
	Infrastructural encroachment					
	Water pollution (Eutrophication)					
	Light pollution					
	Noise					
	Air pollution					
	Invasive alien plants					
	Dumping / solid waste disposal					
	Urban growth / sprawl					
	Poaching of game (eg., rhinos)					
	Overfishing					
	Modified wetlands					
	Quality of water flowing into the reserve					
	Quality of water flowing out of the reserve					
	Erosion / Dongafication					
Stormwater flow/ management						
Land-use changes in the surrounding area						
Removal of vegetation						
Veld fires						
Drought						

	Climate change					
	Risk of floods					

D6 Did the recent poaching of two rhinos influence the management or operations of the Rietvlei Nature Reserve in any way?

D7 Would you like to express an opinion on the possible privatisation of the Rietvlei Nature Reserve. Would it influence the water provisioning function of the reserve?

D8 In which ways does the growing city influence the conservation of greenspace?

E WATER PROVISION

E1 How important is the Rietvlei Dam in providing water to Tshwane? (What is the capacity and percentage contribution of each of the sources?).

I don't know	It is insignificant	It is important	It is vital
--------------	---------------------	-----------------	-------------

E2 Which challenges are experienced in terms of water supply in Tshwane?

E3 Do you know of any agreements for water supply with other stakeholders?

With whom?

E4 Do you have information on the planned expansion of the capacity of the Rietvlei Dam for water provisioning? How will the planned expansion of water provisioning from Rietvlei impact on the reserve?

F ENVIRONMENTAL PERCEPTION AND SENSE OF PLACE

F1 Do different environmental perceptions of users of the reserve influence its management in any way?

No

Yes: Positive, for example _____

Yes: Negative, for example _____

F2 How important are the following ecosystem functions or opportunities for the sense of place of Rietvlei Nature Reserve? (What is Rietvlei Nature Reserve known for?) Indicate X under categories (1)-(5), with (1) as the least important and (5) as the most important option.

Ecosystem function	Function or opportunity	1	2	3	4	5
Regulating functions	Green lungs for urban areas (improved air quality)					
	Cooling effect of the urban heat island					
	Water purification through natural systems of reeds and peat					
	Erosion control					
	CO ₂ sequestration					
	Pollination					
	Natural processes					
	Stabilisation of watersheds					
Supporting functions	Containing the effects of natural disasters, e.g. flooding					
	Habitat for birds and animals					
	Soil formation					
	Life-support value for biodiversity					
	Pollination for crops					
	Stabilisation of watersheds					
	Capacity for waste disposal					
Provisioning	Containing the effect of natural disasters, such as flooding					
	Green lungs for the city (air pollution mitigation)					
	Habitat for birds and animals					
	Water supply					
	Food					
	Wood / Timber					
	Genetic resources					
	Pharmaceutical resources / traditional medicine					
	Metropolitan Open Space System					
	Agricultural activities					
Cultural	Engineering services for service provision					
	Reducing energy costs for cooling of buildings					
	Trees or forests provide shade					
	Landscape opportunity (aesthetic and sensory)					
	Contribution to quality of life					
	Physical and mental health					
	Active recreation					
	Passive recreation					
Socialisation						
Heritage conservation						
Mythological value						
Children's play areas						

	Cultural expression					
	Community interaction and building networks, connections and friendships					
	Events					
	Escape from city life/retreat					
	Education (outdoor classroom) and environmental awareness					
	Experience of rurality in the city					
	Environmental design of the settlement / neighbourhood					
	Scientific research					
	Tourism					
	Property values					
	Income from entrance fees					
	Employment opportunities					

Comments:

THANK YOU FOR YOUR PARTICIPATION

Appendix F: Questionnaire for the face-to-face interviews with visitors to the Rietvlei Nature Reserve



A Geographical interpretation of the interplay between urban development, conservation, and sense of place of urban greenspace in Rietvlei Nature Reserve (Tshwane)

Place where interviewed: Main gate [1], Coffee Shop [2] Marais Dam [3] Camping area [4] Gate to the camping area [5] Event [6]	
--	--

The aim of the study is to apply a geographical perspective to assess the importance of the Rietvlei Nature Reserve as a green infrastructural component and to illustrate the interplay between urban development, sense of place and conservation of urban greenspace.

