Cape Peninsula University of Technology

GREEN NETWORKS FOR SUSTAINABLE DEVELOPMENT IN AFRICAN CITIES: A CASE STUDY OF THE TWO RIVERS URBAN PARK, CAPE TOWN, SOUTH AFRICA.

By

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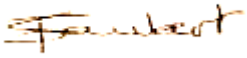
DECLARATION

I, **Irenee Marie Josephine Charlotte FAUBERT SOUZA**, declare that the contents of this dissertation/thesis represent my own unaided work, and that the dissertation/thesis has not previously been submitted for academic examination towards any qualification. Furthermore, it represents my own opinions and not necessarily those of the Cape Peninsula University of Technology.



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ABSTRACT

Green spaces have a long history in urban planning at aesthetic and design levels. However, the focus on the two-dimensional elements of green spaces in the urban system for the resolution of urban environmental problems is still limiting and insufficient. Research has shown that ‘green networks’ should not only include urban systems such as physical spaces (e.g. parks, forests, vacant lots) and service infrastructure (e.g. sewage, waste management) but also the broader natural and biophysical processes that constitute ecosystems (including water, plant, wildlife, climate and other natural systems in localities). This study addresses the concept of “green networks” which translates an interconnected web of urban systems and biological systems aimed at enhancing urban sustainability while improving the environment for people.

Based on a single case study approach, the research was carried out to determine how green networks of cities can improve urban sustainability through the process of emulating natural systems. Data was collected through both secondary and primary sources. The primary data sources involved key informants for the case study, and the secondary data covered different sources and technical documents. A secondary form of data inquiry (on going literature review) provided support to explore the area of the research problem.

The findings indicate the importance of a paradigm shift in human-nature relationships. It is recommended to explore more solutions, for example mimicking how natural systems cope with environmental extremes could stimulate socio-ecological harmony and promote biodiversity conservation through sustainable urban growth. More efforts are needed to ensure that sustainable development approaches are consolidated and promoted in Africa and around the world.

It has been concluded that services provided by nature are essential for human life. Further research is needed to investigate on potential economic gains from solutions inspired by nature and how these gains can translate into benefits for the well-being of all.

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DEDICATION

I dedicate this work to my son, the love of my life, and my daily motivation ***Jaehan Alex***. I hope I will always find ways to make you proud.

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LIST OF ABBREVIATIONS

CBAs	Critical Biodiversity Areas
CCT	City of Cape Town
CFMP	Contextual Framework and Management Plan
CTCCRP	Cape Town Central City Regeneration Programme
CTS	City Think Space
CTSDF	Cape Town Spatial Development Framework
EMF	Environmental Management Framework
IDP	Integrated Development Plan
IUWM	Integrated Urban Water Management
MOS	Metropolitan Open Space
NDP	National Development Plan
SARCC	South African Rail Commuter Corporation
SDF	Spatial Development Framework
SDG	Sustainable Development Goal
SPLUMA	Spatial Planning and Land Use Management Act
TOD	Transit-Oriented Development
TRUP	Two Rivers Urban Park
UIC	Urban Inner Core
WCG	Western Cape Government

GLOSSARY

Biodiversity	Biological wealth of a specified geographic region including the different marine, aquatic and terrestrial ecosystems, communities of organisms within these, and their component species, number, and genetic variation.
Biodiversity network	The map of protected and critical biodiversity areas (including natural vegetation remnants and wetlands) for the city, based on the fine-scale systematic conservation plan, in accordance with the legal requirements.
Critical Biodiversity Area	Critical Biodiversity Areas are terrestrial and aquatic features in the landscape that are critical for conserving biodiversity and maintaining ecosystem functioning, and that are required to meet biodiversity targets (for biodiversity patterns and ecological process features).
Ecological services	Services that indirectly accrue from the natural environment, and do not have direct market values, such as flood attenuation, natural drainage and erosion prevention, wastewater management through biological treatment, air quality management and filtration, carbon sequestration, and biodegradable waste disposal.
Inward growth	Urban development that occurs within the existing urban footprint and infill development of developable land within the current urban periphery.
Nature-Based Solutions	The “nature-based solution” concept builds on and supports other closely related concepts, such as the ecosystem approach, ecosystem services, ecosystem-based adaptation/mitigation, and green and blue infrastructure. They all recognise the importance of nature and require a systemic approach to environmental change based on an understanding of the structure and functioning of ecosystems, including human actions and their consequences.
Transit-oriented Development (TOD)	Transit-oriented development (TOD) is a multifaceted and targeted strategic land development approach to improved urban efficiencies and sustainability by integrating and aligning land development and public transport services provision. It promotes inward growth and compact city form with an emphasis on building optimum relationships between urban form, development type, development intensity, development mix and public transport services to create a virtuous cycle of benefits over the long term as described in the City of Cape Town TOD Strategic Framework.
Urban development	Residential areas are the primary focus of urban development. Urban development occurs by expansion into unpopulated areas and/or the renovation of decaying regions.

CHAPTER ONE
GENERAL INTRODUCTION

1.1. BACKGROUND TO THE STUDY

With half of the world's population living in urban areas and an estimated increase of 66% by 2050, urbanisation and the associated environmental phenomenon of climate change and biodiversity loss are of major concerns for global agencies such as the UN-Habitat and more so for city managers (UN, 2014). The World Commission on Environment and Development noted in 1987 that "a global agenda for change" is required which involve achieving a balance between social, economic and environmental goals and reaching agreement on durable environmental strategies aimed at achieving sustainable development for countries at a different stage of development (WCED, 1987).

Subsequently, other world conferences were held to achieve this objective, and these include the 21st Conference of Parties (COP 21) of the United Nations Framework Convention on Climate Change (UNFCCC) in Paris. This was aimed at reaching a single agreement (Paris Agreement) in the world to strengthen resilience and tackle climate change (Jayaraman & Kanitkar, 2016).

Africa, which is projected to have many of the world's largest cities in the near future remains the least urbanised continent (Satterthwaite, 2017; Hoornweg & Pope, 2016). Although most countries in Africa are still developing and are in progress of rapid urbanisation, cities can ensure that the advantage of urbanisation outstrips the challenges, by applying from the onset the concept of sustainable development, as they plan their urban evolution. There are many opportunities to build cities in developing countries that respond appropriately to the environmental challenges that they are facing in a manner that protect delicate ecological systems and are in concert with natural networks.

Challenges related to rapid urbanisation (rural-urban migration; development of slums; etc.) and climate change (extreme urban heat Islands; sea level rises; abnormal wind velocities; etc.) require the need to integrate natural and urban development processes and minimise the impact of development on sensitive ecosystems (UN-Habitat, 2012). Cities under successive patterns of urbanisation have become fragile from an environmental perspective and require considerable effort to promote the sustainability of urban ecosystems and infrastructure. Cities have a significant influence on the natural

ecological process and this influence can be used as a way to restore biological diversity in the urban environment and to optimise opportunities for reducing the anthropogenic impact on the environment (Hoornweg et al., 2011).

Natural systems are critical components of life and it is necessary to understand the relationship between nature and urban processes. The concept of “green networks” translates to a set of interconnected physical and biological elements, aim to enhance biodiversity while improving the environment for people. Green spaces have a long history in urban planning at aesthetic and design levels. However, the focus on the two-dimensional elements of green spaces in the urban system for the resolution of urban environmental problems is still limiting and insufficient. This study argues that “green networks” should not only include recreational spaces or aesthetic dimensions of space but also the broader natural and biophysical process that constitute ecosystems. These relate to the water, plant, wildlife, climate, and other natural systems.

Even though many studies have reported an increased consideration of sustaining the cities and reconnecting urban area with the ecosystems, there has been very little research reported on the role and function of green corridors of cities in developing countries. The purpose of this study is to ascertain the effectiveness of green networks of cities in improving urban sustainability through the process of emulating natural systems.

1.2. STATEMENT OF RESEARCH PROBLEM

Rapid urbanisation in African cities are accompanied by a wide range of development challenges such as poverty, unemployment, and inequality and these are exacerbated through patterns of urban development that are not in concert with natural processes. These forms of urban development not only impact negatively on ecological processes, but conversely results in human settlement being exposed to the hazards of natural processes that could have been avoided or minimised. It is therefore argued that the fragility of cities is a consequence of successive patterns of urbanisation that have ignored the anthropogenic impact on ecological processes.

Even though the effectiveness of green areas in urban planning has been recognised in recent years and regardless of efforts to take into account the virtues of the natural system, further integration of urban and green ecosystems is needed (UN-Habitat, 2012; Park et al., 2012; Mell et al., 2013; Fatmi, 2016). Green networks should not only include

recreational spaces or aesthetic dimensions of space but also the broader natural and biophysical process that constitute ecosystems.

There is a call for rethinking the relationship between humans and nature. This idea is based on the fact that different approaches are being used to assist cities to deal with a wide range of difficult issues emanating from urbanisation such as accommodating rapid population growth, settlement expansion, environmental degradation and biodiversity loss (UN-Habitat, 2012, 2013, 2014; UN, 2014; Cobbinah and Darkwah, 2016). Africa, presented as the continent with the largest cities in the world in the future, need to develop the means to ensure that it can face these upcoming challenge and to involve urban and nature in this process (Shen et al., 2011; Hoornweg and Pope, 2016; Satterthwaite, 2017). With this goal, this research explored the possibility of emulating green/natural systems in urban areas into African cities for progress towards urban sustainability.

1.3. RESEARCH QUESTIONS

The central research question of the study is to attempt to answer the following:

How can green networks contribute to sustainable urban development in African cities?

In support of the main research question above, two interrelated research sub-questions have been identified to guide the investigations:

i. What are the functional elements of natural ecosystems such as water, plant, wildlife, climate etc. and how relevant are these for green networks in cities?
ii. What are the functional components of urban green networks and how can these be integrated and emulate/mimic natural ecosystems?

1.4. RESEARCH AIM AND OBJECTIVES

The research aims to ascertain the effectiveness of green networks of cities in improving urban sustainability through the process of emulating natural systems.

The research aims particularly to:

i. Establish how green networks respond to current's urban planning challenges and assess whether these systems could be a benefit for improving sustainability in African cities.

ii. Determine the relevance (advantages and disadvantages) of green networks for urban areas and to apply these systems in cities.
iii. Screen alternative approaches to how urban system can emulate/mimic natural ecosystems in urban development action through the optimum use of urban green space systems.

1.5. RESEARCH METHODS AND APPROACH

A methodology is a crucial phase in the research process aimed at detailing the formulation of a plan to collect information and data that serve to achieve the objectives and answer the research questions. The research approach that was followed for the purposes of this research is exploratory and explanatory. This orientation derives from a single case study strategy adopted to conduct the study. The use of this empirical research method was considered the most appropriate to satisfy the objectives of the research.

As far as data collection tools were concerned, a snowball approach which is a non-probability sampling method was used to select individuals on the basis of their knowledge, relationships and expertise regarding a research subject (Palinkas et al., 2015). The selected participants had knowledge pertinent to the context of the study and sufficient experience with the case under investigation. As mentioned, one research method is employed in this study with multiple research techniques using secondary (literature review) and primary sources (unstructured and semi-structured interviews, observations). A basis for this is informed by an extensive literature review around the aims of the research, relevant theories, and a contextual analysis of the site.

The analysis of transcribed interviews was conducted based on capturing concepts to identify critical themes, generate patterns, and meanings from the data around the research topic and the case study.

1.6. DELINEATION OF THE RESEARCH

Contextually, the research sought to contribute to research on urban sustainability and development in African cities. However, it focuses only on a single case located in one city which is the city of Cape Town, South Africa. Therefore, the findings should not be seen as reflecting the state of green networks in all African cities.

Moreover, the main objective of the research is rather to develop an understanding of the interrelationship and potential for sustainable co-existence between urban and natural systems and how green networks could contribute towards urban ecological sustainability. The approach taken in this research could potentially be extrapolated and be considered and/or used as an example for the study of ecological networks in other cities in Africa.

1.7. SIGNIFICANCE OF THE STUDY

Previous authors such as Hough (1995, 2004), Ian McHarg (1969), Lewis Mumford (1937), and others have mentioned that linking nature to urban area benefits cities and people. However, given the phenomenon of urbanisation and the growth of population in cities, appropriate strategies need to be adopted to understand the environmental challenges. The increasing interest in protecting biodiversity has led to the hope that sustainable urban development actions can be achieved.

The research is thus significant on three broad levels:

i. It provides an important opportunity to advance the understanding of nature in an urban area.
ii. It helps establish the significant role played by green networks as an integral part of natural processes.
iii. It fills the knowledge gap in that there is limited substantial research in urban development processes in Cape Town that adequately reflect ecosystems thinking.

1.8. EXPECTED OUTCOMES OF THE STUDY

This research aims to contribute to the following outcomes:

i. Stimulate debate on sustainably integrating natural and urban processes.
ii. Management of natural system as a functional link in cities.
iii. Enhance resilience between people and nature in urban environments.
iv. Increasing awareness of the important role of green networks within cities.
v. Contribute to conservation of natural systems and biological diversity.
vi. Providing new insight into the urban sustainable development processes.

vii. Contribute to the fulfilment of 2030 Sustainable Development Goals (UnHabitat 2015) in particular:

N°9: build resilient infrastructure, promote sustainable industrialisation, and foster innovation

N°11: make cities and human settlements inclusive, safe, resilient, and sustainable

N°13: take urgent action to combat climate change and its impacts

N°15: protect, restore, and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss.

1.9. STRUCTURE OF THE THESIS

The chapter and content analysis pertaining to this dissertation are organised as illustrated in figure 1.1.

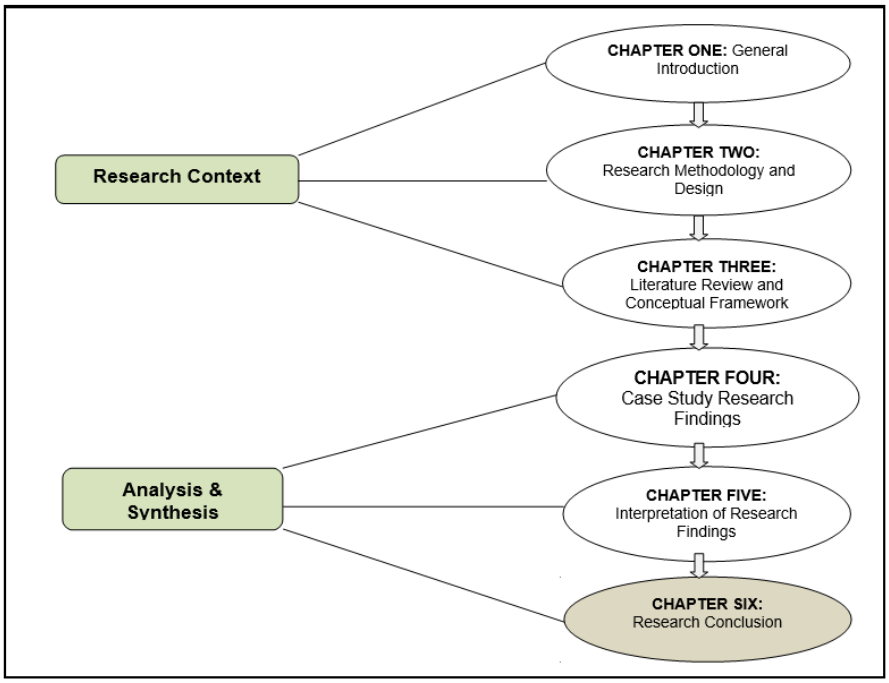

Figure 1.1: Overview of Thesis Structure

Source: Author Construct, 2018

Chapter 1 presents an overview of the topic under investigations, outlining the research problem, research questions, objectives, delimitations, and the significance of the study.

Chapter 2 outlines the research methodology and design. This chapter discusses the strategy and data analysis methods used to gather necessary information to achieve the intended results.

Chapter 3 reviews the existing body of knowledge to the conceptual framework in relation to the research questions.

Chapter 4 presents the case study, associated data as well as the analysis of the data in relation to the research questions.

Chapter 5 broadens the discussion of findings presented in chapter 4 and research implications. It also provides a summary of the main findings of the study in response to the research questions.

Chapter 6 discusses limitations and acknowledges the importance of this type of study for further research and the implications for application. The conclusions are based on the findings of chapter 3, 4, and 5.

CHAPTER TWO
RESEARCH METHODOLOGY AND DESIGN

2.1. INTRODUCTION

Appropriate research method(s) is/are required for the development of knowledge in a given study. This chapter focuses on how the research was carried out. It introduces the research strategy and the techniques applied. It discusses the explorative research design and a single case study approach that is analysed through mix methods.

The techniques for data collection in this research study were semi-structured and unstructured interviews, observation, documentation, and literature review analysis. The use of each data collection methods used in the study was also justified. Finally, to ensure trustworthiness of the research, appropriate criteria and ethics in research were discussed. The research questions and objectives for the study framed the research plan as well as the methodology used for the overall research.

2.2. RESEARCH METHODOLOGY

Research methodology refers to a plan, process, or design, strategy, and action of the study and how these will guide the research process. The research method is discussed by referring to sampling, data-collection, and data-analysis. This research is based on the single case study research method and focuses on a mixed methods approach by using both primary and secondary sources (Yin, 2014).

2.2.1. Approach to Research Design and strategy: Single Case - Study

It is essential to compare the different research methods and decide whether to do a case study. Yin (2004) presents the steps presented in figure 2.1 when doing a case study research.

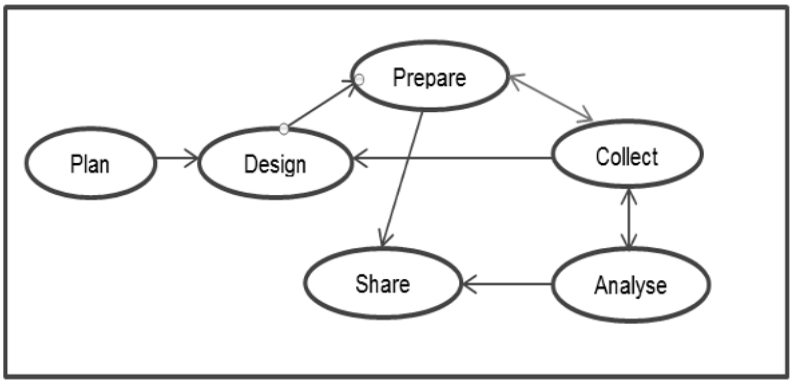

Figure 2.1: Case Study Research Approach

Source: Yin, Robert K. Case Study Research: design and methods_ Fifth edition (2014)

- Step 1 (Design): To define the "case" or unit of analysis
- Step 2 (Prepare): To develop case study and screen candidates
- Step 3 (Collect): To use multiples sources to collect data and maintain a chain of evidence
- Step 4 (Analyse): To examine, categorise and tabulate all data
- Step 5 (Share): To identify the audience for the report and have drafts reviewed.

2.2.2. The unit of analysis

This research study adopted a single case design, and the unit of analysis should be the elements that are the focus of the case study analysis. For the Two Rivers Urban Park (TRUP) case study, the unit of analysis is related to the components of both the green and urban networks and in particular the extent these relate to each other in order to generate both environmental and city sustainability. The case study is concerned with the interrelationship and potential for sustainable co-existence between natural and urban systems.

2.3. RESEARCH DESIGN

The design for this study is exploratory and explanatory as it allows a social investigation, a thorough insight into the problems explored and a direct engagement with the participants chosen in the case study.

This research is interested in the sense and observation of a social phenomenon in a natural environment. Yin (2003) defines research design as an "action plan for getting

from *here* to *there*, where 'here' may be defined as the initial set of questions to be answered and 'there' is some set of conclusions (answers) about these questions" (p.19). Then, the researcher conducted a mix method research approach to address the research problem and to achieve the research objectives.

Given (2016:2) defines qualitative research as: *"An interesting and engaging approach to studying the ways that people experience their world."* It is to take an interest in human and social phenomena by having the same approaches used to analyse natural phenomena. Similarly, qualitative investigations depend primarily on face-to-face data collection through observations and comprehensive interviews but also use a variety of empirical tools such as government documents for example.

Accordingly, qualitative studies are based on a comprehensive approach to answering questions about *why* and *how* (Lapan et al., 2012). On the other hand, a quantitative research is a formal, objective, systematic process in which numerical data are utilised to obtain information about the world (Patton, 1990:20).

To validate sources and ensure quality of information, multiple sources were used and compared. Yin (2006) confirms that, "using mixed methods within the confines of a single study can simultaneously broaden and strengthen the study". He advocates for researchers to value this approach as it provides converging evidence, more compelling than a single method.

2.3.1. Research Strategy

The use of a single case study is a well-established strategy in many investigational studies. It is "an empirical inquiry that investigates a contemporary phenomenon in depth and within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 2009).

To find solutions to an existing problem or shed light on a neglected or unknown area of knowledge, a case study approach which derives from exploratory and explanatory orientations was adopted to conduct this study.

2.3.2. The Case study Strategy

The case study strategy was adopted for several reasons:

Firstly, the case study approach creates a context for the research which allowed an in-depth study which helped achieve the objectives of the study.

Secondly, the case study strategy creates a chain of evidence from multiple modes for data collection and different sources beyond the literature review to come out with reliable information.

Lastly, the case study approach is a common research method in community planning (Yin, 2009) and the research questions anchors on an exploratory and explanatory approach to finding answers.

Equally, Yin (2004) has recognised that a case study should be used when:

- It cannot control the behaviour of those involved in the study
- It covers contextual conditions as they are relevant to the phenomenon being studied
- The boundaries between the phenomenon and the context are not clear
- The focus of the study is to answer “what and "how" questions.

The “how” seeks to explain real-life interventions complex for experimental strategies while the “what” is used to investigate those interventions with no clear outcomes and explores possible reasons.

Given the nature of the research question in this research, the case study methodology was considered the most appropriate approach to use as it provided a logical way to collect, analyse data and understand a particular problem. The case study design suits to phenomenon that can hardly be separated from their context (Yin, 2003).