- Purpose of the survey: data collection towards a Ph.D. in Geography at Unisa
- Unisa Ethics Committee Approval Number: REF #: 2014/CAES/152 dated 10 /11/2014
- Rietvlei Nature Reserve Management Approval: REF23/07/2014 and 21/04/16/03
- Verbal consent was granted by the respondent.

A DEMOGRAPHIC ATTRIBUTES

A1. Where are you from? Please mark the relevant block with X		
South Africa If South Africa, please indicate Province: _____ City/Town: _____	<input type="checkbox"/> Other African country	<input type="checkbox"/> Australasia
	<input type="checkbox"/> Europe	<input type="checkbox"/> America
	<input type="checkbox"/> Other (Please specify): _____	

B EXPERIENCES AND OPINIONS

B1. What is the first thing that comes to mind when somebody talks about the Rietvlei Nature Reserve (Tshwane)? Is there anything at Rietvlei that is special for you?

B2. How would you describe your association with the Rietvlei Nature Reserve? (You may choose more than one option).

- I do not have any association with the Rietvlei Nature Reserve. I am just here today.
- I know where it is located, but I have no feelings about the Rietvlei Nature Reserve.
- What happens at the Rietvlei Nature Reserve has implications for me.
- I like visiting the Rietvlei Nature Reserve, but I could just as well also visit any other greenspace.
- I am dependent on resources from the Rietvlei Nature Reserve
- I feel that I belong here; it is part of who I am.
- The Rietvlei Nature Reserve is part of my heritage.
- I just love this place.
- I would rather visit the Rietvlei Nature Reserve than any other greenspace.
- I am committed to the Rietvlei Nature Reserve and will make personal sacrifices to protect it.
- Other (please specify)

B3 How often do you visit the Rietvlei Nature Reserve?

- I have never visited the Rietvlei Nature Reserve before (first visit).
- I have visited the Rietvlei Nature Reserve once or twice.
- I visit the Rietvlei Nature Reserve at least once a year.
- I visit the Rietvlei Nature Reserve at least once a month.
- I visit the Rietvlei Nature Reserve more than once a month.
- Other (please specify)

- B4 What is the reason for your visit to Rietvlei Nature Reserve? Did the visit meet your expectations?
- B5 Does the change in the surrounding land use influence your experience of the reserve? Please explain.
- B6 Are you a member/employee of or affiliated to any of the following? Please tick and indicate your involvement.
- Friends of Rietvlei Nature Reserve:
 - Rietvlei Photographers:
 - Pretoria Yacht Club:
 - Tshwane Metropolitan Municipality:
 - An environmental group:
 - An environmental education facility/institution:
 - Other (please specify):
- B7 Are you concerned about anything at Rietvlei Nature Reserve? If yes, please explain.
- B8 Do you have a favourite area in the Rietvlei Nature Reserve that you like or one that you do not like? If yes, why?
- B9 Would you like to share any experiences you have had at the Rietvlei Nature Reserve?
- B10 Would you like to participate in a focus group discussion for this research? If yes, please provide your email address.

Thank you for your participation

Appendix G: Letter of invitation



RIETVLEI FOCUS GROUP DISCUSSION

You were invited to the research discussion because of your involvement in photography at the Rietvlei Nature Reserve. Thank you for taking the time to contribute towards a discussion around the interplay between urban development, conservation and sense of place.

Venue: Rietvlei Coffee Shop

Date: 18 May 2017

Time: 10:00 – 11:00

Background

Anna de Jager lives in Centurion with her family. She enjoys visiting the Rietvlei Nature Reserve and does so as frequently as possible. She has observed the changes in the surrounding landscape since her first visit in 1990. The changes are typical of what is happening in the dynamic urban fringe in other cities of the world. Owing to its rapid tempo, and the total change in the area at large, the phenomenon of rural-urban change in areas surrounding a city is in fact sometimes referred to as a tsunami of landscape change.

Anna de Jager is a lecturer in the Geography Department at Unisa. Her teaching of modules on the Geography of Basic Services Provision, Development of Urban Space, Tourism and Human-Environment Interaction, led her to the research theme for her Ph.D. The title of the study is: *A geographical interpretation on the interplay between urban development, conservation and sense of place in the Rietvlei Nature Reserve (Tshwane)*, and her study leaders are Prof. Melanie Nicolau and Dr Jan Olivier.

In this study she would like to evaluate the importance of the Rietvlei Nature Reserve as a green infrastructural component. Thus, not only the recreational value of the greenspace is explored, but also the role of the Reserve in water provisioning and as a wildlife habitat.

The purpose of the focus group discussion is data collection for a Ph.D study. The aim of the study is to apply a geographical perspective to assess the importance of the Rietvlei Nature Reserve as a green infrastructural component and to illustrate the interplay between urban development, conservation and sense of place in the Rietvlei Nature Reserve (Tshwane).

Unisa Ethics Approval Number: REF# 2014/CAES/152 Dated 10 November 2014.

Programme:

1. Welcome and introduction to the research

Aim and objectives

Consent form and attendance register

2. Questions for discussion

2.1 What is special about Rietvlei?

- Characteristics of the natural environment
- Activities
- Memories
- Significant landmarks or special areas

2.2 How do the photographers at Rietvlei contribute to the functions and objectives of the Rietvlei Nature Reserve?

2.3 What are the social, economic and environmental benefits and risks or stressors experienced at Rietvlei?

	Benefits	Stressors or Risks	Suggestions for possible mitigation
Social			
Economic			
Environmental			

3. Are there any specific areas or places in Rietvlei that are more vulnerable to stressors or risks?

4. Suggestions and recommendations

5. Conclusion

Appendix H: Consent form and attendance register for focus group



CONSENT FORM AND ATTENDANCE REGISTER

Research title: A Geographical interpretation of the interplay between urban development, conservation, and sense of place of urban greenspace in the Rietvlei Nature Reserve (Tshwane)

NATURE AND PURPOSE OF THE STUDY

The purpose of the study is towards a Ph.D. in Geography. The aim of the study is to apply a geographical perspective to assess the importance of the Rietvlei Nature Reserve as a green infrastructural component and to illustrate the interplay between urban development, conservation and sense of place of urban greenspace in the Rietvlei Nature Reserve (Tshwane).

RESEARCH PROCESS

1. Literature study and analysis of remote sensing images and maps;
2. Observation of activities at the Rietvlei Nature Reserve and the collection of photographic evidence;
3. Structured interviews with key respondents;
4. Survey using visitors' inputs;
5. Focus group interviews with interested or affected participants.

NOTIFICATION

Photographic material and recordings will be required for this research project. Only with consent will photographs where individuals are recognisable be used.

CONFIDENTIALITY

Responses will be used for academic purposes only and will be generalised in order to protect the identity of the respondents. Your responses will not be used without your approval.

WITHDRAWAL CLAUSE

Should you at any stage no longer wish to participate in the research, you are welcome to say so and to withdraw from the study.

POTENTIAL BENEFITS OF THE STUDY

This study may help to improve our understanding of the use of the Rietvlei Nature Reserve.

DISSEMINATION OF FINDINGS

Would you like to obtain information on the findings of the project?

Not necessarily Yes please

If yes, please provide your email address: _____

CONTACT INFORMATION

Contact information of Ph.D. student: Mrs. Anna de Jager; *****@*****.**. **

Tel: 011 *****

Contact information of supervisors: Dr Jan J. Olivier; *****@*****.***

Prof. M.D. Nicolau: *****@*****.**. **

CONSENT

I, the undersigned, have read the above-mentioned information relating to the project and have also heard the verbal version, and declare that I understand it. I have been afforded the opportunity to discuss relevant aspects of the project with the project leader, and hereby declare that I agree voluntarily to participate in the project.

I indemnify the university and any employee or student of the university against any liability that I may incur during the course of the project.

I further undertake to make no claim against the university in respect of damages to my person or reputation that may be incurred as a result of the project/trial or through the fault of other participants, unless resulting from negligence on the part of the university, its employees or students.