2.4. DATA COLLECTION AND METHODS OF ENQUIRY

A good case study will want to use as many sources as possible (Yin, 2009). The researcher therefore looked at textual methodologies and methods by analysing available reports, documents, photographs, government regulations, blogs, etc. By combining all of those data collections methods, deep and rich data for the study was gathered (Given, 2016).

The data collection was undertaken at a secondary level through literature review and critical analysis of relevant case study documents and at a primary level through structured interviews with key role players.

In this section, the data collection approach, method, instrument, and process are discussed.

2.4.1. Data Collection Techniques

The data was collected through both secondary and primary sources. The primary data sources included key informants for the case study, and the secondary data covered different sources such as reports, government publications, and technical document. The literature review analysis as secondary data helped for the preparation of interviews, discussions and provided a support to explore particular responses during interviews.

2.4.1.1. Secondary Data

A secondary form of data inquiry (ongoing literature review) was conducted to explore the area of the research problem.

- **Documentation & Archival records**

Documents can help before, during and after data collection. They are relevant to any case study topic (Yin, 2009:101). Recent and relevant documents (including reports, administrative policies, procedures, and previous research.) ...whether in printed format, handwritten or in electronic format and which relates to the research question perused for its potential value to the answer the research questions (Henning et al., 2004).

In the selected case study, several workshops have been carried out previously for a number of research and planning studies for the study area. According to Yin (2009:103), “the use of documents is to corroborate and augment evidence from other sources”. That said, document and archival analysis are an invaluable technique in data collection. They may be consulted several times and were used to review the information and to verify references.

Additionally, to gain insights into the problem and help to develop ideas, qualitative research involves direct engagement with participants during data collection and analysis. This implies an interpretive and critical view when studying phenomena in their natural

settings (Lapan, Quartaroli, & Riemer, 2012). At this level, the research was carried out through interviews with people who have relevant experiences, workshop, conversations, and observations.

2.4.1.2. Primary Data

- **Interviews & Conversations**

Interviews aimed to understand how respondents experience the problem focused on. The efficiency of interviews has long been recognised as a key instrument in research design (Weiss, 1994) and the most important sources of case study information (Yin, 2009). For this research, unstructured and semi-structured types of interviews were used as it helped participants to expose their perceptions and allowed gathering rich data regarding the study.

Firstly, the unstructured interview which can be referred to as “In-depth interviews” is one of the widest ways of collecting data in qualitative research (Ritchie & Lewis, 2014:177; Yin, 2009:106). With a very little structure, the interview questions are often based on the interviewee and his previous response. It allows open-ended questions through which a greater flexibility is offered to both sides.

Secondly, the semi-structured interview, sometimes also called focused interviews, is a flexible version of the structured interview. Through an “interview guide”, the interview will be kept within the parameters traced out by the aim of the study (Cohen D, 2006). It gives to participants the opportunity and freedom to express their views in their own terms**.**

In the same vein, the interviews were guided by conversations rather than formal questions and answers. The objective was to deepen the knowledge and to obtain information on the subject, and through this, a phenomenon could be interpreted according to the elements contributed by the interviewees.

- **Observations**

For De Ketele & Roegiers (2015) “Observation is a process that includes voluntary attention and intelligence, directed by a terminal objective and directed to an object to collect information”. Since the case study is in a natural context, there are opportunities to have a look around and get a feeling of the place. The researcher could evaluate the on-site activities and to observe the environmental factors to have more clear ideas and additional information on the case studied.

This study includes multiple research techniques for data collection. Table 2.1 presents an overview of the techniques used to collect data and conduct a detailed investigation of the study area.

Table 2.1: Overview of data collection techniques

Type of Data	Data Sources	Benefits
Secondary Data	- Literature Review	- Helped in the preparation for the interviews and cover different sources - Cross-checked of main organisational players and roles - Helped to get information about historical decisions - Allowed the exploring of responses during interviews.
- Primary Data	- Key informants	- Flexibility in asking interviewees questions and highly interactive - Opportunities to attend related programme which was further enlightening for the research - Allowed for follow up questions

Source: Author construct, 2018

Table 2.1 outlined the main data collection techniques used in this research study and the benefits of each selected techniques. The data collection methods that were used to collect data were interviews, observation, and documentation as secondary data.

2.4.2. Selection of respondents and Sampling process

In the research process, it is necessary to define the target participants. Collis & Hussey (2003:157) stated that “A population is any precisely defined set of people or collection of items which is under consideration”.

For achieving the objectives of this study, a snowball approach was applied for data collection. It is a non-probability sampling method which gives the possibility to recruit hidden population and generate additional and reliable sources (Dudovskiy John, 2016).

The snowball approach technique used in this research entailed the selection of knowledgeable individuals through a process of referrals from public, private, and community-based people involved in planning, operation and management of the Two Rivers Urban Park. The objective was to collect accurate information from reliable sources that could help solve the research problem. Both general and specific information was extracted from each category of respondents.

For this research, participants were purposely selected because of their expertise and domain of knowledge that was pertinent to the context of the study. A total number of 10 in-depth interviews were conducted with the following spectrum range of:

- Officials from local, provincial, and national government departments (information on important facets and perspectives related to previous TRUP projects and current status of the case study)
- Urban planners, engineers, (Information on transport systems, waste management, urban structure….)
- Environmentalists and natural environmental practitioners (Information on natural components such as water, plants, wildlife….)
- NGO and CBO practitioners (Involvement in the TRUP project)

Participants were informed before and after the end of a session that the information shared would be of a confidential nature and treated in this manner.
The total number of interviewees was reached when it became apparent that the scope of new information forthcoming from the engagements was decreasing significantly.

According to Aldiabat & Le Navenec (2018); Francis et al., (2010) and Lisa M. Given (2008), when the same type of answers and patterns began to emerge after many interviews, data saturation is being reached. It is also one way of increasing the trustworthiness of a study by stopping the collection of data the moment the data saturation is reached (Schurink, 2003).

2.5. DATA PROCESS OF ANALYSIS

Bogdan & Biklen (2003) define qualitative data analysis as “working with data, organising it, and breaking it into manageable units, synthesising it, searching for patterns, discovering what is important and what is to be learned, and deciding what you will tell others”.

The interviews were guided by the interview guide consisting of 15 questions (refer to Appendix C) that were used to direct the discussions with the respondents. The length of the interview was dependent on the time the informant had available. On average, most interviews were an hour in duration. The depth of each aspect of the topic covered was therefore dependent on each informant.

The researcher did not impose any viewpoints on the respondents. Instead, the researcher assumed a passive role, adjusted the flow of the conversation by questioning and probing when it was necessary or if the informant was reticent. It appeared to be a useful strategy, as the informants usually were more open and offered more depth of information.

After seeking permission from the informant, the content analysis involved the following procedures:

- ***Recording of data:*** In keeping with the requirements of the university ethics committee, each informant received a signed letter with the university letterhead, that gave an undertaking that the interview was being conducted in confidence and that the recording was to be used solely for the purposes of the research (Refer to Appendix B).

The recording was done by using a smartphone, while audio recording on another device recorder served as a backup of electronic failure and faults; and to ensure that all voices could be heard.

- ***Fieldnotes:*** The notes taken during these interviews served as another backup during the recording procedure and obtain a more in-depth, accurate understanding of the interactions. According to Phillippi & Lauderdale (2018), field notes are widely recommended in qualitative research as an important aspect of enhancing the credibility of research undertaken within the qualitative paradigm.

- ***Verbatim transcription:*** The transcription of the responses commenced after each interview to ensure attention to details and convey to the correct message. Then the original interview of the completed verbatim transcription was listened to again to ensure that the researcher became acquainted with the data for analysis and interpretation. Table 2.2 presents the research process and relevant questions used to conduct this study.

Table 2.2: Research Process

Research Problem	Research Questions & Sub-questions	Research Objectives	Design & Method	Instruments
Half of the world's population living in urban areas and an estimated increase of 66% by 2050, **Climate change and biodiversity loss are major concerns** (UN, 2014). **Projection on Africa to have the world's largest cities in the near future** (Satterthwaite, 2017; Hoornweg & Pope, 2016) **Cities have a significant influence on the natural ecological process and this influence can be used as a way to restore biological diversity and to optimise opportunities for reducing the anthropogenic impact** (Hoornweg et al., 2011).	How can green networks contribute to sustainable urban development in African cities? *What are the functional elements of natural ecosystems such as water, plant, wildlife, climate etc. and how relevant are these for green networks in cities?* *What are the functional components of urban green networks and how can these be integrated and emulate/mimic natural ecosystems?*	To establish how green networks, respond to current's urban planning challenges and assess whether these systems could be a benefit for improving sustainability in African cities. To determine the relevance (advantages and disadvantages) of green networks for urban areas and to apply these systems in cities. To screen alternative approaches to how urban system can emulate/mimic natural ecosystems in urban development action through the optimum use of urban green space systems.	▪ Single case-study Approach ▪ Exploratory Design ▪ Qualitative Research	Data collection will be undertaken at two levels, namely literature review and field data collection ❖ Primary data -Interviews *Unstructured * Semi structured -Observation ❖ Secondary data -Documentation and archival records

Source: Author construct, 2018

The entire transcribed text and field notes were thoroughly read to obtain an overall and comprehensive impression of the content and context. The aim was to generate themes for interpretation to address the research questions. The themes derived were used to reinforce and support the arguments/narratives.

2.6. DATA ANALYSIS

The interviewees were chosen not for their representativeness but rather for their relevance to the conceptual questions. Initial participants were asked to suggest other actors involved in the topic of the case study. All interviews were transcribed in 'word' format and extensive notes were also taken during the fieldwork.

Interview transcripts and written notes were analysed systematically through repeated re-reading of them to gain an increasingly profound understanding of each interviewee's viewpoint and perspective.

Then a thematic analysis was used to allow the researcher to report the many relationships between the relevant concepts developed by participants who were captured during the interview process. Field observation, through photographs, site visits were also used as research techniques to observe and evaluate environmental factors.

Data collection and analysis were performed as described above to determine whether the study result was achieved. Whether or not the study met its objectives were determined by analysing the data collected by various methods (observations, interviews, and review of literature).

2.7. DATA CODING

The researcher analysed the interview transcripts using thematic analysis to identify themes, and sub-themes and categories. The process of coding started with reducing raw data by drawing lines on each unit of text.

Coding allows the researcher to connect and play around with collected data. It provides an opportunity to generate and determine the relationships and assumptions that inform the respondent's perspectives on the research topic and case study.

2.7.1. Utility of Computer-Aided Qualitative Data Analysis Software (CAQDAS)

Each interview transcript yielded an average of approximately 7000 words. After the first few interviews were transcribed and coded manually using pen and paper methods, the body of evidence expanded.

To make the coding process more manageable, the researcher opted to use a CAQDAS for the analysis process. The use of a CAQDAS is only to provide the researcher with a set of tools that will assist in undertaking an analysis of qualitative data (Basit, 2003).

A qualitative research project inevitably processes a large amount of unstructured textual data. It is essential for researchers to explore all the possible nuances and relationships, to view data from a variety of perspectives to support the analytic approach.

A strong characteristic of CAQDAS is its ability to increase the rigour and manageability of qualitative data (Castleberry & Nolen, 2018; Welsh, 2002). It is designed not to undertake the analysis for the researcher, but rather to aid the analysis process. The researcher is thus free to focus on the data, identify and relate emerging concepts pertinent to the study.

During the analysis when a new theme emerged, the researcher changed the coding frame and re-read the data according to the new structure. The data was re-read to ensure that there were no new themes that emerged. To make analysis manageable the data was broken down into units of codes as presented in table 2.3.

Table 2.3: Identified data codes.

THEMES	SUB-THEMES	CODES
General thoughts on TRUP	Value & Potential & Purpose Underused & Undervalued Planning & Research	Research, Valuable, Wetlands, Green Networks, Potential, Green Space, Energy, Nature, landscape
TRUP & the role of ecological systems	Whole Ecosystem Wildlife & Agriculture Water & Rivers Climate Change	River Water, Biodiversity, Green Networks, Pollution, Valuable, River Function, Black River, Liesbeek, Wildlife, Animals, Biodiversity, Nature, Vegetation, Flooding, Restoration, shifting role of rivers, Food Security, Green Space, Proper Planning, Climate Resilient, Detention Ponds, Infrastructure, Plant Mitigation, Renewable Energy, Saltwater, Sea Level Rise, Water, Management, Disconnected, Funding, Planting, Regeneration, Urban and Nature
Opportunities & Constraints for TRUP	Sustainable Development Planning & Rehabilitation Public opinion & Attitude Infrastructure Accessibility and Safety Heritage Buildings	Connection & Harmony, Access, Buffers, Cycles, Interface Treatment, Whole System, Rehabilitation, Attitude, Canals, Nutrients, Planning, Planting, Potential, Wetlands, Waste Management, Government, Technology, Urgency, Wastewater, Accessibility and Safety, Conservation, Development, Government, Historic Center, Infrastructure, Pollution, Wetland, Public Opinion, Sustainability, Threats of Invasion, Water supply
TRUP Development Proposals	Spatial Development South African NDP 2030 UN SDGs	Funding, Management, Potential to Enhance, Unapproved, NDP 2030 and UN goals, Doubt, Opportunity Renewable Energy, Balance, Densification, Ecological system, Location, No-development, River club, Unsure, Collaboration, Engineers, Green space, Policy and Government, Sustainable Development

Source: Author Construct, 2019

The identified codes were: General thoughts on TRUP, the role of ecological systems, opportunities, and constraints and TRUP development proposals. Table 2.3 tabulates a list of all identified themes and subthemes.

2.7.2. Using Nvivo to conduct analysis

At first, all notes and transcripts were read to gain an overview of the body and context of the gathered data. Then, the analysis and coding process began to yield concepts that related to one another.

A systematic approach is important to ensure that qualitative data analysis is undertaken rigorously. Nvivo software led to a reorganisation of codes (Themes) into tree structures (refer to Figure 2.2) with the idea that each tree contained a group of conceptually linked items.

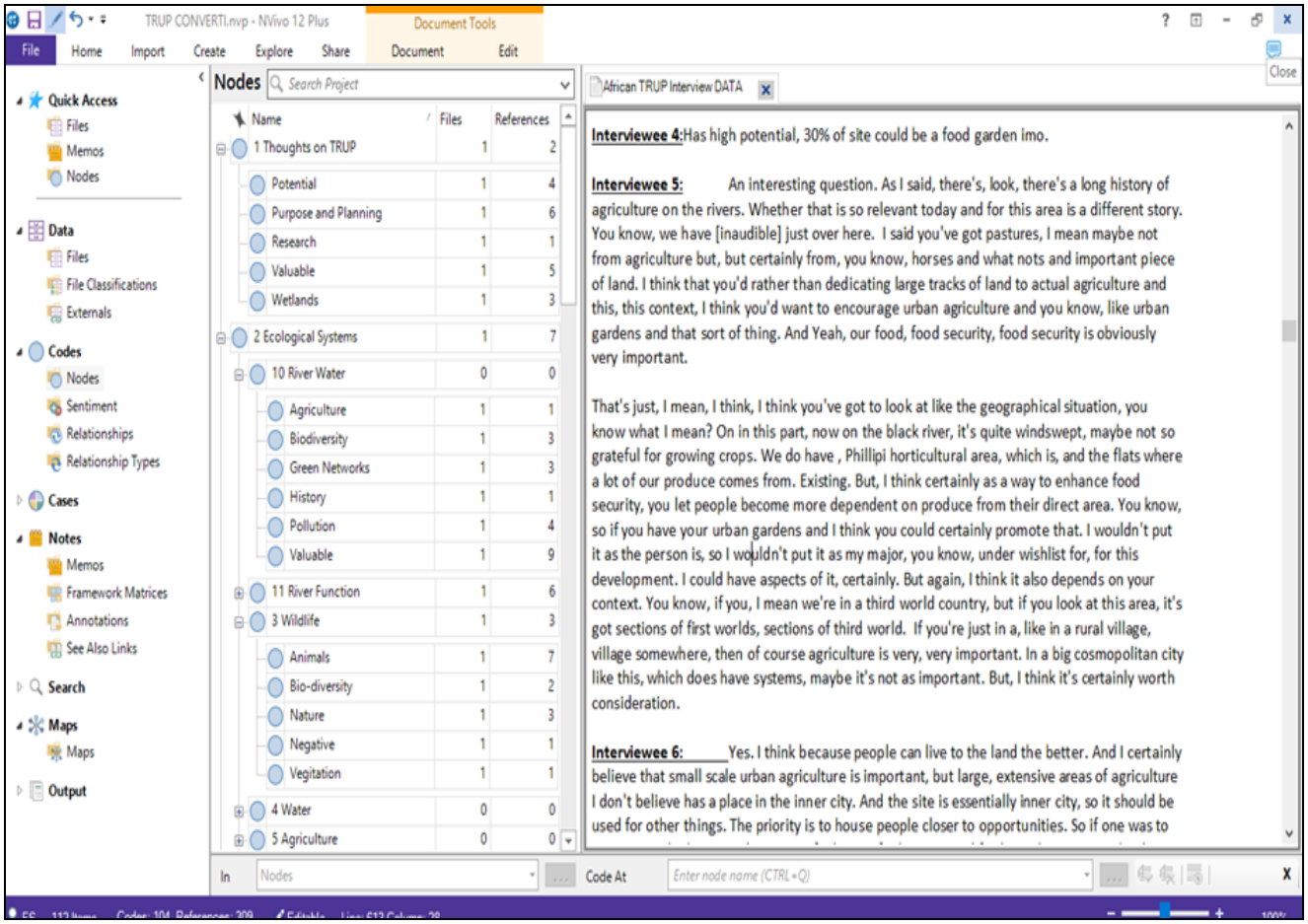

Figure 2.2: Organisation of codes making use of Nvivo

Source: Author, 2019

Numerous researchers have suggested that both pen and paper methods and computer-assisted qualitative data analysis (CAQDAS) tools such as NVivo, offer unique strengths in academic research (Castleberry & Nolen, 2018; Kaefer et al., 2015; Bazeley & Jackson, 2013; Bergin, 2011; Saillard, 2011; Ryan, 2009; Basit, 2003; Welsh, 2002). Making use of Nvivo software contributes to the followings:

1. Provide an organised and structured approach to analysis by creating one database, allowing easy access to all information when needed and keeping track with the coding process while making notes (memos) of emerging ideas.
2. Helps to create a visual output from the data, allowing to produce significant visualisation tools to explore, understand the context surrounding words or phrases and map ideas from across your data.
3. Makes the data analysis and report more efficient by extracting information across selected criteria with the push of a few buttons, allowing to easily insert verbatim text directly from the NVivo project.

2.8. DATA-DISPLAY

This phase of data analysis leads to the classification, description, and discussion of data. Themes, concepts, and ideas have been identified and systematically linked to categories and subcategories.

Data-display involves an organised presentation of relevant textual extracts from the transcribed interviews. It is the synthesis of coded and analysed data. The presentation and discussion of the results were done to reflect the objective and context of the study.

2.9. DATA VALIDITY AND RELIABILITY

The use of multiple methods for data collection was guided by some type of code:

i. Validity: Validity is an index of the value or quality of research. The more valid a research is, the more accurate or reliable conclusions can be drawn. As Leacock, Warrican and Rose (2015:102) mentioned: “An instrument is valid to the extent that it measures what is expected to measure or that it collects the

data you need to answer your research questions." Therefore, the construct of validity was achieved by using a multiple source of evidence.

ii. Reliability: "Reliability is the degree to which measures are free from error and therefore yield consistent results" (Thanasegaran, 2009). This was achieved by developing a "case study database" (Yin, 2014). The assessment procedure produced precise, stable, and consistent results.

2.10. ETHICAL CONSIDERATIONS

In the context of research, "Ethics refers to the appropriateness of your behaviour in relation to the rights of those who become the subject of your work or who are affected by it" (Saunders, Lewis, & Thornhill, 2009:183-184). The following ethics were observed in the research study:

i. ***Informed consent:*** Participants were informed in advance of the nature of the study and had the choice to participate or not. A full consent form was obtained from the participants prior to the study. It is necessary for all participants to be informed of how their data is used and the potential damage or benefits that may result (Bryman & Bell, 2007). c

ii. ***Confidentiality/Anonymity:*** As part of the consent process, participants were assured of respect for their privacy, identity, and any other confidential details. It helps them to feel at ease and give more open and honest answers (Bryman & Bell, 2007).

iii. ***Harm and risk:*** In this research, the researcher ensured that neither the participants nor the environment was put in a situation where they could be harmed because of their participation.

2.11. CHAPTER SUMMARY

This chapter dealt with research methodology, strategy and design that had been followed in this study, including procedures, participants, data collection tools, analysis methods, data credibility issues and measures to meet ethical concerns.

This study used an explanative and explorative case study that was analysed largely through interviews and literature reviews. A summary of this chapter is presented in Table 2.4 through highlighting the major decisions made in order to conduct this research work. The following chapter presents the relevant literature review.

Table 2.4: Summary of the research design and methodology

Decisions	Choices
Epistemological and ontological assumptions	Explanative and Explorative
Methodological assumption	Mixed Methods
Research Strategy	Single Case Study
Research Techniques	- unstructured and semi-structured interviews - discussions - observation - documentation analysis
Respondents	- Officials from local, provincial, and national government departments - Urban planners, engineers, developers - Environmentalists and natural environmental practitioners - NGO and CBO practitioners
Unit of Analysis	Green networks
Sub-unit of Analysis	Natural and Urban components

Source : Author Construct, 2018

CHAPTER THREE
LITERATURE REVIEW AND CONCEPTUAL FRAMEWORK

3.1. INTRODUCTION

A review of literature provides significant evidence on how planning and development in concert with natural systems can address a wide range of societal challenges in sustainable ways and generate co-benefits for the economy, society and the environment in particular in urban areas. This research highlights various issues and provides an in-depth understanding of the potential role and function of green networks in efforts aimed at achieving urban sustainability (Hough 1995 & 2004; McHarg, 1969; Mumford, 1937).

The review includes consideration of published articles and books; professional research reports as well as other contemporary sources with the aim of developing a sound empirical knowledge on the areas of research identified through the study research questions.