Name	Position/ representation	Contact details	Signature	Comment (optional)

Appendix I: Friends of Rietvlei Newsletters



**FRIENDS OF
RIETVLEI**

Newsletter April 2018 / Nuusbrief April 2018

DATES

12 May, 8:00	Alien Invasion Control
19 May, 8:00	Hike / Stap
26 May, 8:00	Work Session / Werk Sessie
2 Jun, 8:00	Committee Meeting / Komiteevergadering
9 Jun, 8:00	Alien Invasion Control
23 Jun, 8:00	Work Session / Werk Sessie
21 Jul, 8:00	Hike / Stap
28 Jul, 8:00	Work Session / Werk Sessie
4 Aug, 8:00	Committee Meeting / Komiteevergadering
25 Aug, 8:00	Alien Invasion Control
8 Sep, 7:00	Hike / Stap
15 Sep, 8:00	Work Session / Werk Sessie
22 Sep	RHINO DAY
29 Sep, 8:00	Alien Invasion Control
6 Oct, 8:00	Committee Meeting / Komiteevergadering
13 Oct, 7:00	Alien Invasion Control
27 Oct, 8:00	Work Session / Werk Sessie
10 Nov, 7:00	Alien Invasion Control
17 Nov, 7:00	Hike / Stap
24 Nov, 8:00	Work Session / Werk Sessie
1 Dec, 13:00	Committee Meeting / Komiteevergadering
1 Dec, 16:00	Year-End Function / Jaar-Eind Funksie



Photo by Elize Labuschagne-Hull

RIETVLEI'S PEATLANDS: LITTLE KNOWN, YET IMPORTANT

Peatlands, also known as bogs, mires or fens – are wetlands characterised by the accumulation of dead and decaying plant material in marshy areas. Under the right conditions, peat is the earliest stage in the formation of coal. Worldwide, 50% of all wetlands are peatlands, but of these less than 1% occur in Africa. Only about 10% of all South African wetlands contain peat – as some of the wetlands in the Rietvlei Nature Reserve.

This peatland complex, which is about 8 km long and at places up to 600 m wide, consists of three distinct sections:

- The southern basin - on the Witkoppies portion of the Reserve
- The central section is a floodplain wetland, stretching from the old Witkoppies boundary to the confluence of the Grootvlei- and Rietvlei streams.
- The northern peatland basin stretches from the above confluence to the inflow of Rietvlei Dam.

Growing at less than 1 mm annually, these peatlands were formed over a period of 10 000 years, with sections between 1.2 - 5 m thick.

Their importance? Apart from being a unique biodiversity hotspot, peatlands can mitigate climatic change impacts by storing carbon - much more than living forests - and soak up 1000 times their weight in water – releasing the latter slowly long after rains have stopped. This sponge-like nature is also a highly efficient filter of pollutants, pathogens and sediments, whilst also reducing the likelihood of flash-floods along the stream after heavy downpours.

Website: www.friendsofrietvlei.org

Facebook: <https://www.facebook.com/groups/friendsofrietvlei/>

<http://friendsofrietvlei.org/wp-content/uploads/2018/05/Friends-of-Rietvlei-Newsletter-April-2018.pdf>

Appendix J: Proposed templates for the evaluation of benefits and stressors in other but similar urban greenspaces

Plate J1: The physical characteristics and context of the urban greenspace

Aspects	Information about the greenspace
Name of the greenspace	
Absolute location	
Relative location	
Type and general purpose of the greenspace	
Area (km ²)	
Climate	
Hydrology	
Biome	
Terrain	
Geology and soil	
History (literature and oral tradition)	
Changes in the urban area surrounding the greenspace	
Stakeholder involvement in the greenspace	
Facilities, infrastructure, services, and events	
Identification of possible stressors	

Benefits and stressors within the greenspace are identified through a variety of sources, including the results of observations, responses to face-to-face interviews, group discussions and online surveys. The identified benefits and stressors are then evaluated in a focus group discussion.