Firstly, this literature review discusses the broad concept of sustainable development which has been the driver of change in urban planning's decision making. Secondly, it briefly explores the elements of natural systems and looks at the similar components of urban green systems from a functional perspective. Thirdly, it will investigate the integration of both urban and natural systems and in order to provide a deeper understanding of the interrelationship. The review is preceded by consideration of the current development and environmental challenges and state of planning faced by African cities.

3.2. CONTEXTUAL ISSUES

Initial discussions and analyses about sustainable development became prominent during 1987, during the World Commission on Environment and Development. The "Our Common World" sought to reconcile two issues (environment and development) which were seen as ''a dividing line between North and South'' (WCED, 1987; Spangenberg et al., 2002:2). Since then, sustainable development has been adopted by international agencies such as Un-Habitat:

> "*As an overarching goal of economic and social development by UN agencies, by the Agenda 21 countries, and by many local governments and private-sector actors. (…) It is now perceived as an irreducible holistic concept where economic, social, and environmental issues are interdependent dimensions that must be approached within a unified framework*" (Paredis, 2011; IPCC 2007:122).

This narrative associated with sustainable development was elaborated upon at the 1992 Rio de Janeiro Earth Summit and the localisation of Agenda 21. The UN Conference on the Environment and Development (UNCED) revolved around environmental improvement, in other words, sustainability was the guiding principle for the UNCED Agenda 21 (Pugh, 2013).

UN activities in the context of sustainable development have led to several international conferences: Rio 1992; New York 1997; Johannesburg 2002; Rio 2012; New York 2015 (UN, n.d.; Pallemaerts, 2003; Kurtas, n.d.; UN, 2016). This series of conferences were aimed at preserving, improving and enhancing the earth's environment and natural resources for the long-term, and maintaining the major ecological balances, reducing risks and mitigating environmental disasters.

To address the three dimensions of sustainable development (social, economic, and environmental), the United Nations (UN) new agenda 2030 focussed on overall human and ecosystem well-being (Cumming et al., 2017). It is important to note that sustainable development must be economically efficient, socially equitable and ecologically tolerable. Accordingly," the social must be a goal, the economy a means and the environment a condition" (Maine-et-Loire, 2017).

3.2.1. Population Growth and Urbanisation

The expansion of urban areas in Western developed countries drew significant public interest during the late 1960s. However, some countries such as China remained on a critical period of rapid urban development. For instance, the urbanisation rate of China was 56% in 2015 and exceeding 58.5% in 2017. This represents an increase of 2.5% in two years and 5.95% higher since 2012 (Peng et al, 2016; Stanway, 2018).

Population growth and the resultant need for housing, economic activity, and the related urban infrastructure, confronts cities with several challenges. These challenges are

associated with the increasing occurrence of slums, the need to develop urban infrastructure, to deal with social inequities, and respond to the environmental consequences of pollution, local changes to climate and impact on potable water systems (McPhearson et al., 2016).

Figure 3.1 shows that the planet is rapidly urbanising, with countries such as Nigeria projected to add 212 millions of urban inhabitants, China 292 million and India 404 million people by 2050. The extent of infrastructure planned for the development of new urban areas will have a massive impact on natural resources. Some theorists argue that all things considered, the major cause of environmental problems can be attributed to urban development (Lee & Kim, 2015).

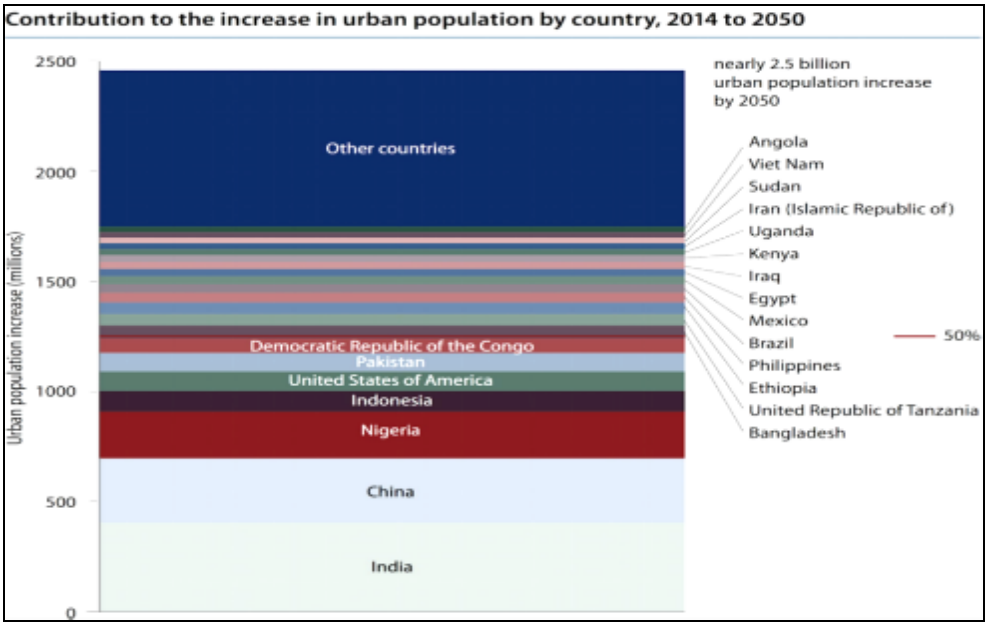

Figure 3.1: Global urban increment between 2014 and 2050.

Source: United Nations, 2014

The 2014 World Urbanisation Prospects reported that:

> *"The most urbanized regions include Northern America (82 per cent living in urban areas in 2014), Latin America and the Caribbean (80 per cent), and Europe (73 per cent). In contrast, Africa and Asia remain mostly rural, with 40 and 48 per cent of their respective populations living in urban areas. All regions are expected to urbanize further over the coming decades. Africa and Asia are urbanizing faster than the other regions and are projected to become 56 and 64 percent urban, respectively, by 2050"* (UN, Department of Economic and Social Affairs, 2014, p. xxi).

The unprecedented scale of urbanisation is currently underway throughout Africa. In sub-Saharan Africa, the population increase was 14% in 1950, 40% in 2010, and is expected to surpass 50% in the next two decades.

> *The economic growth of countries globally, and Africa in particular, is inextricably linked to the growth of cities and towns. Urbanization and the accompanying forces of transformation are a reality, with the population of cities and towns projected to increase rapidly over the next few decades (Madell,C.2013)*

South Africa, for example, is already well ahead of this ratio, with an urban population of about 64% (United Nations, 2014; Shackleton et al., 2015).

The South African National Development Plan - Vision for 2030 reports that along with the rest of the world, South Africa has also experienced rapid urbanisation. Today, an increase of approximately 60% of the population lives in urban areas, representing a 10% decrease in the population living in rural areas since 1994. The movement of people from the countryside to cities continue to rise especially in fast-growing regions such as Gauteng and Cape Town, and 70% of the population is projected to be urbanised by 2030 (National Planning Commission, 2009).

Demographically, Africa and Asia are the most populated, but the least urbanised regions. The importance of cities and international attention on the need to managing urban growth, are reaffirmed through policies and global agreements such as the 21st meeting of the Council of Parties (COP 21) in 2015 on climate change; the October 2016 New Urban Agenda of Habitat III (global process towards a new Human settlement agenda) and the African 2063 vision (Pieterse et al., 2018).

3.2.2. Climate change

With the exponential growth of cities and the concentration of people in smaller geographic areas, projections of climate change indicate that temperatures will increase in the near future (Kong et al., 2014). Johnson (2015) contributed that the urban environment has a significant influence on the climate and heatwaves can be identified as a direct result of urban form and function.

The most common climatic consequence in the urban space is the formation of heat islands due to human concentration and activities in one area. Urban Heat Islands (UHI) are created when strong temperature differences exist within as opposed to their

surrounding rural areas (Bao et al. 2016; Johnson 2015; Zhou et al. 2014; Mackey et al. 2012).

Urban areas, therefore, experience a great increase in temperature due to the urban heat island effect (Kong et al., 2014). Thus, intense heatwaves can be observed within the same city resulting in negative effects on both human health and the environment (Oliveira et al., 2011; Luber & McGeehin, 2008; Yuan & Bauer, 2007).

Stone Jr et al., (2014); Liu et al., (2015) argued that UHI not only alters the urban thermal comfort but also provoke extreme heat events, increases air pollution, energy consumption and threatens human health. It should be noted that urban heat islands are neither a cause nor a consequence of climate change, but the effects of each other aggravate the impacts of each. An increase in global temperatures, will make the urban islands even more intense. Similarly, to a much lesser degree, the dynamics that preside over the formation of urban islands and their consequences such as consumption of energy and pollution are more factors of climate change (Magdelaine, 2014). Hence, steps towards restoring the ecosphere can enhance health and well-being benefits by reducing the impact of UHI.

Climate change can be regarded as an additional overlay on the challenges faced by cities such as housing, public safety, pollution, immigration, and economic development. Cities are increasingly responding to climate change by pursuing strategic adaptation actions.

A large and growing body of literature has investigated the role of cities in tackling climate change mitigation measures to reduce emissions and introduce energy-efficient systems (Da Silva, Kernaghan and Luque, 2012). Cities are considered less as problems and more as “drivers of sustainable development” and an actor for the global environment change (Klopp & Petretta 2017:1; Parnell 2016; Joan Fitzgerald 2010). Hoornweg (2011:208) argued: “Cities highlight the overlapping challenges of sustainable development, climate change mitigation and urban resilience”.

Even more, cities have the unique ability to respond to global issues such as climate change at the local level and usually offer more immediate and effective communication between the public and decision-makers. By their scale, cities are more credible to bring significant changes and potentially participate in mitigation and adaptation measures.

Cities also have to find innovative ways to respond to other critical issues, such as solid waste management and water supply as well as mitigate the impacts associated with greenhouse gasses (GHG) (Hoornweg et al., 2011).

By way of contrast, to date, there is little empirical evidence on how cities in the urbanisation phase manage projects for strategic urban development, particularly those related to environmental protection, poverty reduction, infrastructure and economic growth (Chu et al., 2017). D Satterthwaite (2007), added that developing cities facing rapid urbanisation is often characterised by 'poor planning, weak institutional structures, inadequate services (health care and emergency services) and large deficits in basic infrastructure (sewerage and drainage, water and energy). Cities have therefore limited capacity, political discipline and resources to tackle climate change (Da Silva et al. 2012).

Based on recent discussions, green strategies appear to be effective for addressing the UHI inasmuch as natural systems and urban green spaces are recognised for their strong potential to regulate urban air temperatures (Johnson 2015; Doick et al. 2014). Equally, the existence of green spaces is potentially a promising urban planning strategy for mitigating the UHI effect. They play a central role in evapotranspiration processes, shading effects and cooling temperatures (Bao et al. 2016; Mackey et al. 2012; Susca et al. 2011; Oliveira et al. 2011).

Various factors relating to urban green spaces contribute to the cooling effects of urban heat islands are reported in the literature. These include plant-specific properties as well as the occurrence of parks and forests. However, past research was based either on small scales and not the hypothesis on the potential impact if a particular method was applied to a larger scale or a city.

Cities are not identical in design or in terms of their climate; it is difficult to understand the impact of green spaces on urban cooling from a single city perspective. Therefore the comparison of the effect of green spaces on climate in urban areas remains a challenge (Bowler et al., 2010). Considering that green spaces have a promising role in urban areas, several studies have revealed that they provide a cooling effect in urbanised areas and there would be a potential in maintaining and increasing vegetation cover to significantly cool urban environments (Feyisa et al., 2014; Hamada et al., 2013).

3.3. THE NATURAL SYSTEMS

Natural systems are composed of two elements, which are the biocenosis and the biotope. The biocenosis is a dynamic set of living organisms (plants, animals and microorganisms) that interacts with each other and the biotope is the environment (soil, climate, water, light) in which they live (Planète Sciences, 2003). Formed naturally, they can be of various sizes and are defined for example, according to the vegetation, an animal species or relief (Futura Planète, nd).

Forman (2008:8) stated that “Natural system refers to nature, but focuses on its structure, functioning, and change”. Hence, nature is not a product of human activity or intervention, but the composition of various manifestations of plant and animal life that are encountered in landscapes rather than those of the built environment (Low et al., 2005:74). The following discusses the various components of natural systems:

3.3.1. Water systems

Water is essential for existence, development, and life. In fact, "All life on earth depends on water and the quality and supply of water is in turn dependent on healthy ecosystems”. With the possibility of linking the landscape across rivers, streams and wetlands, it is an essential element for biodiversity landscapes (Mader, 2010). The perpetual movement of water through the different components of the earth's climate system as well as the whole process of water transformation and transfer (condensation, precipitation, infiltration, runoff, and evapotranspiration) form the hydrological cycle. This cycle is important because it provides plants, animals and humans with water (Pagano & Sorooshian, 2014).

Rivers and streams in most watersheds are maintained by lakes that contain virtually all existing freshwater and create a network across the landscape that promotes biodiversity conservation and diversity (UN-Habitat, 2012; Hough, 2004:27). These corridors have great potential for linking ecosystems through landscapes, often isolated or fragmented by human activities such as agriculture, highways, canals on concrete banks, railways, etc. Madera (2010) confirmed that this connectivity has a crucial function as it provides connected habitats for the survival of many animal and plant species.

Wetlands are among the most productive environments in the world because they provide considerable economic benefits at the global level, namely water supply (quantity and quality), fisheries, agriculture (rice fields), leisure and tourism opportunities etc. (Anon,

2013). They are essential to biodiversity (Anon, 2015) and apart from the water they provide, they have many beneficial services for people, fauna and flora. Among those services or functions, there is also the protection and improvement of water quality, the storage of floodwaters and the maintenance of the flow of surface water during periods of drought (US EPA, n.d.).

As stated by Hough (2004:43) "The basic lesson that nature provides in the water cycle is that of storage". Vegetable soils and forests guarantee storage by trapping and percolating water in the soil with minimal flow and maximum benefit for groundwater recharge. More, by their self-purifying effect, wetlands function as natural sponges. Unlike expensive dredging and dykes, they slowly trap and release surface water, rain, snowmelt, and groundwater and floodwaters (US EPA, n.d.). Thereby, water quality is enhanced by vegetation and storage, which, in turn, contribute to the diversity of human and natural habitat (Hough, 2004:71).

These valuable functions are the result of the unique natural features of wetlands (naturally improved water quality, flood protection, coastal erosion control, recreational opportunities, and aesthetic appreciation at no cost). However, the development of reliable water supply in the growth of cities has become an important factor. Because it has provided the means to control diseases, raise public health standards and fight the fire, at the same time, its abundance and supply often lead the perception of water as a free product and result in misuse, waste and environmental pollution (Hough, 2004:33).

3.3.2. Plant systems

“Plants are the basis of life on earth…they produce oxygen and provide food and habitat through the photosynthesis that supports all living creature” (Hough, 2004:87). The maximum temperature level in summer can be 1 to 3 degrees higher in cities than in rural areas due to the effect of building heat bank and global warming.

Critically, plants provide shade that city dwellers need (Low et al., 2005:79). With that, trees should not be considered simply as a cosmetic embellishment in cities. They contribute enormously to the cities, both in terms of aesthetics and ecology, as well as public health and quality of life. For example, street trees are important because they absorb air pollution, provide habitat for birds and other wildlife, but can also be used to enhance the visual image of a community (Low et al., 2005:78).

From an ecological point of view, it is important that the plants be used as much as possible in urban areas as they help to conserve the flora of the region while providing shelter and food for local animals (Low et al. 2005:90).

3.3.3. Wildlife

With enough species, a diversity of vegetation that connects the areas and offers a great diversity of fauna, the rivers, streams, forests, marshes, water, canal and the pre-urban landscapes that exist in the neighbourhood of the city are the habitats for wildlife (Hough, 2004:131,138**)**. Wildlife is another integral part of the natural system that helps us maintain biodiversity. However, urban activities alter natural habitat, create a complex environment for wildlife and have many repercussions (Hough, 2004:133,136).

Indeed, “when people and animals share limited space in the absence of natural controls, diseases transmitted from wildlife to humans and humans to wildlife occur more easily” (Hough, 2004:137). While the preservation of rare or endangered species is a major concern of government policy, they are often unaware that maintaining and enhancing the representativeness of these species is also essential to the biological integrity of our cities.

The protection and preservation of natural places and the interaction of living organisms in cities is one of the important bases for understanding the importance of nature as a whole (Hough, 2004:138**)**. Hence, “wildlife in the city provides lessons we can learn about the balance of nature upon which all living beings depend” (Hough, 2004:158).

The maintenance of biodiversity in urban areas has been one of the Swedish national environmental objectives since 1999 in accordance with the Convention on Biological Diversity and Agenda 21 from the Rio de Janeiro summit (UNCED, 1992; Lofvenhart et al., 2002). A natural system is a balanced environment where living species interact and exploit the contributions of the biotope.

To be able to maintain this balance, changes in land use and its influence on the structure of biotopes in urban areas must be considered. The current situation with urbanisation and biodiversity loss challenges requires new ways to approach the natural system and the need for research has been stressed.

3.4. THE URBAN SYSTEMS

With the social-demographic changes and challenges in the technological and environmental sectors, there is a need to understand different components, their functioning and how these should be managed for both city dwellers and biodiversity. Regarding the urban structure, green open spaces, urban transport system and waste management, establish an urban system that has become a necessity as it plays an important role in creating the ideal conditions that promote the health and well-being of people (Niemelä, 2014; Bilgili & Gökyer, 2012).

3.4.1. Green Open Space

Most people today live in urban areas not knowing exactly what its components are and how to live and benefit from urban green spaces. From physical activity to the well-being of urban residents, green open spaces (parks, forests, green roofs, streams, community gardens, street trees, and nature conservation areas) provide essential services and is considered to be a “key social and environmental infrastructure for a sustainable city’’ (Ives et al., 2014; Wolch et al., 2014).

The term open space is most often used in urban planning and refers to “ any urban ground space, regardless of public accessibility, that is not roofed by an architectural structure*”* (Stanley et al., 2012:1089). Very often, open spaces are categorised into yards, recreation spaces (sports field) and the natural environment which is popular for walking and the natural beauty (Low et al., 2005:78).

Furthermore, places such as parks and open spaces improve the quality of life; have a beneficial contribution and have become indispensable to the social, economic, environmental and aesthetic value in a city (Bilgili & Gökyer, 2012). These spaces offer, recreation, social and cultural activities, are also a way to protect biodiversity and habitat (Malek et al., 2008).

Research showed that access to open and green spaces is very important, especially for the elderly, children, mothers and their babies and individuals with disabilities. When these spaces are accessible and secure, they help with the physical and psychological development of children and have a positive effect on the health and well-being of an individual, which is essential in any society (Lestan et al., 2014; Spencer & Blades, 2006).

However, the inadequacy and poor quality or management of green open spaces in cities can be seen as a barrier on the development and well-being of the inhabitants, because it does not help in the development of a healthy lifestyle. It is important to be in direct contact with nature. Therefore the green areas of urban landscapes cannot be replaced by artificial green spaces found in the cities (Lestan et al., 2014).

Ives et al. (2014)recognised that little research has been done on the values that the communities attribute to open green spaces. In a report, he identified the following values: aesthetic / scenic (i.e. the visual attractiveness of a place); activity / physical exercise (i.e. opportunities for physical activity); native plants and animals (i.e. the protection of native biodiversity); nature (i.e. experiencing the natural world); cultural significance (i.e. appreciating culture or cultural practices such as art, music, history and indigenous traditions); health / therapeutic (i.e. mental or physical restoration); social Interaction (i.e. opportunities to interact with other people).

When questioned, people tend to prefer more green open spaces for their natural settings, the opportunity for physical exercise and the visual attractiveness. For example, parks near to water are considered to be a valuable asset for aesthetics and social activities (Ives et al., 2014). It is obvious that green open space has several values, but it is crucial to recognise that it is also vital to maintain biodiversity and the urban ecosystem services in cities (Corkery & Marshall, 2011; Konijnendijk et al., 2013).

Indeed, natural corridors, parks, reserves are significant ecological features for maintaining species and ecological functions within the urban landscapes, especially knowing that green open spaces can influence biodiversity and also have the potential to serve as links between habitats and increase the flow of organisms in an urban landscape (Bolger et al., 2001; Ives et al., 2014).

Human activities and urban structures outside open green spaces cause changes in environmental conditions, fragment habitats and affect species composition is affected. For this reason, some research has focused on improving green open spaces and the connectivity of landscapes by suggesting to consider also green spaces such as gardens and backyards to best participate in the conservation of biodiversity (Goddard et al., 2010).

It is clear that biodiversity present in green open spaces greatly depends on the quality and its habitat structure (Ives et al., 2014). Thus, far from the aesthetic aspect that it can

be worth in the cities, it is essential to consider first the conservation of biodiversity in all the ecological decisions of planning open space. If the green open spaces are well-planned beforehand, they can contribute significantly to the conservation of many species and maximise the benefits that can bring the green open spaces.

3.4.2. Waste Management

Green open spaces contribute to the quality of life in urban areas. Planners are striving to establish green open systems in urban areas and an important related strategy in this regard is waste management. The management of urban green spaces and urban waste is usually done by the municipalities and involves finance, development and maintenance policies. (Meisel & Thiele, 2014).

The primary purpose of waste management is to meet environmental, aesthetic, economic and health needs. For Zaman & Lehmann (2013:123), “waste is the symbol of inefficiency of any modern society and a representation of misallocated resources”. In some cities, progress has been achieved in managing and reducing waste, but for others, the waste management system is still not effective.

The fact that most of the world largest cities are projected to be in Africa also raised concerns about waste management (Satterthwaite, 2017). In Africa, it means an increase in challenges already caused by the urban growth phenomenon. As UNEP (2002:2) noted:

> “Key environmental issues in urban Africa are related to the provision of services for waste, water and sanitation, and urban air population”.

In developing countries, waste management mainly focuses on collection and removal services (Marshall & Farahbakhsh, 2013). City authorities, responsible to provide an effective and efficient systems to inhabitants, face major challenges due to the rapid urbanisation and increase of population levels, the amount of waste generated, lack of organisational capacity and limited budgets. Due to rapid urbanisation and changes in consumption habits, the amount of waste is increasing exponential rates in most African cities Waste that is illegally dumped or not collected is not only a threat to human health, but also to food production, tourism, flora and fauna and therefore the broader economy. From what follows, uncollected waste dumped illegally into drainage canals or water bodies can cause flooding in cities, waste dumped in open spaces can lead to insalubrity, while waste buried and burnt can result in soil and water pollution (Achankeng, 2003).

Thereby, McMichael (2000) asserted that insanitary generated by waste is the cause of the predominance of certain parasites, tetanus, malaria, cholera and diarrhoea so common in African conditions. Waste management remains an unsolved problem faced by African cities (Guerrero et al., 2013). Then, alternatives and new approaches to waste management system must be considered. This should include refocusing in methods such as waste sorting at source and the recycling of waste in all its basic forms, i.e. plastic, paper, metals, etc. Landfill sites will remain an important part of an urban waste management strategy but can also form an integral and vital part of green open system networks in cities.

3.4.3. Urban Water Management

Urbanisation and increasing demand for water confront cities with new challenges. In many countries around the world, the hydrological cycle, aquatic systems and ecosystem services are disrupted (Dilling et al., 2019). Cities are looking for new sources of water upstream while rejecting their effluents downstream with consequences for the surrounding residents (Bahri, 2012). The management of water in an urban area is aimed at supporting urban water issues in cities due to massive wastage, climate change, the impact of water shortage and drought.

It is important to find innovative approaches and tools for sustainable urban water management. For Hough (2004), new approaches and technologies must respect the environment, through the treatment and recycling of wastewater. It is not enough to move away from river valleys, wetlands, and woodlands but rather to seize the opportunity to live in harmony with nature and the services it provides to us.

Water resources should be managed in an integrated manner by making the population aware of the need to protect the environment and to care for water when using it. Integrated urban water management (IUWM) is a comprehensive and sustainable approach to the water cycle which estimate current and future demands and anticipate the climate change. It helps recognise that different types of water can be used for different objectives. For examples, wastewater (yellow, brown, grey and black water) can be treated to meet the expectations of industry and agricultural demands; desalinated water and fresh water sources (rainwater, surface water, groundwater) may properly supply domestic use (Bahri, 2012).

Unlike past methods, the supply, use, treatment of water does not follow a one-way path but can be recovered and reused several times, from higher quality to a lower quality through the integrated urban water management (Moddemeyer, 2010). One of the most important transformations today is the way we look at wastewater. They must be perceived in a much more positive way, as opportunities, by grasping their potential value.

The integrated urban management process will help cities reduce the number of people without access to water and sanitation especially in developing countries (UnHabitat, 2009) by managing runoff pollution, stormwater drainage, rainwater, and wastewater while preventing resource degradation and mitigating floods, droughts, and landslides (Bahri, 2012). More strategies will be asked of urban water management in the future to respond to issues related to water supply and sanitation.

3.5. INTEGRATION OF URBAN AND NATURAL SYSTEMS

When comparing global ecological footprints with the ability of ecosystems to continue providing biotic resources, shows that the abundance of natural resources in the past has led most countries to promote economic development that consumes a lot of natural resources and often being degraded or used in an unsustainable manner (Giljum et al., n.d.; Loh et al., 2008; UN-Habitat, 2012).

The planning, construction and management of urban spaces, buildings and infrastructure systems have direct and indirect consequences for the natural environment in the short, medium and long-term (UN-Habitat, 2012). These consequences impinge on natural ecosystem services, in particular in cities that are vulnerable to urban sprawl caused by rapid metropolitan growth.

The city should be considered as a living system and the integration of urban and natural processes (water, plants, wildlife, agriculture) as essential and this requires cities to safeguard the natural ecosystems in which they rely on and promote environmentally sustainable development (Hough, 2004). A natural system is “one that exists in nature, independent of any human involvement and consists of all the physical and biological materials and their intertwined processes…human survival is dependent on this network of processes” (UN-Habitat, 2012:13).

Collaboration with nature in the urban planning process and allowing adequate space for natural systems will give a very concrete overview of what biodiversity is and what nature

brings to the city. The UN-Habitat (2012:13) also recognised that “the city is an urban system that grows within a set of interlinked natural systems”. What the natural environment offers is essential to our living environment, our well-being and it can be maintained in urban areas through green networks.

3.5.1. Biodiversity and Urbanisation

Environmental challenges necessarily involve the challenges of urbanisation. According to Park et al. (2012) and UN-Habitat (2012), urbanisation through the expansion of human populations degrades biodiversity by reducing the quantity and quality of habitat available to wildlife and by fragmenting the landscape and disrupting the remaining natural systems.

As more and more of the world becomes urbanised, maintaining the earth’s biological balance has become a challenging goal. Further loss of natural and semi-natural habitats and increasing pressure on the remaining habitat fragments are to be expected. If cities are successfully facing this challenge, they must be aware of ecosystem degradation and build their economies by respecting and rehabilitating the biological systems on which life depends (UN-Habitat, 2012).

For instance, China's rapid economic development has resulted in significant environmental pollution. Hence, China is investing in Africa and other countries and encourages its companies to follow best environmental practices, using more and more the environmental impact assessments (Shinn, 2016). Through this, they will be able to address the challenges and improve the quality of life of all their citizens.

Preservation and management of urban ecosystems are crucial to urban resilience as they provide a source of food, water and materials, as well as contribute to flood control, waste absorption and amenity (Roberts, 2010). Mader (2010) also pointed out that by building and operating a water treatment plant, for example, to replace the ecosystem service has proven to be more expensive than the preservation of the ecosystem and its use to filter and clean water.

Luo et al., (2016) presented a case of the Karst area in southwest China with unique fauna, rich in terrestrial organisms and endemic species where the increasing human population influence and destroyed the original vegetation. Biodiversity loss is invaluable when it comes to extinction. Also, Da Silva et al., (2012) stated that one of the

fundamental urban functions aim at securing well-being, is underpinned by the natural resources and services provided by ecosystems. Therefore, the maintenance of a sustainable economy depends on the conservation of biodiversity.

According to Parkand and others (2012) reducing the impacts of urbanisation on biodiversity can be achieved through green spaces in urban areas. Although urbanisation can threaten biodiversity, cities also offer a variety of opportunities for habitat because they are often built on land formerly occupied by natural spaces:

> *"Cities are located in or near biodiversity hotspots, for example, estuaries, coastlines, ecotones and fertile plains. If well managed, they can support biodiversity by acting as shelters for species whose habitats have been destroyed by intensive agriculture and forestry; by being a socio-ecological system where new habitats and communities of species can develop; and by providing ecosystem services that cannot be imported (noise reduction, absorption of air pollutants and water)"* (UN-Habitat 2012:chap 2).

That is, cities are important for global biodiversity and biodiversity itself is important for the urban sustainability and well-being of city dwellers.

Previous studies have confirmed the urgent need to develop strategies to adapt and mitigate the continued increase in temperature (Bowler et al., 2010; Buyantuyev & Wu, 2010). Therefore, the role of urban green space in the moderation and cooling of climates in urban areas is widely studied. Outside of the aesthetic level, it turns out that the vegetation in a city can also reach other benefits such as the reduction of rainwater runoff and ameliorate the impacts of urbanisation on biodiversity(Kong et al., 2014; Kong et al., 2010).

In the contribution of this, Fatmi (2016), explained that urban green spaces are not only aimed at restoring ecological balance in the city, but also to have key objectives that are essential, such as the purity of the air we breathe; ensuring social equity and a pleasant and sustainable living environment for all.

Needless to say, the debate on the ecological, economic, and social dimensions of sustainable development and how they apply to urban contexts is far from being resolved and understood. The literature on sustainable development shows colossal debates on

which green systems should be developed and how this can be effective in cities, but to put them into practice remains a challenge.

Moreover, sustainable development is difficult to achieve, particularly in developing countries where sustainable land use management and forward planning is not often considered in decision-making. Ideally, it should be incorporated into the overall decision-making framework to guide the development process. This highlights the fact that there are inseparable links between nature, cities and sustainability, and cities are important for biodiversity.

3.5.2. The Pressure of Urbanisation on green spaces in Africa

Recent studies indicated that urbanisation in Africa is stimulated by increased investment in natural resource extraction (minerals and oil in particular), growth in commercial agriculture and other sectors that draw on natural resources (Cobbinah & Darkwah, 2016; Mensah, 2014; Fall & Coulibaly, 2016).

The extraction of its resources contribute towards a decline of urban greenery in the cities of many African countries at a time when the functions and benefits of greening cities \for the creation of functional urban environments and preservation of biodiversity are known and reported worldwide (Cobbinah & Darkwah, 2016). Africa is considered to be a vulnerable continent as it is less able to adapt to global climate change (Shinn, 2016).

Cobbinah & Darkwah (2016) and Mensah (2014) made it clear that cities in the West, East, and Central Africa with “more favourable tropical rainforest, deciduous vegetation zones and rainfall” support natural spaces, compared to cities in North and Southern Africa with poor rainfall, soil conditions, desert and unfavourable vegetation .The pressure from urbanisation has accelerated the depletion of green spaces in major cities in Africa (McConnachie et al., 2008). Studies also showed that in various towns in South Africa such as Jeffrey’s Bay, Mossel Bay, Bisho, King-Williams and Butterworth, less than 10% of the total land is occupied by natural spaces (Cobbinah & Darkwah, 2016; McConnachie, Shackleton & McGregor, 2008; Mensah, 2014; UN-Habitat, 2012).
The city of Lagos in Nigeria has less than 3% of its total area (3600 km2) occupied by urban greenery; Kumasi (Ghana) formerly the Garden City of West Africa, has only about 7% of its territory (254 km2) in the urban green space; Addis Ababa (Ethiopia) and Nairobi (Kenya) have also been rapidly depleted in natural species. Other cities such as Nairobi

(Kenya), Accra Ghana) and Kampala (Uganda) are finding it increasingly difficult to respond and recover from the risks imposed by rapid urbanization (UN-Habitat, 2014). These risks include the deterioration or destruction of natural areas.

Most developing cities claimed that they are pursuing sustainable development as a goal, but so far little has been done to achieve the desired outcomes and many of these studies focus on European cities and other parts of the world (Mensah, 2014). The lack of prioritising green open spaces, corruption, and political instability are factors other than rapid urbanisation that impact negatively on the process of urban sustainability, delay the development of green spaces in cities and reflect less awareness of the importance of natural elements within the city space.

As Hamza & Zetter (2000:434) stated: “The record of planning and managing rapid urbanisation in the developing world has not been impressive either in terms of the instruments used or the quality and performance of the resulting urban environments”. Thus, improvements and new approaches are needed to reach this goal.

All in all, urbanisation is a major problem encountered by developing countries in Africa, mainly due to a lack of infrastructure, poor resource management, poverty, and various inequalities. These challenges can limit the potential benefits urbanisation can offer, especially as it has the ability to be the ‘engine rooms’ for national economic development.

3.5.3. Weak Planning Capacity: Need for well-planned cities and challenges in Africa

In Africa, significant economic growth is taking place with rapid urbanisation, including demographic changes without the required infrastructure, spatial and settlement development (UN-Habitat 2013:6). Shinn (2016) explained that African leaders have been more concerned about issues such as disease, civil conflict, violence, poverty etc. and not the protection of the environment as a first priority. Hornweg & Pope (2016) suggested that “13 largest cities in the world may be in Africa by 2100”. However, these cities are likely to be confronted with serious development and planning challenges.

Mensah (2014:6) argued that one of the planning issues in Africa is the obsolete nature of some regulations to meet current urban development trends. He pointed out that bureaucratic processes and weak on non-existent planning measures are factors not

grounded in ecological systems and these hinder effective urban planning and environmental actions.

Okpala (2009) opined that most African cities have remained rooted in static town planning and exclusive urbanism approaches. In other words, Anglophone (sub-Saharan) African countries, for example, are mostly the result of British colonial creation and where much of the planning legislation, acts, revisions have been derived and evolved during the 12th century.

The UN reckons that harnessing new techniques and moving beyond the traditional colonial approaches to urban management requires profound changes. The UN (2012) believed that rethinking urban planning involves a change in decision-making to recognise the benefits of self-sufficiency and new forms of governance should focus more on learning, adaptive capacity and social equity. This is even more critical at a time when rapid urbanisation is disrupting the development of Africa and certainly the management of urban natural spaces in Africa (Cobbinah & Darkwah, 2016).

Furthermore, sustainable cities are becoming increasingly important in the development programs of many nations but particularly needed in developing countries with the phenomenon of urbanisation (Shen et al., 2011). The understanding of biological diversity and the importance of natural systems in urban areas remain unclear as urban biodiversity strategies and assessment are neglected (Kwame, 2014). Concerns about biodiversity in urban areas are only secondary issues compared to those of solving unemployment and poverty (Elmqvist et al. 2013:23).

3.6. GREEN NETWORKS AND URBAN PLANNING

Green network means different things depending on the context in which it is used: For some it refers to technology (such as energy-efficient networking, software) (Bianzino et al., 2012); others to engineering (waste management, water treatment); still others associate this to ecological benefits in urban areas.

A green network sometimes referred to as "ecological infrastructure" is a natural equivalent or complement to building infrastructure, providing services to society (Cumming et al., 2017). This theoretical concept of landscape ecology focuses on both the interactions between biological and physical environment functions (Moseley et al., 2013).

Moseley, Marzano, Chetcuti and Watts (2013) nuanced the use of terms green space for the individual components (such as parks, gardens, etc.) and green network to refer to the configuration and management of green space as a functional system. According to the Glasgow City Council (2012), Green Network is:

> "*The linking together of natural, semi-natural and man-made open spaces (which may include leisure or recreational facilities) to create an interconnected network that provides opportunities for physical activity, increases accessibility within settlements and to the surrounding countryside while enhancing biodiversity and the quality of the external environment."* (Heritage, S.N. 2012:2)

Along similar lines, green networks functions provide a range desired outcomes in relation to climate change and environment such as reduction in urban heat, increase of tree canopy cover, save energy through natural rather than artificial or engineered solutions, link natural features or existing habitat and allows movement, management of waterside habitat and protection of aquatic species, creation of diverse habitat rich in flora and fauna, reduction of pollution, and reduction of floods through natural drainage (Council I., 2014 :5,7).

In urban areas, the concept of green network highlights green and blue elements (green spaces and water). It encompasses a holistic and integrative approach to urban planning, management that focuses on habitat conservation for wildlife and human well-being, and also offers a tool for the development and integration of sustainable urban planning (Na Xiu et al., 2016).

In other words, a green network can improve the connectivity of places and mitigate environmental impact. It can maintain and enhance biodiversity by linking existing habitats and provide corridors for species movement. It preserves the integrity of habitat systems and may provide the physical basis for ecological networks which make an important contribution to the creation of sustainable cities (F. Kong et al., 2010; Na Xiu et al., 2016) . Therefore, green networks could have an influence on urban ecosystem health by contributing to ecosystem resilience (Tzoulas et al., 2007).

While a variety of definitions of the term green network have been suggested, urban green networks is defined as a set of networks of ecological functions and interact with the landscape matrix (Na Xiu et al., 2016). The concept is based on the needs of both humans

and nature. In this context, green network approaches appear to be a nature-based solution “inspired by, supported by or copied from nature. Some green networks involve using and enhancing existing natural solutions to challenges, while others are exploring more novel solutions, for example mimicking how non-human organisms and communities cope with environmental extremes” (EC, 2015:5).

The main idea behind is the understanding of the natural environment as capable to mimic a wide variety of essential ecosystem services and emphasizes the need of connectivity for natural areas and other open space to facilitate the migration of species into proper habitat and increase ecosystem resilience (Benedict, M.A. & McMahon, 2012). These spaces and corridors associate should enhance the area’s biodiversity.

3.6.1. Green networks: A way toward sustainability

As ecological networks have become a promoted element of urban planning and conservation of biodiversity, it is a contribution to sustainable urban planning. The requirements of the Scottish Planning Policy (SPP) (2014) indicated that “planning should protect, enhance and promote green infrastructure, including open space and green networks, as an integral component of successful placemaking ” (Council I., 2014:2).

The claim “urban greening can form a mainstream framework to facilitate a sustainable approach to urban expansion” takes the approach that green networks in urban planning equilibrates the difficulties of balancing economic growth with sustainable urban development (Mell et al., 2013)**.** Authors like Benedict and McMahon have also proposed that it is the natural life support systems that underpinning development, particularly in rapidly developing cities such as Ghaziabad (China); Surat (India); Bamako (Mali); Lagos (Nigeria); Dar Es Salaam (Tanzania); Luanda (Angola) etc.

On the same note, Schäffler and Swilling in “*Valuing green infrastructure in an urban environment under pressure*”(2013) reaffirmed that rapidly expanding cities can find sources of resilience in their own natural elements. This is based on research through a Johannesburg case study, they believed that ecological systems present a compelling case for including green areas as sources of ecosystem services in environmental issues management and urban planning. While the new development agenda in South Africa could potentially alter the natural environment, but it also creates the opportunity to

demonstrate that nature and development needs can be inclusive through the rehabilitation and maintenance of natural areas (Cumming et al., 2017).

As it can be seen, evidence of increasing attention to support green networks in the cities are supported by the case study of the Shenzhen Greenway in southern China. Shenzhen Greenway, a part of the Pearl River Delta, which is an important metropolitan area in the country, is one of the first innovative planning projects in China (Chen et al., 2017). The greenway connects nature preserves, historical heritage sites, regional country parks and cities. More, it also connects existing parks, green belts, and waterfronts. Figure 3.2 presents the urban greenways systems in Shenzhen. The project started in 2009 and helped develop a green quality and network around the city (Liu et al., 2016).

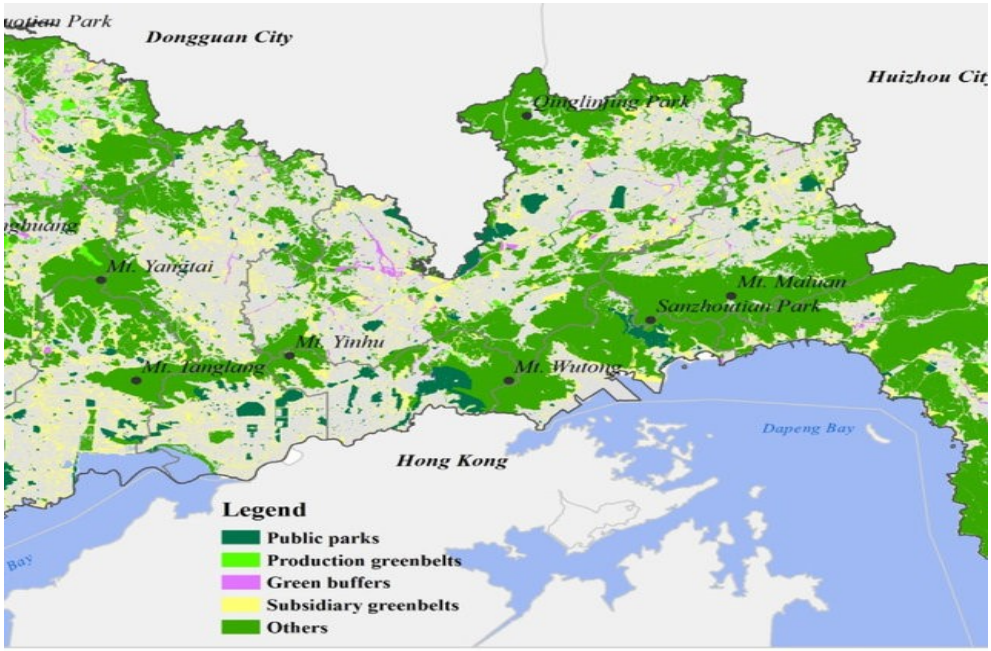

Figure 3.2: Shenzhen urban greenways systems

Source: Indicators for quantitative evaluation of the social services function of urban greenbelt systems (Hong & Guo, 2017).

Hansen & Pauleit (2014) had indicated that the green network unlike other approaches in urban ecology (a natural area to fence or embellish cities) provides a more flexible, yet integrative, process to develop urban areas. In urban areas, it helps to establish and maintain networks that meet biodiversity, water management, social and economic functions. Thus, it is an approach to urban development that promotes a specific role

natural systems within a human-centred perspective of how landscape and other built infrastructures interact (Mell, 2009).

Literature shows that a sustainable urban concept was established for the city of Gdynia in Poland (Kowalewska, 2011). The concept study aimed at solving both ecological and social problems, focusing on the need for protection of natural landscape and the social need for recreation in close surroundings of places where people live. The project was to define an urban green network and how it should be functional to promote cohesion and interconnectivity between the built environment and green zones (Kowalewska et al. 2011). However, very few publications can be found in the recent work of literature that address the outcomes of that project in Gdynia.

Another study of urban green networks in Stockholm has applied graph theory to look at the physical green-blue spaces extents. It illustrated how green networks can be expanded as a multiple functional framework that can be transferred between different scales. Based on their experiences of testing the approach in Stockholm, Na Xiu, Ignatieva, Van den Bosch and other researchers (2017) observed that suggestions can be proposed for improvement in response to currently isolated landscapes and the desire to create optimal green networks. Yet, they also recognise that several questions need to be further explored with more case studies of green networks in a way of effectively evaluating the merit of this approach and provide references for city planners in other cities.

Borgström, Similä, Kistenkas and authors also argued that the intensive use of natural resources and land-use changes affect ecosystems. Consequently, ecosystems are under great pressure degrading his services (climate regulation, water purification, waste management, pollination etc.) with negative impacts on human well-being and biodiversity. Alternatively, it is necessary to reverse the norm by protecting, improving and using natural processes to achieve economic and social benefits and not to continue to deplete natural resources and build costly technical systems for the same services that natural processes can provide (Borgström et al., n.d.).

The European Commission (EC) pointed out that, investing in natural capital has potential to contribute and improve numerous objectives, such as human health and well-being, climate change adaptation and mitigation, environmental risk management, regional

coherence etc. The EC recommends boosting the implementation of natural elements within the ambit of sustainable development (Commision, 2013).