The following templates were used to evaluate the benefits and stressors in the Rietvlei Nature Reserve and can be adapted to the context of the greenspace to which the Greenspace Stress Model of Urban Impact is applied.


Plate J2: Template for individual evaluation of identified benefits within the urban greenspace

	BENEFITS Identified benefits that support the future existence of Rietvlei in terms of being fit for its purpose, and providing ecosystem functions and services	EVALUATION					COMMENT
		In-significant (1)	Somewhat important (2)	Important (3)	Very important (4)	Extremely important (5)	
1	Accessibility (proximity)						
2	Biodiversity						
3	Conservation status						
4	Drainage and flood mitigation						
5	Ecological processes						
6	Economic opportunities						
7	Education and training						
8	Employment						
9	Environmental awareness						
10	Facilities and amenities (eg. venues, picnic areas, fishing area, sailing club)						
11	Green infrastructure						
12	Habitat (provisioning and supporting)						
14	Partnerships						
15	Presence of endangered species						
16	Recreation (human physical and psychological health)						
17	Servitude for electricity network						
18	Setting for nature-based activities						
19	Tourism						
20	Water provisioning						

Plate J3: Template used to capture the consensus ranking of benefits

Ranking of benefits of the urban greenspace

Which perspective do you represent?

- Development
 
 Conservation
 Sense of place

FOR OFFICE USE
 Respondent number
 Date
 Location

What is your involvement with this greenspace?

.....

.....

.....

Rank the ten most significant benefits, with (1) as the most important

Rank	Rank value	Benefit	Comments
1	10		
2	9		
3	8		
4	7		
5	6		
6	5		
7	4		
8	3		
9	2		
10	1		

Plate J4: Evaluation of benefits of the Rietvlei Nature Reserve

Benefits	CLSV _B *	Individual: top ten	Development group: top ten	Conservation group: top ten	Sense-of-Place group: top ten	RBV **
Ecological processes	54	10		10	5	79
Legal protection of the conservation area (conservation status)	54	9	4	1	10	78
Habitat (provisioning and protecting)	52	8		6	9	75
Drainage and flood mitigation	51	7	10	8	6	64
Green infrastructure	51	6		7		64
Biodiversity	49	5	5	2	8	69
Environmental awareness	49	4	9	9		71
Water provisioning	49	3	1		4	57
Presence of endangered species	45	2	2	4	3	56
Recreation (human physical and psychological health)	44	1	3	5	2	55
Accessibility (proximity to the city)	43				1	44
Facilities and amenities (e.g. venues, picnic areas, fishing area, sailing club)	43		6		7	56
Tourism	43		7			50
Education and training	42		8	3	1	54
Setting for nature-based activities	42					42
Partnerships	37					37
Economic opportunities	32					32
Employment	28					28
Servitude for electricity network	22					22

* Cumulative Likert Scale Value for benefits

** Relative Benefit Value

Plate J5: Template for comparison of individual evaluation of benefits and ranking by groups representing development, conservation and sense-of-place perspectives

Benefits	RBV**	Individual rank	Development Group	Conservation group	Sense-of-place group
Green infrastructure	82	70	100	80	60
Ecological processes	79	100		100	50
Legal protection of the conservation area	78	90	40	10	100
Habitat	75	80		60	90
Water provisioning	71	40	90	90	
Environmental awareness	69	50	50	20	80
Biodiversity	62	60		70	
Recreation (human physical and psychological health) and tourism	55	20	20	40	30
Education and training	55		60		70
Accessibility (proximity)	54	10	30	50	20
Presence of endangered species	53	30	10		40
Setting for nature-based activities	49		70		
Partnerships	49		80	30	10
Facilities and amenities (e.g. venues, picnic areas, fishing area, sailing club)	44				10
Economic opportunities*	32				
Employment	28				
Servitude for electricity network	22				

Plate J6: Template for the individual evaluations of the identified stressors of the urban greenspace