In September 2015 , The United Nations (UN) adopted 17 Sustainable development Goals (SDGs) and they range from “ensure availability and sustainable management of water and sanitation”, “access to affordable, reliable, sustainable and modern energy”, “make cities and human settlements inclusive, safe, resilient and sustainable”, “take urgent action to combat climate change and its impacts” to “conserve and sustainably use the oceans, seas and marine resources for sustainable development and “protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss” to name a few.

These principles will guide global development until the year 2030 and will pave a way towards sustainability *(The Sustainable Development Goals Report*, UN 2016). Figure 3.3 below demonstrates that investing in ecological infrastructure can support the achievement of a range of SDG outcomes.

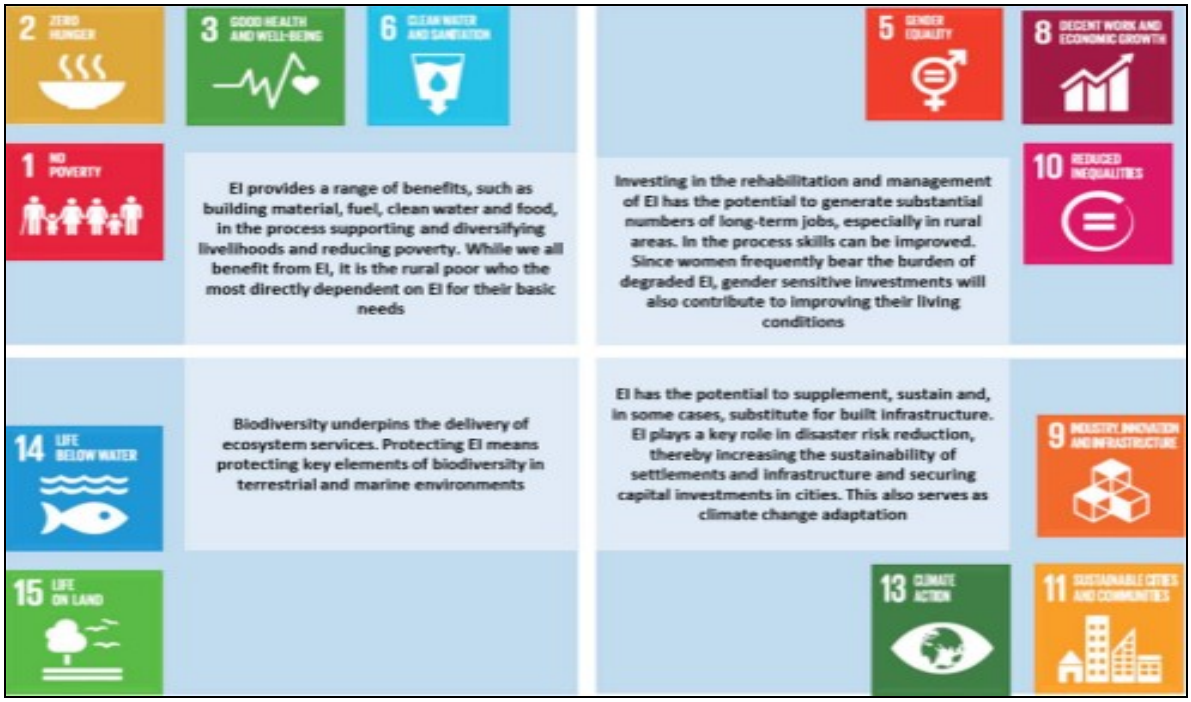

Figure 3.3: Investing in ecological infrastructure supports a range of the SDG targets.

Source: Achieving the national development agenda and the Sustainable Development Goals (SDGs) through investment in ecological infrastructure (Cumming et al., 2017).

The above views have started painting a clearer picture of the role of green networks within an urban area and it can be considered as an innovative response to city developmental challenges and an approach to enhance resilience between people and nature in urban environments. It has been also mentioned by the Inverclyde Council in their local development plan 2014 that green systems must be integrated into the development plan to ensure that adequate attention is paid to their beneficial contribution and this seems to be a reliable innovative approach (Council, I., 2014)

Green spaces are an integrative way to sustainability. To ensure a well-balance of green spaces, an effective and harmonious urban green network can be the solution (Fatmi, 2016). The concept of a green network is to create a tool that would provide a sustainable planning basis and adhere to standards of development for specific types of green areas in the city. It has been introduced to enhance green space systems as a comprehensive planning entity (Sandström 2002).

Several researchers, local governments, and councils have discussed the usefulness and importance of "green networks" in recent years. The major drawback of some of the approaches to green infrastructure are those that have typically focused on implementing trees and creating man-made open spaces, leisure or recreational facilities, but not promoting the ecological functions of natural systems as an integral component of sustainability and biological conservation within the urban area. Having nature in the city does not only mean parks and gardens and should also include rustic and wild natural environments.

3.6.2. *Urban and landscape ecology: Nature connectedness*

Urban ecology is the coexistence between the city and nature: It defines the interactions between urbanism and the natural, animal and vegetable species that evolve on the territory. Urban ecology deals with biological models and associated environmental processes in urban areas. In this sense, it strives to analyse the relationships between plant and animal populations and their communities, as well as their relationships with environmental factors, including human influences (Endlicher et al., 2007).

In his research on the spatial patterns and relationships between people and the environment, Richard Forman (2008) defines urban ecology as “the study of the interactions of organisms, built structures and the natural environment, where people are

aggregated around a city or town". He classified nature into four sections: A "natural zone" (wild area or forest, A "semi-natural", similar to a natural ecosystem, but often degraded (city park), An "intensive-use green space", a highly adapted landscape (golf course or agriculture / rural agriculture), and a "built area", a typical urban landscape (residential, offices and roads)" (UN-Habitat, 2012). He argued that the level of environmental degradation is determined by the relationship between people and that these areas determine the level of environmental degradation and the negative effect on nature by humans is more considerable fact.

According to Forman (1995), landscape ecology encompasses the complex mosaic of all local ecosystems, land use and ecological interactions at the landscape scale. It is determined mainly by the dispositions of these basic elements which are patches (Patches of natural green space come in all shapes and sizes and are found in clusters, dispersed or isolated) and corridors (linear arrangements of natural areas that come in many forms: long or short, wide or thin, straight or curved) (Low et al. 2005:86). For Forman (2008), patches and corridor approach can link these systems that allow a city to develop around natural systems, provide connectivity and allow species to move between areas. In this sense, the infrastructure or the model of a landscape determines the function of an area (UN-Habitat, 2012).

Generally, larger patches support diverse populations of plant and animals and provide a good range of habitats (Low et al., 2005; Forman, 2008). It helps to protect elements of the natural systems, such as aquifers, rivers, long-range species, and viable species populations. However, fragmentation of larger patches may decrease the number of species and provoke their extinction.

With challenges such as fragmentation and biodiversity loss, developed and developing countries are looking for more efficient and effective green space planning approaches to ensure the protection of natural resources (Na Xiu et al., 2016). The relationship between nature and city is perceived as a way to reconcile urban development with the biosphere. (Scott et al., 2016). A case study of Hangzhou, China in response to decline in wetland areas and the degrading of the ecological and cultural functions of the natural landscape has recognised the important links between ecosystems and urban services and the need to seek more sustainable resources. The city established suburban forest parks, water reservation areas and developed green belts along rivers, streams, and roads (Madell, 2012:6).

Another case study presents the Cheonggyecheon river located in the heart of Seoul, South Korea which was once polluted and has experienced frequent floods. Due to rapid urbanisation, an elevated highway was built to cover the river. The urban renewal project resulted in cooler temperatures and clean water in Seoul. It has also helped to reduce the air pollution caused by the sewage that was once in the area and improved economic development because it has become a tourist attraction. Today, it is considered as a flood relief channel (UN-Habitat, 2012). This project shows how urbanism and the natural environment interact and has the advantage of maintaining ecological and social sustainability.

From another view, Aldo Leopold in “The Land Ethics” (1949) highlighted the need for human beings to relate to nature. In the literature, he gave the first reference to ecological integrity: “A thing is right when it tends to preserve the integrity, stability, and beauty of the biotic community. It is wrong when it tends otherwise.”

Leopold encourages people to see water, plants, animals and soil as “biotic communities” worth protection and respect and not resources to be exploited (Leopold, 2014; Shackleford Hayley, no date). Thus, although urban areas will never have the naturalness of immaculate natural spaces (Noss, 2004), by restoring biotic to the urban environment, there are opportunities to maintain biodiversity and ecological integrity that encompass conservation values, including ecological resilience and preservation of vernacular zones. This will require significant changes in city planning and management.

The debate on the ecological, economic, and social dimensions of sustainable development and how they apply to urban contexts is far from being understood and resolved. The literature on sustainable development shows colossal debates on how green systems should be developed and how this can be effective in cities, but to put them into practice remains a challenge. Moreover, sustainable development is difficult to achieve, particularly in developing countries where sustainable land use management is not often considered in decision-making. Ideally, it should be incorporated into the overall decision-making framework to guide the development process.

The following section deals with the various concepts encountered during the literature review to create a framework that captures and incorporates all relevant research, observations and pieces of knowledge directly related to the purpose of this research.

3.7. CONCEPTUAL FRAMEWORK

A conceptual framework is an interconnected set of ideas (theories) developed through a conducted analysis of the study and serves as the basis for understanding the interconnections across ideas, concepts, events and other components of the issue studied (Svinicki, 2010).

The literature review and the conceptual framework were developed in parallel; combining or dividing concepts to create distinct sections that inform this study. The analysis started with a comprehensive review of each theoretical field included in the literature review aimed to provide a sound knowledge base for studying the contribution of green networks in urban areas.

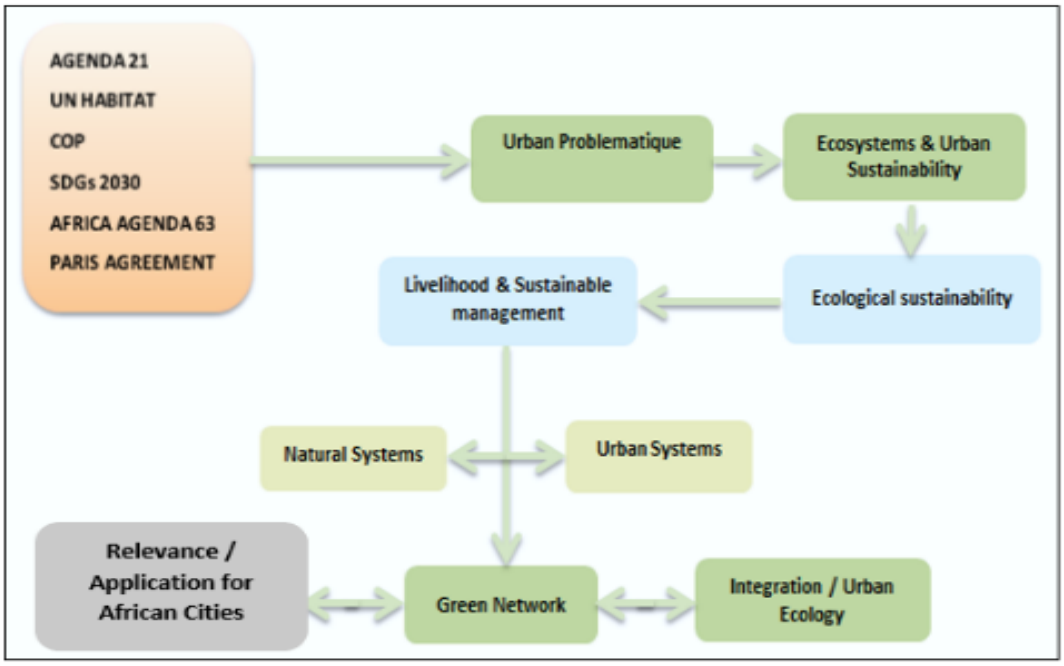

Figure 3.4: Conceptual framework for the research design & development of the study

Source: Author construct, 2018

The conceptual framework presented in Figure 3.4 is a literature review informed by an evaluation of existing scholarly work on sustainability, landscape ecology, natural and urban systems. The framework was developed mainly to conceptualise the problem and to guide the interpretation and understanding of a social phenomenon. The above conceptual framework is further elaborated below:

i. ***Urban problematique –*** this section is linked to urban problems that several global entities and conferences (Agenda 21, UN-Habitat, SDGs 2030, Africa 2063, Paris Agreement etc.) have already pointed out in the past and now. These issues concern rapid urbanisation caused by population growth, climate change, biodiversity loss, water, and waste management…

ii. ***Ecosystems and Urban sustainability –*** introduce the sustainability of ecosystems and urban environment which present two systems (natural and urban) that need to be integrated through urban ecology and green networks to improve the management of ecological sustainability of African cities and ultimately the livelihoods of their citizens.

iii. ***Integration / Urban ecology –*** shows the environmental processes, as well as opportunities to maintain biodiversity and ecological integrity in urban areas. The intersections within the framework demonstrate the relationship that exists between the concepts and ideas.

iv. ***Relevance / Application for African cities –*** represents the need for African cities to act in the management of urban natural spaces to tackle environmental issues due to significant population growth and rapid urbanisation.

The components illustrated in Figure 3.4 do interact with one another and represent the complexity of ecosystems and urban sustainability. This study used this conceptual framework to investigate the coexistence between the city and nature and to contribute to the body of knowledge regarding the contribution of green networks for sustainability in African cities.

3.8. CHAPTER SUMMARY

The chapter introduced the relevant literature and painted a distinct picture of the limited attention given to natural processes that have helped shape the city and, in turn, have been changed by it. The review leads to an understanding of the current challenges faced by cities and help in developing strategies to further integrate nature in the urban environment to sustain cities.

The chapter further highlighted some research regarding the ecology and urban sustainability. It was ascertained that nature in urban areas plays a vital role in supporting conservation values and ecological integrity and protecting the natural environment has become crucial for both human well-being and ecosystem health. It was also mentioned that green networks should be viewed as a reliable approach for nature connectedness and green spaces management in African cities.

Finally, a conceptual framework was developed from the literature and the conceptualisation of the research questions to understand the research domain and how green networks can contribute to sustainable urban development in African cities.
The next chapter introduces the case study and the research methods used in conducting the research findings.

CHAPTER FOUR
CASE STUDY RESEARCH FINDINGS

4.1. INTRODUCTION

Nature and its processes are essential as a basis for human life. This research mediates the balance between city and nature by raising concern for environment and natural resource conservation, so that an alternative conceptual framework and more constructive ways of looking at the physical environment of cities can be found.

Ian McHarg (1969) promoted an ecological view in which landscape planners should work with nature and learn as much as possible about the natural world. Indeed, little connection exists between the aesthetic values that the landscape of urban parks and open spaces rely on and the dynamics of natural process. Another key element of McHarg's theory is to design human environments in accordance with natural features and process relating to climate, the topography, hydrological, biophysical, and other settings.

In a similar vein, Michael Hough's (2004) theory is based on creating a holistic urban landscape form in tune with natural processes. He recognises that the technology that sustains modern cities has altered the wilderness of landscapes and unsustainable pressures are placed on environmentally sensitive ecosystems. The urban system seems to have been established with objectives aimed at economic issues rather than the environment or social.

These theories paint a distinct picture of the limited attention given to natural processes that should helped shape the city and, in turn, have been changed by it. Within the current context, it is essential to understand the current challenges and planning should respond to the need to further integrate nature in urban development on well-located sites such as the Two Rivers Urban Park (TRUP) in Cape Town, South Africa.

To locate the study, this chapter presents the area, as well as approaches of the TRUP site. The chapter provides an overview of the site characteristics and historical background. It then continues with a presentation of the environmental attributes such the fauna, flora, the aquatics, and wetlands systems. This chapter includes with a reflection on the views and perspectives of a wide range of environmental, community based, urban planning and public officials involved with the management and future development of the TRUP.

The data referred to in this chapter was collected through the various methods set out in Chapter 2 and are aimed at answering the following research questions:

RQ1: **How can green networks contribute to sustainable urban development in African cities?**

RSQ 1.1: What are the functional elements of natural ecosystems such as water, plant, wildlife, climate etc. and how relevant are these for green networks in cities?

RSQ 1.2: What are the functional components of urban green networks and how can these be integrated and emulate/mimic natural ecosystems?

The aim of this chapter is to provide a strong contextual understanding of the site and its processes in order to inform future strategies and interventions for the TRUP area.

4.2. THE SELECTION OF THE CASE STUDY

The purpose of this thesis is to create a better understanding of the interplay between the natural and urban systems to determine how urban sustainability can be improved in cities. A range of possibilities exists in the selection of a case study. But for this research, the urban and natural processes must coexist. The main criterion for selecting this case for this study was for it to include the following:

- ✓ components of natural systems (water and biodiversity, etc).
- ✓ components of urban systems (social and cultural features, transport, etc).
- ✓ importance from a biodiversity perspective and a green corridor within the city.
- ✓ accessibility of the site physically and the availability of different information resources.

A case study approach was used to explore the process of emulating natural systems in urban areas. The Two Rivers Urban Park (TRUP), a site located in Cape Town, was selected as a suitable case for this research as it includes both urban and natural components and meets the criteria of selection mentioned above.

4.3. SITE LOCATION, CONTEXT AND HISTORICAL USES

The Two Rivers Urban Park (TRUP) consist of a green belt in the City of Cape Town, South Africa and comprises sensitive ecological systems and habitats; open space areas and cultural landscapes; state owned psychiatric and mental health hospital buildings as well as, retail, recreation and research activities (see Figure 4.1). It is a unique place in Cape Town located near the city centre and surrounded by a wide range of residential

neighbourhoods, including middle income areas as well as large parts of the Cape Flats, home to a significant part of the urban poor area. With sensitive natural systems and habitats, TRUP has a distinctive ecology and, sense of place in the Cape Town and represents the opportunity to meet both the environmental and human settlement needs of the city (WCG, n.d.)

4.3.1. Site Characteristics

The Two Rivers Urban Park (TRUP) is centrally situated around where the Black and Liesbeek rivers meet and the floodplains and adjacent areas form the core of the site.

The site offers the opportunity to continue serve as a major recreational amenity within the city, while also accommodating some of the developments needs of its growing population. One way of bringing about better human-nature relation is by incorporating ecological planning with spatial planning when considering development within special site. Through the influence of the natural environment, the site has the ability to encourage and spur on appropriate mixed-use urban and recreational interventions. This brings to the fore the opportunities available on the site for the advancement of ideas which are novel and potentially replicable in the path to foster a closer relationship between humans and the natural environment. This will be explored, as well as new ways by which humans can coexist peacefully with nature within the context of the study area and broader Cape Town.

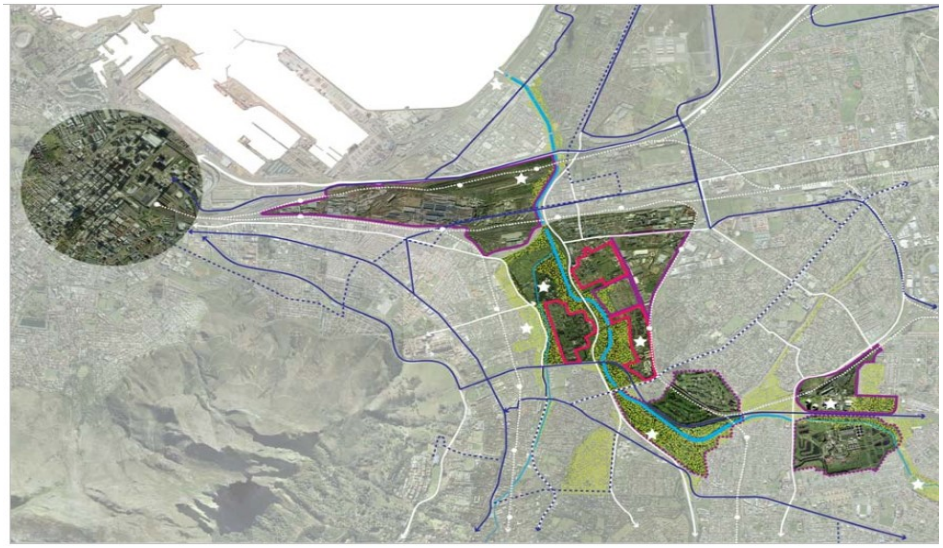

Figure 4.1: **Focus of Study Area.**
Source: City Think Space, 2012

Although TRUP is strategically located, it is not well adapted and integrated with the surrounding predominantly urban areas. Road access is limited, although rail links with

number stations can be found on the perimeters of the site. The M5 freeway dissects the site and significantly impedes pedestrian and vehicular movement between the Liesbeek and the Black River components of TRUP. The principal feature of the site is the convergence of the rivers with the adjacent green corridors and large public and privately-owned land use activities.

4.3.2. Land Use and Ownership

The Western Cape Government has ownership of numerous properties within the 2003 TRUP Contextual Framework boundary, such as the Oude Molen (Valkenberg East); the Alexandra Mental Institute; the Valkenberg Psychiatric Hospital (Valkenberg West) and the Observatory site City Think Space (CTS) (2012). Other notable public landowners within the site include the City of Cape Town, the South African Rail Commuter Corporation (SARCC), and Transnet. The current land uses and ownerships, identified by CTS in 2012, are shown in figure 4.2.