	STRESSORS	EVALUATION					COMMENT
		Daily hassle	Ambient	Serious	Life changing	Catastrophic	
	Negative impacts on the functioning of the Rietvlei Nature Reserve						
1	Budget constraints						
2	Catchment conditions						
3	Diversity of social needs and demands						
4	Environmental degradation						
5	Fire (accidental or arson)						
6	Governance challenges						
7	Human-animal interaction						
8	Ineffective environmental management						
9	Image of the greenspace						
10	Invasive species						
11	Poor service provision in the catchment						
12	Land claims						
13	Limited environmental awareness						
14	Security (crime, poaching, vandalism)						
15	Trans-boundary challenges						
16	Pollution						
17	Social exclusion						
18	Urban encroachment						
19	Visitor behaviour						
20	Water quality						
21	You are welcome to add any others						

After the table has been completed by the individual participants, the researcher calculates a cumulative Likert Scale value for each of the stressors indicated in the list. The stressors are also discussed in a plenary session where stressors are confirmed or adapted.

Plate J7: Template used to capture the consensus ranking of benefits

Ranking of stressors of the urban greenspace

Which perspective do you represent?

- Development
 
 Conservation
 Sense of place

FOR OFFICE USE
 Respondent number
 Date
 Location

What is your involvement with this greenspace?

.....

.....

.....

.....

Rank the ten most significant benefits, with (1) as the most important

Rank	RV	Benefit	Comments
1	10		
2	9		
3	8		
4	7		
5	6		
6	5		
7	4		
8	3		
9	2		
10	1		

Plate J8: Evaluation of stressors within the Rietvlei Nature Reserve


Stressors	CLSV _s *	Individual: top ten	Development group: top ten	Conservation group: top ten	Sense-of- Place group: top ten	RSV**
Water quality	48	10	9	8	6	81
Environmental degradation	48	10	3	9	4	74
Catchment conditions	45	7	10	10	2	74
Pollution	46	8	0	7	5	66
Security (crime, poaching, vandalism)	44	6	1	6	0	57
Budget constraints	37	0	7	0	10	54
Invasive species	40	4	0	5	3	52
Governance challenges	38	3	0	3	8	52
Urban encroachment	41	5	4	1	0	51
Fire (accidental or arson)	38	3	6	0	1	48
Ineffective environmental management	38	3	0	0	7	48
Land claims	36	0	2	0	9	47
Social exclusion	34	0	8	0	0	42
Trans-boundary challenges	37	0	0	4	0	41
Diversity of social needs and demands	33	0	5	0	0	38
Limited environmental awareness	35	0	0	2	0	37
Poor municipal service provision	35					35
Human-animal interaction	30					30
Image of the Rietvlei Nature Reserve	25					25
Inappropriate visitor behaviour	24					24

*Cumulative Likert Scale Value for Stressors ** Relative Stressor Value

Plate J9: Comparison between the cumulative relative stressor value (RSV) and the top ten rankings of individual evaluation and that of different groups

Stressors	Individual: top ten 10RV	Development group: top ten (10RVD)	Conservation group: top ten (10RVC)	Sense-of-Place group: top ten (10RVSoP)	RSV**
Water quality	100	90	80	60	81
Environmental degradation	100	30	90	40	74
Catchment conditions	70	100	100	20	74
Pollution	80	0	70	50	66
Security (crime, poaching, vandalism)	60	10	60	0	57
Budget constraints	0	70	0	100	54
Invasive species	40	0	50	30	52
Governance challenges	30	0	30	80	52
Urban encroachment	50	40	10	0	51
Fire (accidental or arson)	30	60	0	10	48
Ineffective environmental management	30	0	0	70	48
Land claims	0	20	0	90	47
Social exclusion	0	80	0	0	42
Trans-boundary challenges	0	0	40	0	41
Diversity of social needs and demands	0	50	0	0	38
Limited environmental awareness	0	0	20	0	37
Poor municipal service provision					35
Human-animal interaction					30
Image of the Rietvlei Nature Reserve					25
Inappropriate Visitor behaviour					24

Appendix K: Receipt for submission to originality software



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URBAN DEVELOPMENT,
CONSERVATION, AND SENSE OF
PLACE OF URBAN GREENSPACE IN
RIETVLEI NATURE RESERVE,
TSHWANE, SOUTH AFRICA

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