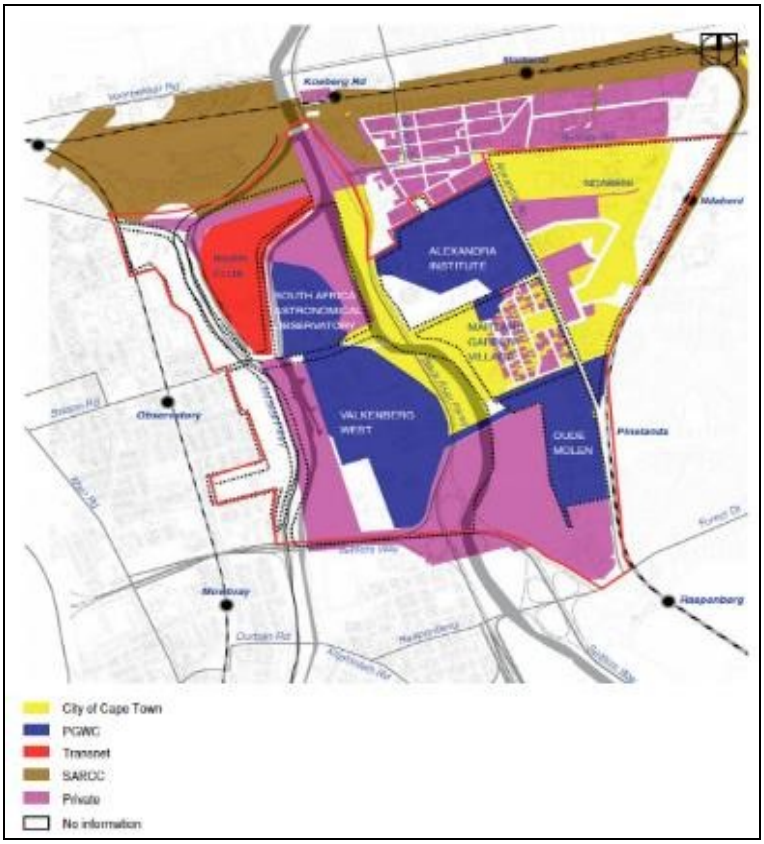

***Figure 4.2*: Land uses and Ownerships**
Source: The Two River's Urban Park Local Area Sustainable Neighbourhood (CTS, 2012)

The City of Cape Town owns some of the land within the floodplain, the Garden Village low costs housing estate as well as a few properties that are located outside the original TRUP Contextual Framework (2003) boundary, but which are a part of the site as of the 2012 policy of CTS. These land parcels include the significant Maitland Abattoir site as well as some surrounding land parcels in the Ndabeni area.

4.3.3. Historical Role of the Site

The Baseline Heritage Study reports that the site was used by the indigenous tribes of Khoi and San hunters and gatherers to collect food and hunt (CFMP, 2003). At around 1657, with the arrival of the Early Dutch settlers, crops were cultivated along the Liesbeek River and farms such as Valkenberg and Bloemendal, were established along the riverbanks. The British colonial period introduced industrialisation and the working-class areas such as Maitland, Observatory, Salt River and Woodstock were established in the area between the Castle and the Liesbeek River, with rapid expansions along Main and Voortrekker roads. The site was largely not affected, with farming gradually been replaced, with the development of public health and research institutional uses.

A Heritage Study was done in 2002 by Aikman Associates and in 2016 by NM & Associates Planners and Designers on behalf of the Western Cape Government, to provide guidance for the future development of TRUP. Five areas of heritage were considered worthy of conservation. These include mostly the colonial period buildings which have historic value as well as their relationships to the host landscape in terms of trees, visual prominence, and topography, which in their totality should be retained and enhanced.

Shown in figure 4.3, the areas of historical value were defined by in the TRUP Contextual Framework and Phase 1 Management Plan as follows (CCT, 2003:12) :

- The Valkenberg Manor House
- The main Valkenberg Hospital building
- The Nieuwe Molen (Alexandra Mill)
- The Observatory and surrounding historical buildings
- The Oude Molen complex and its surrounding landscape
- The main building of the River Club
- Maitland Garden Village

However, these studies did not include consideration of the pre-colonial period and therefore did not identify places and artefacts that are of value for the Khoi and San communities. The site is reported as a place of the first major conflict between the invading colonialist establishing farms and the indigenous tribe that attached significant ceremonial value to this location.

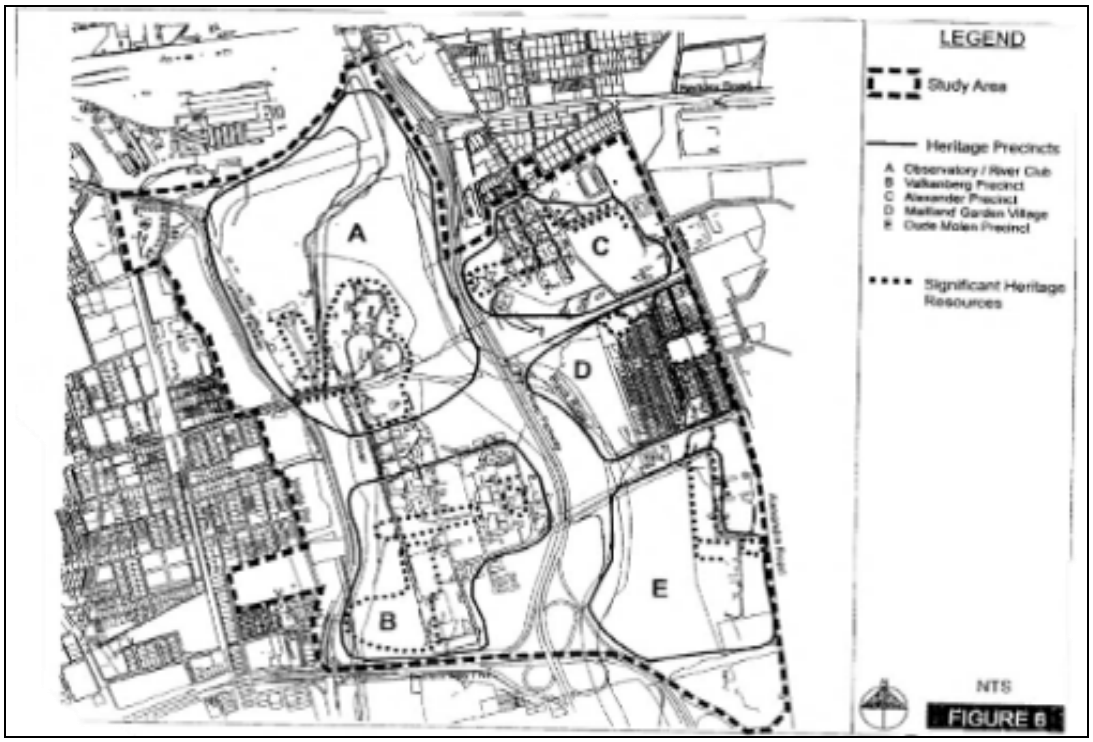

Figure 4.3: **Significant Heritage Resources in the TRUP Contextual Framework.**
Source: TRUP Contextual Framework and Phase 1 Management Plan (CFMP, 2003).

Developed on Ebenezer Howard's planning principles, Maitland Garden Village was constructed during the 1930's and a large wetland area was filled in so that the major freeway developments of the Black River and Liesbeek Parkways during the 1950's may be accommodated. Road construction and the canalisation of the two rivers, followed by flooding during 1941 and 1943, have defined the landscape visible today (CFMP, 2003).

4.4. ECOLOGICAL ANALYSIS

The City of Cape Town's considers and regulates proposals for the site in relation to its Environmental Management Framework (EMF). The framework sets the site aside for open space and biodiversity considerations. The framework does not, however, consider the development potential of TRUP, given that most of the site has already a developed state.

Across all the information and data gathered for the site, a common theme emerged, of the need to focus on the ecosystem as a whole, rather than in fragmented parts such as just the wildlife or just the rivers. For example, one respondent expanded on this and said,

> *"Historically, urban and environment were seen as two separate points. But now we're getting to the point where we understand that its one whole, and it's now the ecology. It's one whole system. Ideally, you want to see that all of these new understandings are influencing how we plan our green open space in the urban environment."* (Respondent 2)

Well-functioning natural environments provides several ecological services, such as reduction of heat islands, provision of water, flood attenuation and cleansing of air and water. When these processes are impaired in function, it causes increased social exposure (usually through the loss of natural services) and extended degradation of the environment. Another respondent commented on the ecological systems in the following way:

> *"I think the ecological role is obvious because with climate change and the planting of trees in particular, can help with heat mitigation. The planting of trees helps with temperature control and various other things. It helps when you have flooding. It helps to prevent erosion. It supports habitats, which in turn make more robust ecological systems. But from an urban planning perspective, what planting also does is providing visual relief, so when we live in very dense cities, especially in Africa, we lose our connection with nature and that nature can provide, what we call visual relief" and well-being"* (Respondent 6)

4.4.1. Water Systems

The Raapenberg and Pallotti wetlands are remainders of the formerly extensive wetland system that occurred originally along the Black River. They are important for the health of the river and should be well managed and maintained. In addition, the site plays an important role in the reduction of flooding. Unfortunately, both the Liesbeek and Black Rivers are not in good states. The Black River has been polluted so much that it is unsuitable for contact with neither human nor wildlife.

Figure 4.4 shows the TRUP hydrological systems on a site scale. The two rivers on the site confluence towards the north and form part of the Salt River Catchment Area.

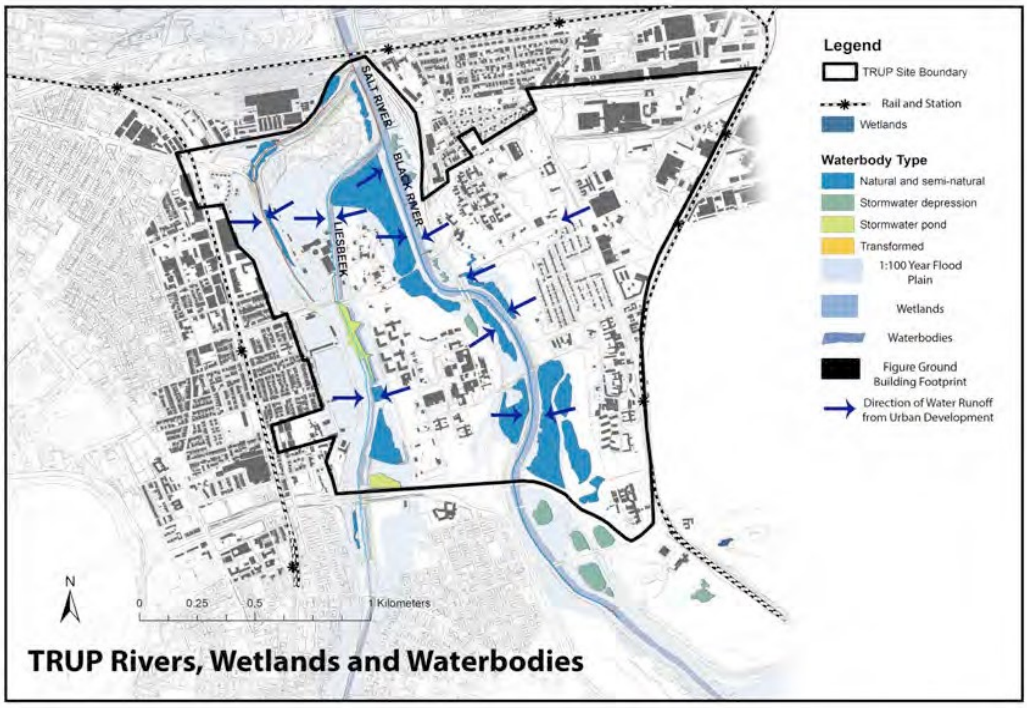

Figure 4.4: **TRUP Hydrological Systems.**

Source : Towards More Integrated Human- Nature Relationships (Blatch, 2016)

Respondents agreed with the idea that water plays a crucial role for natural ecosystems, and that water is absolutely essential for TRUP. However, many respondents spoke about the high degree of pollution in the water as a challenge and liability for an ecology. The need for restoration was expressed throughout all the interview transcripts. For example, respondent 1 explained, "*The rivers need to be rehabilitated and restored to its best state to achieve its full potential as a natural system. Much work needs to be done to catch pollution before it enters the rivers*."

Most of the time, the rivers are contaminated along their courses; the Black River pollution is caused by urban development and industrial waste disposal. The drainage also runs through informal settlements, which lacks infrastructure to dispose of wastewater and therefore negatively impacts on water quality of the river. The river also passes through the Cape Town industrial areas and is thus made liable to waste disposal, negatively affecting the flora and fauna. The wetlands along the rivers are therefore poor in quality and in need of rehabilitation and better management.

❖ Liesbeek River

The Liesbeek River originates from the top of Table Mountain and flows through Kirstenbosch Botanical Gardens. Below the gardens, the river flows through the predominantly wealthy residential areas of Newlands, Rondebosch, Mowbray, and Observatory. Main sections of the lower parts of the river have been made into canals and riverbeds made to stand with gabion structures. Some sewage pump stations are located along the Liesbeek River (Faragher, 2014; MAA & ARCON, 2016)

The Liesbeek River experienced problems relating to pollution, with dog faeces and fertilizer runoff being key reasons for the low quality of water, in particular towards the more slower flowing floodplain of the Observatory area. There have been efforts towards curbing this problem, through community-based organisations such as the “Friends of the Liesbeek River”. This organisation aims to create an awareness of the importance of the Liesbeek as a green corridor in an urban setting and their work includes the rehabilitation, enhancement, and conservation of the river and its environs. Other challenges include the poor coordination, which has been said to cause the inadequate use of resources as well as the annual flooding of the River Club area due to inappropriate developments (WCG, n.d.)

***Figure 4.5*: Photo of Canalised Liesbeek River.**
Source: Author, 2019

❖ Black river

The Black River is an artificial river which was created for draining of the Cape Flats wetlands and the management of stormwater flowing from predominantly low-income residential township developments for non-white residents during the apartheid era. The Vyge and Elsieskraal rivers joined to the Black River in the Athlone and Pinelands areas and all three rivers are part of the Salt River catchment area.

These river functions also as disposal canals for treated sewerage originating from works at the Borcherts Quarry (at the Airport) and the Athlone Quarry. The watershed releases its waters into Table Bay through the Salt River channel and is responsible for the pollution of the system because of various settlements in the watershed, waste, overflow of sewage and illegal discharges (WPI, 2011)

Furthermore, there are plugs and malfunctions in sewage systems and nutrients from the wastewater treatment facilities of Athlone Quarry and Borcherts. Farming in the upper Elsieskraal River increases nutrient levels and spurs weed growth, while topsoil fertilizes riverbeds, further obstructing flow. The rise of sea level is a constant problem in the lower watershed, leading to an increase in the likelihood of winter flooding. Without a doubt, the poor coordination and management of the river is a barrier to the proper maintenance of the river (Blue Science, 2016).

Figure 4.6: Black River
Source: (Worcester Polytechnic Institute, 2011)

For development to interact positively on TRUP site, the rivers will need to be rehabilitated. Especially the Black River, which is unusable by the communities as human contact with

the river can cause serious health problems. By the de-canalisation, elimination of pollutants and alien plant species from the rivers, the biodiversity, wetlands, and natural resources of the two rivers should be restored to a natural and healthier state.

The rivers hold great potential and opportunities to rethink the relationships between human and nature in terms of protecting and enhancing natural and human systems. It is important to restore the natural assets, balance development needs and ecological sensitivity in order to ensure that development is not at the expense of the natural environment.

The Liesbeek and Black rivers are two interconnected, but different watercourse, in that the first is a natural stream, while the later functions predominantly as a stormwater channel, the site's topography and nearness to a densely populated urban areas make the site valuable and one of significant interest. Unfortunately, the water quality and amenity value of the Black river in particular is compromised by pollution through sewage and street refuse (MAA & ARCON, 2016).

Figure 4.7 illustrates the decline in biodiversity and natural resources in the city of Cape Town since its development.

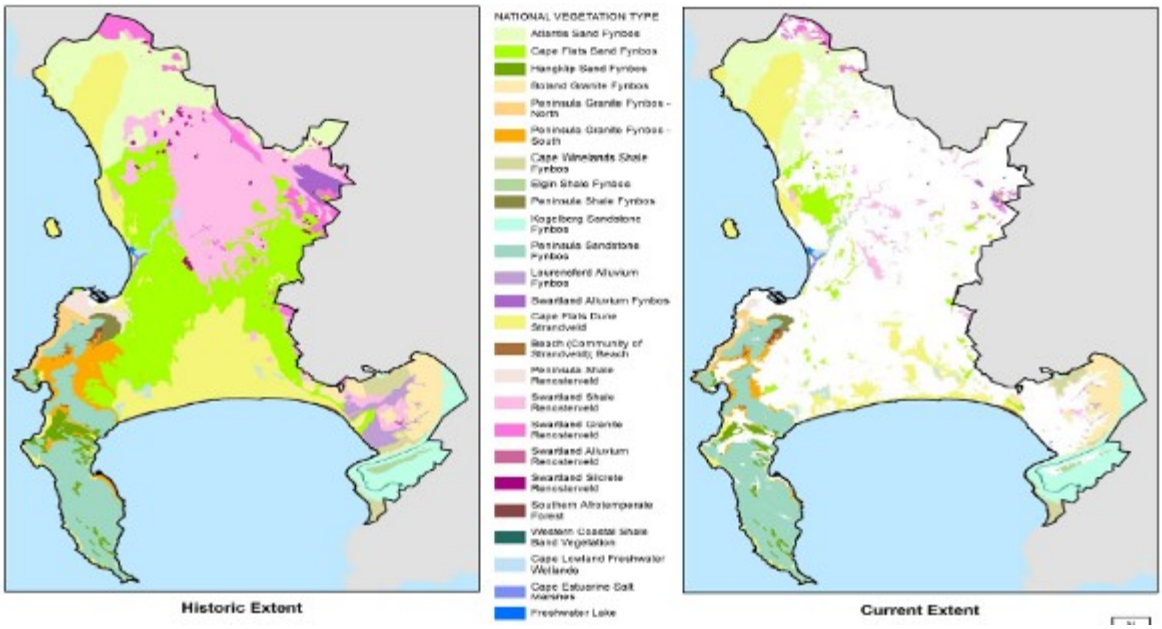

Figure 4.7: **Decreasing of biodiversity in the city of Cape Town.**
Source: City of Cape Town, 2018

The loss of biodiversity, due to urban development, is rampant in Cape Town. The TRUP site has a crucial role in the development of natural resources and the protection of biodiversity as it forms part of a green open space corridor network, connected by the city's river systems, which cross the metropolitan area.

4.4.2. Plant Systems

The biodiversity network in the TRUP study area includes protected areas and the presence of other natural vegetation (See Figure 4.8). The figure indicates the transformed sites of conservation significance in the southern portion of the TRUP study area. It also shows the fragmented nature of habitats found in and around the TRUP area. However, there are pockets of valuable biodiversity despite the fragmentation, level of transformation and polluted water flowing through the site.

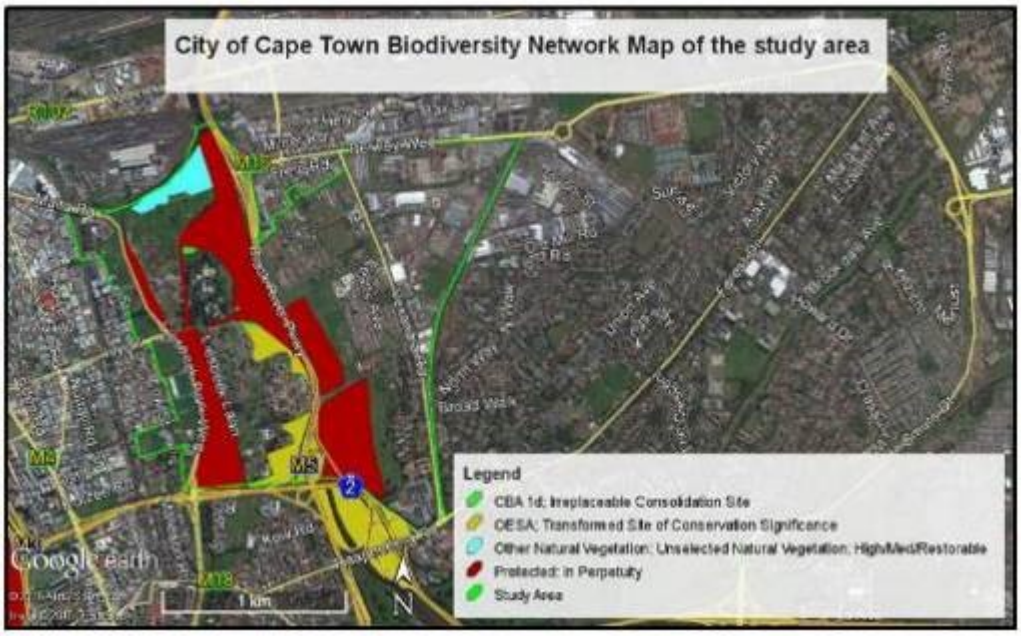

Figure 4.8: **Extract of the City of Cape Town's Biodiversity Network Map (2016) for the study area. The northernmost Protected Area west of the Black River includes the Raapenburg Bird Sanctuary.**
Source: Biodiversity Baseline - Two Rivers Urban Park (Helme, 2016)

In 2003, there was a plant species assessment of the TRUP area where it was recorded that there are only 38 local species present on the site, and roughly 51 alien plant species. The high number of alien plant species is worthy of attention, and it can be mostly

explained by the changing nature of most of the site, including the polluted river which breeds the growth of alien water plant species.

The conservation concern found in the study area is likely to be *Moraea aristate*. This Iris-like species of flora is endemic to clay slopes in the north-eastern part of the Cape Peninsula. The habitat of *Moraea* is classified as Peninsula Shale Renosterveld vegetation and this protected species is “Critically Endangered” as a result of urbanisation (SANBI, 2013).

Worthy to mention that its presence on the site is the last trace of this flower species in the world. *Moraea Aristata* location on the site is shown in figure 4.9. The species is currently restricted to a single population near the Liesbeek River, in the suburb of the Observatory, despite its location in a protected area.

Figure 4.9: **Moraea Aristata**

Source: South African National Biodiversity Institute

Respondents spoke about the importance of plants and natural green space for the overall functioning of natural ecosystems. There is concern of the alien species and threats of invasion expressed throughout the data, some with suggesting the solution to plant more indigenous species of plants. For example, to, “…*plant suitable locally indigenous species along banks*.” (Respondent 4)

It is clear from the data that there is an emphasis on treating the ecosystem as a whole, with planting helping the wildlife etc *: “Roosting, nesting and feeding space for birds and*

aerial insects; feeding resources and breeding habitat for many taxa; wetlands can filter water and improve quality and provide valuable flood attenuation" (Respondent 4)

A supporting quote reads, *"Without the appropriate plants, we are losing whole sub species"* (Respondent 8). Indeed, a comment by one respondent illustrates some of these complex issues: "a *lot of pockets of natural vegetation, very isolated in the urban environment and they lack connectivity between them. So, by creating, even if it's not an accorder per se, but even if it's just allowing natural vegetation, the indigenous species, to take root and be promoted in these spaces, you soften the urban edge"* (Respondent 5).

Trees planting and green natural space have valuable function for ecosystem. A subsidy for carbon credits using trees is proposed because, "the only way you get to get people councils and local municipalities interested in planting is if there's an economic benefit. It seems as if carbon credits for trees, didn't get much attraction in South Africa and in fact, is very few places in the world… the City of Cape Town on average has about 55,000 trees that are council owned" (Respondent 8).

4.4.3. Wildlife Systems

In terms of the flora and fauna on the site, the TRUP local area supplies different habitats for a wide range of plant species and avifauna as well as playing a crucial role in the wider biological corridor system, which extends across the city. According to the City of Cape Town's Biodiversity Network, a large portion of the wetlands found within the TRUP are grouped as 'critical biodiversity areas' (CBAs). Despite the utter transformation nature of the TRUP study area, there are valuable reserves of terrestrial and aquatic biodiversity contained in the site. Particularly, the Raapenberg Bird Sanctuary and Pallotti Wetlands are said to be an important open space cluster in Cape Town.

The Fauna and Plant Species Report (Annexure 3 of the CFMP 2003) made a list of several birds which make their homes along the Black River and the river's associated wetlands. An example is the Raapenberg Bird Sanctuary, a ten-hectare protected area between the Liesbeek and Black Rivers, towards the right of the Observatory. It also serves as a home and nesting ground to several birds which are as well listed in the report. According to respondent 5 *"bird life seems to be the greatest, greatly effective pollinators as well".*

When asked how critical the role of Wildlife in the development of urban green networks is and why, the responses from the interviews were mixed. One respondent explained how the focus should be on the natural vegetation rather than on wildlife in order to sustain an ecosystem, stating, "*Without the appropriate plants, we are losing whole sub species."* (Respondent 8). Some respondents spoke about how alien species threaten the ecosystems as these are not endemic to this environment.

Furthermore, there are many endangered Western Cape leopard, toad, and several other species of frogs along the Liesbeek River, especially around the Observatory, shown in figure 4.10. Thus, it requires preservation.

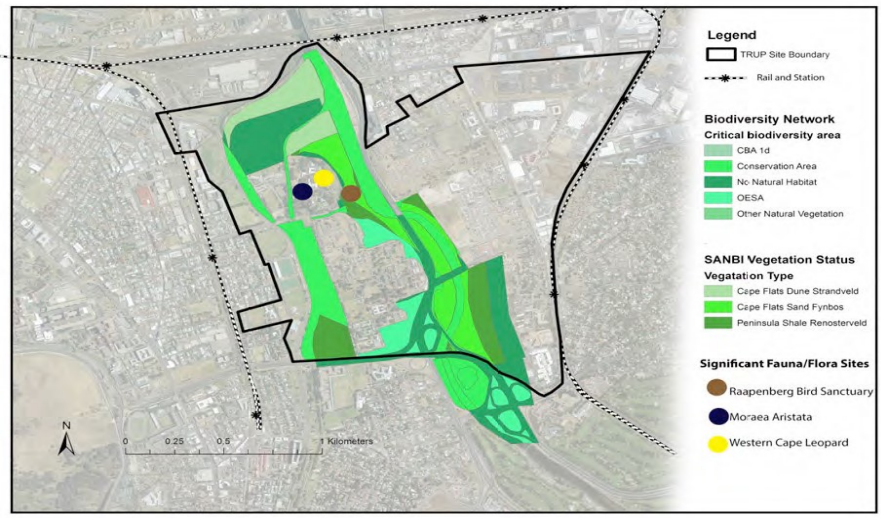

Figure 4.10: **TRUP Biodiversity, Vegetation, and Significant Fauna and Flora Sites.**
Source : Towards More Integrated Human- Nature Relationships (Blatch, 2016)

The importance of wildlife for functional biodiversity was recognised by participants during the interviews. For example, one respondent stated, *"Rebuilding habitat that has a balanced functional diversity of species is essential"* and that *"the wildlife is also a pollinator and you're not going to get certain trees pollinated at all unless you have the wildlife"* (Respondent 1 & 8) .

Some more positive views are identified in the data about how wildlife is important for the green space and for reconnecting citizens with nature. For example, one respondent said:

> *"I think there's a deeper importance rather than just the ecological functioning or ecological services that they provide. You know, especially in an urban area, so many people and especially children are cut off from the natural environment. And so to be able to see wildlife on your doorstep effectively and you take your dog for*

a walk around the neighbourhood, you will see something really nice and that's what engages people with environmentalism and creates that effect, especially in children who share and multiply their experiences." (Respondent 5)

4.5. URBAN GREEN SYSTEMS

The Contextual Framework and Phase 1 Management Plan (2003) argues that TRUP is one of a few parks planned for the City of Cape town. It aims to provide a framework for:

- the rehabilitation, protection, and management of the intrinsic ecological qualities of the area,
- conserving the uniqueness of the cultural landscape and encourage environmental education,
- maximising opportunities for all people, and to promote sustainable development,
- guiding authorities, landowners and future developers ensuring appropriate and integrated development (CFMP, 2003:5).

4.5.1. Green Open Space

TRUP forms an integral part of the broader Cape Town metropolitan wide-open space systems (MOSS), with its location at the confluence of the Liesbeek and Black rivers and the meeting point of three reserves, namely: The Table Mountain, Tygerberg and Rietvlei Nature Reserves.

TRUP has significant recreational and development potential in many ways, but unfortunately the space is underutilised and not accessible for much of the public. As mentioned earlier, a common constraint present in the data was the lack of accessibility of the TRUP and how much of the land is not usable for the public. It is also explained that the land is very undervalued. Other respondents talked about how the land is also unsafe, such as the hazardous freeway cutting through the middle of site with the associated traffic, dirty water, and potential health problems. This quote summarises these themes:

"…*it's a wonderful space. But it's not a space that you can be in safely. So, from a public open space perspective, I think it's enormously underutilized. I think the way that this has become an island means that it's not accessible to the kinds of people that really need it."* (Respondent 3)

For example, one respondent explains, "*It's a huge amount of green open space within the boundaries of what was called the Two Rivers Urban Park (TRUP). And almost none of it*

is usable by the public. And for me that's the biggest problem" (Respondent 6). Some disappointment is expressed about the lack of accessibility of the TRUP and the ownership over the land by the provincial government as these are the least accessible.

4.5.2. Opportunities and Constraints

The sustainable development of the TRUP site presents several opportunities and constraints identified in the Contextual Framework and Phase 1 Management Plan. Some responders expressed how an opportunity for the TRUP is to build a heritage/educational centre. They explained how education can help support the area and spread knowledge about the wetlands and the environment in general. For example, "*So we lack, we lack these…centres. So that could certainly be a good opportunity. I think that on top of that you could also include environmental education, um, the centre of sorts"* (Respondent 5). It is important to note that the opportunities and constraints presented are not necessarily limited to the following:

❖ Opportunities

- There is an opportunity to rethink conservation and better integrate it into human development processes by inviting people in, rather than separate them from nature.
- The site could become a natural resource and asset to the city and its residents.
- Raapenberg Bird Sanctuary and the Pallotti wetlands provide a high diversity and abundance of suitable habitats for water birds and are presently buffered from disturbance.
- The site has important historic and ceremonial value for the indigenous Khoi and San community.
- There are a myriad of Dutch and English colonial era historic buildings and landscapes as well as important vistas, focal points, and archaeological sites, which enhances the character and sense of place of the area
- The old Liesbeek River course could be restored to its natural state and utilised for a variety of recreational activities, such as boating and fishing, as well as serving the ecological functions of a river.
- The Park is highly accessible, and major public transport routes (rail, taxi, and bus) exist adjacent to the site.
- The variety of land uses within the Park would contribute to its envisaged diversity.
- There are panoramic views of Devil's Peak, the rivers, and the wetlands.

- Mature groves of trees exist on the site and contribute to the cultural value of the Park.
- There is a significant amount of underutilised land on the edges of the Park and adjacent to existing buildings within the park which could be utilised for development where appropriate.
- Urban agriculture is currently being practiced within the Park, and the possibility of extending this practice are feasible.

❖ Constraints

- There are limited accessible and safe recreational spaces and facilities.
- Many of the open space areas are underutilised and not well maintained
- The Black River is highly polluted and not suitable for human contact.
- The number of birds is declining as a result of the decrease in bird habitats around Raapenberg Bird Sanctuary and the Pallotti wetlands
- The floral species in the area are largely alien.
- The Liesbeek River has been canalised and cut off from its original course, resulting in the canalised section functioning purely as a conduit for stormwater, while the old water course remains stagnant for several months of the year.
- Widening the Black River to accommodate future runoff from the catchment would negatively impact on the Raapenberg wetlands.
- The wetlands and rivers are presently inaccessible to the general public as a recreational amenity or resource.
- Many of the historical buildings are in poor condition and are separated by visually impermeable walls.
- There is little surveillance on a portion of the site, thus threatening the safety of people in this area.
- The site is separated by the Black River Parkway and is only connected via two bridges in a state of disrepair., one providing limited vehicular and pedestrian access, and the other providing pedestrian access.
- A congestion problem exists at the intersection of Station Road and Liesbeek Parkway.
- Little provision has been made for cyclists and pedestrians along Liesbeek Parkway and for cyclists along Alexandra Road.
- The full potential of the Park as an environmental education and research centre has not yet been realised, due to institutional constraints.

- Existing access into the Park is extremely limited, compromising permeability and integration.
- Competing interests and private developer interests are a constraint to sustainable development, protection, and enhancement of the natural resources on the site.

In addition to the above constraints and challenges, the poor planning co-ordination and lack of agreed vision between the public institutions, the main landowners for the site. It appears there is a lack of political buy in for a shared vision for the site, lack of budgeting, funding, and poor management of the site. Many responses expressed their frustration with the government and lack of support for a clear vision informed by sustainable development principles.

A respondent stated in exasperation: "*One of the biggest challenges is that, most of the land is owned by the provincial government and is used for institutional purposes*" (Respondent 6). Another interviewee expressed their thoughts on why sustainable development has not been pursued for TRUP, "*So, the reason it hasn't been developed is because of institutional infrastructure constraints because of the government*" (Respondent 3).

4.5.3. Waste and Flow Management

The ecological flows and changes in urban areas accentuate the link between human and nature. One respondent believes that:

> *"A lot of thinking that has to happen before we start to implement the real changes that will prevent the separation of human activity from the environment. It's getting to the point where only one space that activities should work very well together. There's a term for that, namely metabolic cyborg. So, the whole idea is that it's no longer environment vs human, but rather that it's one energy space"* (Respondent 2).

The need for water management was also expressed throughout the data, along with the issue of flooding. This was a main theme across the data as a challenge. For example, "…*human-beings need water to survive. So, our cities need huge amounts of water. However, the irony is that we also need to get rid of all excess water in our city in a way that we can live free of hazards and dangers like flooding*" (Respondent 6).

One interviewee described how important the rivers are in terms of community and growing up in this environment, and how there is a shifting role of rivers in green spaces. The response states:

> "*Everybody is in contact with that river. We view rivers solely as the way for the rains and storm water to be send it out to sea. I think there's been a shift to this, of recognising the role that that rivers play and in green resilience and creating these blue green card holders that, connect cities*" (Respondent 5).

When asked if the river is an asset to this site and how water can help to enhance the green networks, most responses were supportive of not only using rivers a stormwater disposal infrastructure. Across the data, the pollution of the rivers is a common theme. Many respondents expressed that if the rivers were cleaned, they would provide much more value to the ecosystem and for humans.

Many responses across the data speak about the need for cleaning up of the area and eliminate pollution of the natural resources. Respondent 2 offered several suggestions for rehabilitation of the area:

> "…*the way I see it would involve your clearing out alien invasive species, improving the buffer zones, improving the wetland functionality. All of this comes with cleaning up, giving breathing space, just pulling development back. So, for me, these are rehabilitation measures you can* introduce"

The theme of wetlands and storm water is also expressed throughout the data. Regarding rehabilitation and wetlands, respondent 6 said, "…*the rehabilitation of the wetlands I think is easy in a sense. What we just going to do is stop is allowing polluted storm water going into the rivers. Manage them by ensuring that this doesn't get out of control and so forth*."

In addition, buffer zone helps for the sensitivity in the wetland areas. Another viewpoint sates:

> *"You know because it's all complex system. And most definitely they will be invasive alien management. So, that's three key things for me really; its storm water management checking for pollution; it's controlling our spread of invasive species and managing our buffer zones. For me, that's three key things that can improve our natural system"* (Respondent 2).

A constraint was found with the rehabilitation, i.e. canalisation of the rivers. Responses expressed how canals are damaging for rivers, particularly the Liesbeek River, and should be removed or replaced by rocks and gabions: "reduce stormwater rubbish inputs; plant

suitable locally indigenous species along banks, remove canalisation and widen where possible" (Respondent 4).

Respondent 6 explains a possible solution for this:

> "…*if you want to rehabilitate the current river into a more natural state, you're going to have to deal with edges. Because as I've said, it was carved out as a canal and the ages need to be softened. And with doing that to you allow more natural habitats to grow along its length. That would definitely help*."

Another possible solution was suggested:

> *"The Liesbeek can be improved by stopping littering and by having storm water catchments that can be tested to track sources of pollution. The Black River and its various tributaries have added pollution from untreated sewerage, farmlands, industries litter and storm water and these can also be dealt with, by tracking the origins to sort out that at source, having detention ponds that filter pollution and have opportunities to collect litter"* (Respondent 1).

Other opportunities are found within the space of the TRUP. For example, opportunities include that the Liesbeek river is still relatively clean, therefore there is "*lots of rehabilitation potential which would result in much higher plant and animal diversity, cleaner water and higher crop yields*" (Respondent 4)

4.6. INTEGRATING URBAN AND NATURAL SYSTEMS

The need to protect and rehabilitate the natural environment has drawn the city's attention to Two Rivers Urban Park. As stated in the Contextual Framework and Phase 1 Management Plan (2003:1), there is "an urgent need to protect and rehabilitate ecological systems and to encourage mutually beneficial relationships between people and the natural environment".

When respondents were asked about their views on the different development proposals for TRUP, many answers were mixed. In fact, several respondents stated that they could not answer entirely because they were not familiar with the details of the developmental proposals. One respondent mentioned how there are no-development lobby groups who, "…*have a lot of support from environmental legislation*" (Respondent 6). It is clear there is some doubt to the proposed plans.

On the other hand, one participant expressed hope for the existence of developmental plans, sharing how proposals that include green space is a positive step in the right

direction for healthy ecosystems and sustainable development. Additionally, interviewee 6 liked how the proposals are consistent, and how, "*They've all talked about the densification of the edges and I think that really needs to happen still*." There are positive views on the proposals such as these.

One participant expressed their frustration with the recently approved SAEON Environmental Offices proposed for a site on SAAO, stating, *It is destructive to the sensitive natural environment that needs to be conserved restored and preserved but also destructive to its status as a park that has highly significant and unique heritage*!" (Respondent 1). It is clear there are mixed thoughts and feelings about developmental plans for TRUP.

When asked about the proposed spatial development proposals for TRUP and if it would enhance or curtail the function of natural systems, most responses positively indicated there is potential to enhance the function of natural systems. It is seen as having the potential to open many opportunities for improving the natural ecosystems. Respondent 5 shared how it could improve the functionality of the system, "*I think that could have a big, a big difference in the way the system function*."

The ecological role of natural vegetation is still undervalued. One explains that:

> *"the ecological role is complex in all aspects of regenerating full habitat biodiversity and environmental completeness… greenery is needing to be more than paint! It needs to be regenerated well adapted indigenous appropriate landscaping. We are talking about well-integrated balanced environment rather than green astro-turf"* (Respondent 1).

However, even if the natural features of TRUP area have been seriously degraded, it retains its potential ecological and urban functional role that can support the United Nations Sustainable Development Goals, South Africa Sustainable Development Agendas, and make the city more climate resilient.

The need for proper developmental planning and more research was expressed throughout the data. For example, respondent 2 states, "*And it's my understanding also from existing literature and research is that we do not yet fully understand the importance of our green open space in the urban environment*."

Planning for flooding, development, infrastructure, agriculture, etc. are needed. One example explains, "*If you don't properly plan the area, you could end up with, huge flood*

that could take out half the houses along the riverbanks or make the place unliveable and that's not sustainable" (Respondent 5). Further research can help inform the developmental plans.

4.6.1. Rehabilitation and Management of the Natural Ecosystems

The Contextual Framework and Phase 1 Management Plan 2003 aimed at conserving and enhancing the natural areas and its plant and animal habitats. The Management Plan has been prepared to ensure that future development contributes positively rather than impacting negatively on the environment (CFMP, 2003). Projects should therefore be undertaken to improve and protect the TRUP natural systems.

The CFMP (2003) provides the following recommendations for improving water quality, avifauna diversity and biodiversity. It represents a good starting point for the environmental management of the park space but is out of date and does not include more recent plans and information.

❖ Water

- Water hyacinth should be removed from rivers.
- Dredged material should be removed from site and dumped at a legal waste disposal site. Where appropriate, alternative uses of dredged material should be explored
- Exploration of alternatives methods of dredging and cleaning that have less impact on the environment should be explored, for example harvesting.
- Green areas should be planted with appropriate indigenous trees, shrubs, and grasses to increase the capacity of the area to filter out pollutants from stormwater that flows over the buffer areas.
- Re-establish appropriate riverine vegetation along the banks of the Black and Liesbeek Rivers.
- Monitored whether the breeched berms in Raapenberg North are at an appropriate level to permit floodwaters to flow into Black River if not, increase or decrease levels as appropriate.
- Investigate the possibility of reducing the height along the entire length of the berm.
- In the mown area west of Palloti wetlands, introduce a seasonal flow of water from the Black River by way of a pipe or partial lowering of the berm, thereby creating a reed marsh.

- In the old course of the Liesbeek River, clean the River, plant indigenous trees and shrubs along its western and northern banks, and increase flows by diverting more flow through this course rather than the canal in order to provide a natural control against waterweed infestation.
- Create a wetland by regulating existing drainage from the Valkenberg picnic site adjacent to the Valkenberg wetlands. This would also assist in removing excessive nutrients from the stormwater, which drains via this area into Liesbeek.

❖ Avifauna

Diversity of waterbed species should be maximised by maintaining and enhancing habitats:

- Establishing permanent open water bodies, including ponds surrounded by reedbeds.
- Enabling islands and perches, in particular for birds as they prefer islands with sloped shores as access from the water is easier.
- The planting of more reedbeds
- The introduction of temporary pans and more low marsh areas.
- The planting of terrestrial vegetation of medium height and trees adjacent to the wetlands.

❖ Fauna

A programme to reintroduce indigenous plant species to appropriate niches should be established:

- Species to be selected from previous botanical records of the area.
- Species to be introduced at the appropriate locations, considering their ecological requirements and methods of revegetation.

In the data it was expressed that a change of attitude will be helpful for urban inhabitants. In particular, the need for education and a shift in attitude so that citizens will refrain from polluting and littering in the rivers:

> "*To rehabilitate the Black River, the Black River runs miles and miles into the Cape flats. That rehabilitation process will take years of education, years of telling people please not to dump stuff in the river*" (Respondent 8).

4.6.2. Ensuring Sustainable Urban-Ecological Development

The above contextual and site analysis was used to engage with a wide range of environmental and urban specialists, officials, and community-based organisations interest's groups for the TRUP area. For assessing the transferability of the information and substantiate views of respondents, the main components are discussed next.:

❖ Role of the site, Value, Purpose and Potential

Across all the responses, views on the existing and future role of the TRUP was mixed. Some respondents focussed on the role of TRUP in terms of its importance for urban development environment, while others emphasised its conservation, wildlife, green open space and amenity and cultural value for attracting visitors; its productive potential for agriculture and fishing and its value as a hydrological for water management. Respondent 8 explained how the TRUP is important for green space, stating: "*Two Rivers Urban Park (TRUP) is absolutely crucial to that original idea of the green corridor."*

Some responses spoke about the existing potential of the TRUP. For example, interviewee 1 said, "[It] *Needs co-design and participation of all interested and affected parties to lift the quality of the green open space to its full potential*." One respondent explained how the TRUP could improve the status and function of both the Liesbeek and Black River, "…*highly polluted water, such as the Black River can be more of a liability for the ecology than a benefit. The Liesbeek on the other hand is much cleaner, but the canalisation of it is ecologically problematic. TRUP could help improve the status and function of both*" (Respondent 4). It is clear there is much potential for this park.

Some respondents noted that confusion exists about the future role of the TRUP. For example, one interviewee said,

> "*It's an important* [the green space]*, but we also need to have a clear vision, where are we heading with our green open space? It's often not very successful just to have a green open space in your development but there's no real understanding, no real foundation as to what the purpose is. What are our plans? Where's our funding for the long term? How will we utilise this green open space*?" (Respondent 2).

While another respondent stated, "*So in TRUP we've got all this water. This is kind of in a sense, in inverted commas, excess water, the storm water that we have to deal with. But it*

doesn't serve any purpose in its current form and location" (Respondent 6). Overall clarity and vision regarding the purpose of the TRUP was needed as expressed in the data.

❖ Blue-Green Urban Network

Most respondents agree water is a fundamental aspect of a green environment and is an asset for the TRUP. Many explained how rivers have significant potential to connect green networks. This is explained with this quote, "*Green networks are interconnected green open spaces and the rivers are interconnecting green corridors that link them. The interconnected environments make an interconnected habitat for biodiversity and for linked recreation"* (Respondent 1).

Regarding the function of the two rivers, Black River and the Liesbeek River, respondents pointed out many differences between these ecosystems. Namely that the Black River is much more polluted than the Liesbeek River, and it has a larger catchment and thus danger potential for floods. Respondent 6 explained, "*Apart from just the scale of the Liesbeek River handles huge volumes of water. It has a much bigger catchment. And as a result, as I've said, it's much more polluted. There's hardly any natural life in it. Whereas the Liesbeek River has a small catchment*."

The Liesbeek River appeared to be favoured for its higher quality and habitat integrity, as expressed by interviewee 2, "*I think Liesbeek is slightly more ecologically functional because of its lower level of pollution. And I think it has a slightly higher level of water quality which then equates to a higher level of habitat integrity*." As it has been said: "*human beings need water to survive. So, our cities need huge amounts of water. But the irony is that we also need to get rid of all excess water in our city in a way that we can live free of hazards and dangers like flooding*" (Respondent 6).

In the cities, rivers are privileged supports for ensuring the continuity of ecosystems:

> *"You know because it's all complex system. And most definitely they will be invasive alien management. So, that's three key things for me really; it's stormwater that's greatly managed and checked for pollution, it's controlling our spread of invasive species and it is our buffer zones. For me, that's three key things already that can improve our natural system"* (Respondent 2).

❖Potential for Urban Farming

When asked what the required level of agriculture for the development of urban systems and what potential exists for the TRUP, various responses and ideas were offered. Examples included ensuring appropriate methods, understanding the needs of the community, collaboration, panning, food security, green gardens and space and geographical awareness.

Two respondents explained how assumptions should not be made about the needs and wants of the community regarding agriculture. Proper research, planning and collaboration are needed for the appropriate methods of developing urban agriculture. For example, one respondent said, "*There are opportunities for certain types of agriculture in appropriate forms, but care needs to be taken not to lose topsoil or use inappropriate methods and not in ways that totally undermines natural habitat or recreation space"* (Respondent 1).

The need for collaboration was also expressed by several interviewees. It is important that many people and disciplines are working together to develop agriculture, so the work is efficient and effective. For example, one response states:

> *"…now we are realising that we need a lot more nuanced communication with the different role players. And the different role players are from top-level government organisations to the actual people in the community. So, we need to involve them all. To help understand what the problem is. So, when we talk about agriculture in the urban system, I'm always a bit concerned because I need to know what the plan with this procedure is. Is this what the community wants?"* (Respondent 2).

Some respondents described how there is great potential for TRUP to be used as a green garden. The interviewees responded more favourably to the potential of small-scale urban agriculture rather than large scale. For example, *"I certainly believe that small scale urban agriculture is important, but large, extensive areas of agriculture I don't believe has a place in the inner city"* (Respondent 6).

One respondent spoke about climate change, rising sea levels and dangers of flooding. Respondent 8 expressed how,

> *"If it's high tide and with global warming and increased sea, you can have saltwater along here which is going to affect this sponge because they going to need fresh water for the produce, not saltwater… The urban agriculture can only exist if the water is not salty. You cannot spray saltwater onto agriculture produce. De-salinizing the water in other to grow crops is going to be a major costly challenge."*

❖ Climate Change Mitigation

When asked about the impact of climate change on large urban areas such as TRUP and how adaptation to climate change be enabled and the impact mitigated, several responses and suggestions were offered. Examples of suggestions include the use of detention ponds, plant mitigation, planting trees and green space, developing improved infrastructure, solutions for waste management, sustainable development and renewable energy and introducing saltwater.

One example of how renewable energy can help climate change is, "*It's resource efficiency, so that's water, electricity, looking at renewable energy, and the technologies around that, and waste management. Renewable energy goes together with low carbon. Which then would contribute to solving the biggest issue of climate change*" (Respondent 2). Other respondents described the significance of green habitat and plant mitigation, how this is one way to restore the environment and combat climate change. For example, "*We should keep as much as green land to help cool the temperature, provide oxygen and mitigate the urban heat island*" (Respondent 9). The extent to which the green habitat is important in urban areas can be seen in the following excerpt:

> *"The role then and the opportunities of green infrastructure are multiple and it's not only green, it's also social. So, we have green infrastructure, and we can get that from our rivers and our buffers, our wetland buffers area from the rivers, which then become vegetation buffer areas. So, it serves a conservation role supporting your bird communities, your aquatic life. It supports your species and then it supports your waters, so you can become a more water resilient hub as well. And then it protects society. So, let's move away from thinking about a luxury effect to seeing how it actually supports us. Because when we are strong in our green terms, then we are more resilient, we are ready for climate change, we're ready for the shocks so we can bounce back. Because that's the whole understanding behind resilience, we will bounce back, so we don't suffer as many losses"* (Respondent 2).

Plants and natural green spaces participate, among other things, in the supply of ecosystem goods and services that in turn enable the functioning of a natural ecosystem. In this regard, interviewee 6 gave the following account:

> *"With climate change planting and trees in particular can help with heat mitigation. Yes, planting of trees helps with temperature control and various other things. It helps when you have flooding. It helps to prevent erosion. It supports habitats, which in turn make more robust ecological systems. But from an urban planning perspective, what planting also does is providing visual relief, so when we live in*

> *very dense cities, especially in Africa, we lose our connection with nature and that nature can provide what we call visual relief and well-being"*

Comment on restoration and how this can mitigate climate change explains, *"Rainwater should not be wasted to simply run into the sea. Detention ponds should collect run off and slow the release. Water should soak into the ground rather than permitting more hard surfaces. Water needs to be pumped back up to storage dams in catchments. Green habitat restoration would heal the environment. Trees and plants are essential"* (Respondent 1).

Many respondents spoke about the importance of preventing droughts and floods as related to climate change. Interviewee 1 explained how new filters are needed:

> "*Sea level rise could seriously impact TRUP as new filters are already needed to prevent high tide sea water flowing up into freshwater areas of TRUP. Droughts and floods tend to fluctuate more greatly so this needs to be noted and remedial options implemented to balance that impact*."

It was mentioned that "*roosting, nesting and feeding space for birds and aerial insects; feeding resources and breeding habitat for many taxa; wetlands can filter water and improve quality and provide valuable flood attenuation*". It was also suggested "*to incorporate sustainable urban drainage systems into your developments to make sure that you're not increasing runoff. That you allow water either to be harvested or captured for storage and used elsewhere. Or, if it's not used on site or allowed to infiltrate into the ground…through flood attenuation schemes through measures such as water storage; planting lots of trees to ensure appropriate habitats for species and for carbon capture*" (Respondent 4). These represent a valuable contribution to solve the biggest issue of climate change.

Another respondent spoke about the importance of introducing saltwater in supporting the ecosystem. This is illustrated in this quote, "*The crucial thing is going to be the introduction of saltwater. Saltwater is an entirely new ecosystem*" (Respondent 8). Data also shows, *"renewable energy goes together with low carbon. Which then would contribute to solving the biggest issue of climate change, which is coming from greenhouse gases"* (Respondent 2).

❖ Sustainable Forms of Urban Development

The main themes across the data in this section focussed on sustainability and development and viewing opportunities as constraints. The following extract from the interviews illustrates a view of sustainable development:

> *"That is a constraint but at the same time, it's also an opportunity. So, many of our sustainability angles, will show you that it's a constraint. But if you start looking at a more system level, the bigger picture you will see, there are opportunities around this as well. So, we know we have pressure for land because we need land for so many different uses, of which green is just one. But if we start from the perspective that its opportunity for us to engage in multiple land uses, it doesn't become that constraint versus opportunity but more a holistic view*. This is *essentially the vision for sustainable development; it's resilient, it's responsive to social needs, it's responsive to the environmental needs, and it supports economic development. So, significant opportunities exist and let's work with the constraints, let's turn them into opportunities"* (Respondent 2).

Many respondents explained the importance of sustainable development for Cape Town and natural ecosystems. It is clear that there is much work needed to be done in TRUP and other issues in the area. For example,

> *"Everything needs to be sustainable. Development is defined as the act of growing or improving but it turns out that not all that is put forward as development is actually improvement! Much is devastating! Hard surfaces, extensive roads with intrusive traffic and buildings that intrude into natural environments cannot be seen as development since they cause devastation if not appropriately sited or essential to that place!"* (Respondent 1).

Development tends to simplify ecosystems and reduce their diversity of species. The loss of plant and animal species can significantly limit the options for future generations. As confirmed in the research results, the species, once extinguished, are not renewable:

> *"Development is defined as the act of growing or improving but it turns out that not all that is put forward as development is actually improvement! Much is devastating! Hard surfaces, extensive roads with intrusive traffic and buildings that intrude into natural environments cannot be seen as development since they cause devastation if not appropriately sited or essential to that place!"* (Respondent 1).

Respondent 2 spoke about a vision for sustainable development for Cape Town and its importance for the socio-economic status of the area. The quote reads,

> "*That is firstly readying ourselves for the expectations of climate change and improving our socio-economic standing. For me personally, that is the two key things that I know that we are working towards when we say sustainable development…Essentially, what I've described now is our vision for sustainable development; it's resilient, it's responsive to social needs, it's responsive to the environmental needs, and it supports economic development. So, significant opportunities, and let's work with the constraints, let's turn them into opportunities*."

Another interviewee explained how there is potential for much development, but it is often too expensive. It is suggested that the current system be utilised and optimised if development is too difficult. The real function of nature is not adequately considered when we planned our cities, for example green components are only considered as an add-on. A common theme identified in the data was the opportunity to design and develop green infrastructure.

It is clear that the infrastructure is not optimal. Data found that the retention of nature in cities should not be viewed as a luxury *"... it should be regarded as the foundation, because if we don't have our green foundation in place, eventually our urban environment will suffer. We will not be climate resilient; we will not be water resilient, and we will not be waste resilient"* (Respondent 2). Respondent 2 added: *"urban and environment were seen as two separate points. But now we're getting to the point where we understand that it's one whole, and it's now the ecology. It's one whole system"*. The following extract relates to the new paradigm:

> *"it's a lot of thinking that has to happen before we actually start to implement the real changes that will prevent that separation from human and environment. It's getting to the point where it's really one space that's working very well together. And there's a term being used; the term is Metabolic Cyborg… So, the whole idea. It's no longer environment and human, it's one energy space"* (Respondent 2).

Several responses advocated for green infrastructure development. For example:

> *"And so, for me, one of the key opportunities here that we are looking at is that we have the opportunity to actively design for green infrastructure, which will be would be another key focus. And it is a key focus on what is being done already. So, that's actually how I understand green infrastructure.* (Respondent 2).

"There is no urban system without green system. People need to understand the relationships between those systems" (Respondent 3). The theme of environmental awareness was also present in the positive view of the spatial development proposals, as

much learning and awareness can be raised through this case study. This is described in this quote:

> "*...because once we educate ourselves and as urban planners or scientists, we start to study this, we can help our community become more aware and get them involved and excited about it. We ourselves as urban planners and environmental managers scientists can learn from these case studies*" (Respondent 2).

Other concerns with the development proposals include the management and maintenance of the open land and the funding mechanisms. On this point, respondent 1 commented: *"We do not support the idea of intruding with construction of mega projects inside wetlands, flood plains, on beaches and other inappropriate places reserved for conservation".*

When asked if the TRUP project can respond to the *South African National Development Plan* 2030 and contribute to the United Nations Sustainable development goals, most interviewees expressed positivity with the themes of opportunity and importance to these development goals. For example, one respondent states, "*I do believe it can contribute…we are developing smarter, and more conscious of our environmental aspects, our environmental constraints*" (Respondent 2).

Another respondent explained the importance for other goals such as public transportation and housing, "*The opportunity of having an efficient city with people living close to where they work and working near to where they live is an important goal for existing public transport routes not to intrude into the park and flood plain with new highways and massive fill, destroying habitat and existing sustainable park space and heritage*!" (Respondent 1).

Respondent 1 also shared thought about effective methods for achieving sustainable development goals by focusing on what is good for the people and planet instead of self-interest:

> "*The National Development Plan and Sustainable Development Goals are best achieved by integrating well consulted upgraded District Plans and Local Spatial Development Frameworks that integrate all the values in an efficient affordable well-conceived integrated sustainable plan with incentives to implement them with minimal delay*."

Overall, responses were positive and hopeful for the potential of the site to contribute towards achieving the aims of the National Development Plan as well to the United Nations' Sustainable Development Goals.

4.7. PLANNING FOR INITIATIVES IN TRUP

Despite its huge metropolitan potential, currently, the TRUP site is poorly integrated into the urban area in Cape Town. A few development plans have been proposed for several years, but nothing has materialised in terms of development within this area. Natural and urban systems occur within the TRUP area, albeit in conflicting and sometimes undermining ways.

There are other initiatives which have been undertaken by the government, business, and civil society which in relation to the rivers:

- Portions of the two rivers have been included in the Two Rivers Urban Park (TRUP); introduction of the 2002 Contextual Framework which was a City policy document; and
- The Greater Two Rivers Urban Park Area Programme (GTAP), based on the Two Rivers Urban Park Local Area Sustainable Neighbourhood, 2012 which was a Province-led project (Province refers to the Regeneration Programme within the Department of Transport and Public Works).

The development process of the area into an urban park was introduced in 1998 and was referred to as the "Black River Urban Park Development Framework process". The Urban Park Contextual Framework and Phase1 Management Plan focuses on the management of the City-owned land (the park and wetlands and includes a Baseline Heritage Study, Traffic Impact Assessment and recommendations for improving water quality, avifauna diversity and biodiversity (CFMP, 2003)

In 2015 a multidisciplinary team was introduced to formulate a Development Framework and to bring about the necessary authorisations for the development of the Park. Aquatic and water quality assessment study was done to inform the project team of the aquatic and water quality related challenges and opportunities for the site, and the possible impact of proposed development framework proposals in order to encourage the authorisation processes for the project (Blue Science, 2016).

The City objectives are to restore the two river ecosystems by greening in and around the Two Rivers and by creating recreational infrastructures such as pathways and parks.

4.8. WESTERN CAPE VISION FOR THE SITE

The Western Cape Government, through the Cape Town City Regeneration Program (CTCCRP), imagines a city which is vibrant, well structured, distinct, and globally connected (City Think Space, 2012:4).

The programme advocates new approaches to development, informed by environmental sustainability through green and blue spaces, waste-to-resource, urban food growing, and natural resource protection processes. It should recognise the value of having a well-functioning ecological system and forward spatial planning initiatives must also appreciate the Cape Town's unique ecology. New urban development should be targeted towards areas where its impact on critical biodiversity areas, water bodies and historical areas will be significantly reduced.

The CCT SDF (2012) claimed that to put Cape Town on a path which would lead to more sustainable growth, the results of urban development on biodiversity and the city's natural and ecological services must be well supported. According to the City of Cape Town (2003), there is a need to protect ecological systems in the city and to promote the sustainability of the city's natural environment. The area which is studied affords a good opportunity to see and meet these needs. The following objectives have been directly informed by the current state and vision for the site:

- To conserve the wetland and river environment through sound management principles
- To protect and enhance species diversity
- To investigate the possibility of replacing the canalised section and restoring the old Liesbeek river course.
- To ensure that any alterations to river courses do not impact negatively on the natural environment.
- To manage the area as open space for the enjoyment and recreation of all members of the community.
- To maintain and where feasible, upgrade existing recreation facilities and amenities.
- To address the issues of management of access and use in more ecologically sensitive areas to ensure that avifauna and fauna are not unduly disturbed.

4.9. FINDINGS OF CODING ANALYSIS

With mixed used methods, incorporating both quantitative and qualitative research , there is an inseparable link between data collection , data analysis and coding analysis. In this study, as the data was being transcribed, patterns and divergent themes started to emerge. As mentioned in chapter 2 , the use of a CAQDAS provided another set of tools to assist the data analysis. To create an order out of the different concepts and participants perspectives, a process of coding was used. Hence, it was from this combined process of data collection and analysis that an analytic approach was developed. This enabled clearer presentation of data when the themes were described and supported by quotations. Themes that emerged from the data, along with sub-themes and categories outlined in figure 2.3 were discussed with supporting quotes from the recorded sessions. The following sub-theme relationships emerged from participant narratives:

- Between perceived value of the property vis-a-vis potential and purpose.
- Between wildlife, agriculture, the rivers and the importance of water.
- Localised impact of climate change.
- Importance of research, planning and sustainable development.
- Relevance of public opinion, attitude, heritage and rehabilitation.
- Connection between infrastructure, accessibility and safety.

The findings from the coding analysis revealed the importance of green networks for sustainable urban development as it can ensure the conservation, protection, and enhancement of ecological areas which deliver vital ecosystem services. The inseparable interplay between human development and natural development was recognised by the different categories of participants.

4.10. CHAPTER SUMMARY

This chapter presented the case study context, systems, and main features of the Two Rivers Urban Park. Clearly, the Two Rivers Urban Park offers a unique opportunity to integrate ecological and urban developments in a sustainable manner. It can not only have a positive impact on the natural environment and key environmental features of the site but, can also facilitate the development of the site to strengthen the links between the urban and natural environment. However, its potential still needs to be realised. Despite its unique naturalness, numerous policies and plans for this site, no clear development vision has been agreed to by the key role players.

The analysis process aimed to present data in an intelligible and interpretable form in order to identify trends and relations in accordance with the research aim. Data gathered in this chapter provided some answers to the relevant research questions and revealed the importance of green networks for sustainable urban development in the study area. The conservation, rehabilitation, protection, and enhancement of ecological areas deliver vital ecosystem services, improve the environment while enhancing human well-being.

Chapter 4 covered the results of the study in detail. The collected data provided information about the respondent's understanding of the contribution of green networks in the urban area as well as their views and experiences about the Two Rivers Urban Park in Cape Town.

Further urbanisation processes in the city could increase the environmental degradation. These reiterates the need for intervention in planning to facilitate integration between human and natural systems. The two cannot be separated and conservation efforts should target actions inspired by nature to improve resilience of ecosystems. In the next chapter, the findings of this case study are interpreted to attach meaning.

CHAPTER FIVE
INTERPRETATION OF RESEARCH FINDINGS

5.1. INTRODUCTION

The main purpose of this chapter is to provide an interpretation of the results obtained from empirical research. Chapter 5 juxtaposes findings presented in Chapter 4 with findings identified from the literature review presented in Chapter 3 for interpretation. Then, it provides a discussion of the main findings from the research and where applicable, links the literature to the research outcomes. This chapter aims in particular to respond to the main research question:

How can green networks contribute to sustainable urban development in African cities?

From the results presented in chapter four, numerous findings have become apparent. The next presents a detailed overview of the findings related to the themes emerged from data analysis and the literature review. These findings seem to concur with findings from the literature analysis

5.2. RELATIONSHIP TO PREVIOUS RESEARCH

This section will give a brief overview of the findings of the study and their relationship to previous work in these areas.

- *Sustainable development as both opportunities and constraints.*

Economic and sustainable development is part of an anthropocentric conception of the world in which human are supposed to be responsible for his future and that of the planet, which is the case with various approaches to sustainable development. The major cause of environmental problems is due to urban development (Lee & Kim, 2015). It is often argued that globalisation exacerbates environmental problems by promoting growth and pressure on the natural environment.

On the other hand, environment and development are not necessarily opposed. The concern of sustainable development is being imposed globally, it is possible to transform these constraints into opportunities to develop new solutions and approaches adapted to our ecosystem and to better integrate economic and ecological considerations in decision

making. The sustainable development aims to promote harmony among human beings and between humanity and nature (Brundtland Report, 2019: Chap 2).

- *Need to focus on the ecosystem as a whole and importance of natural green space*

The research findings from this study show some consistency regarding the importance of natural green space for the overall functioning of natural ecosystems and the need to focus on the ecosystem as a whole**.**

Urban ecosystems are based on interactions between the social, economic, biological, and physical components that together form a functional unit that is the city. However, the biological components also include human populations, their demographic, economic and social factors, their institutions and decision-making that alter the environment. Pickett (2015) stated that the physical components of urban ecosystems include the energy use, transformation, and export of materials but also buildings, transport networks and other infrastructures.

According to Odum (1971), any area of nature that includes living organisms (plants, animals and organisms) and non-living substances (weather, land, sun, soil, climate, atmosphere) interacting to produce an exchange of materials between the living and non-living parts is an ecological system or ecosystem. Living organisms (biotic) and their non-living (abiotic) environment are inseparably interrelated and interact with each other.

Like the natural system, cities form ecosystems that provide energy and materials. These energy and material transformations involve not only beneficial contributions such as housing, transport for example but also pollution, waste, and climatic pressure. Therefore, it is important to no longer think of city and nature as ecosystems that have nothing in common.

Several aspects of urbanisation influence the presence and distribution of natural green spaces in urban areas. These spaces, however, are important because they provide many benefits to human and contributes to his well-being.

Natural systems in urban areas also serve to maintain the link between man and nature, an essential link to encourage the implementation of conservation projects and to ensure their continuity.

➢ *Potential of green habitat*

The other major finding from literature exposes the potential of green habitat and plant in restoring the environment and combat climate change.

Green habitat is designed to provide and manage ecosystem services such as water purification, air quality, space for recreation and climate mitigation and adaptation. There is immense potential in improving environmental conditions and therefore citizens' health and quality of life. Trees and plants are essential.

Besides, there is an emphasis on treating the ecosystem as a whole, with planting helping the wildlife etc. From the literature review, plants are identified as “the basis of life on earth”. They produce oxygen, food and habitat through the photosynthesis that supports all living creature (Hough, 2004:87).

While urbanisation is extending throughout the world, pressures on wildlife are increasing. In the findings, respondents revealed the importance of wildlife for functional biodiversity. The main threats to wildlife include fragmentation and habitat loss (deforestation, agricultural expansion) /destruction /degradation, poaching, overexploitation, hunting, pollution, and climate change.

Even if the urban environment imposes very strong constraints on the animals and the plants which populate it, the biodiversity is rich of many very varied species. All these species form the urban ecosystem that renders valuable services to men.

Although having a positive effect on human well-being and ecology, these species in urban areas are still too often perceived as harmful (animals often carry parasites and bacteria that can be dangerous for humans). Unfortunately, as species disappear, we lose all the benefits they provide. It is then necessary to find possible solutions to allow a good cohabitation between the man and the fauna.

Wildlife is another integral part of the natural system that helps us maintain biodiversity. It is important to recognise that wildlife products and services, whether in consumption, recreation, health, or others, can encourage to promote the conservation of biodiversity while simultaneously meeting human needs. Hough (2004:158) states that “wildlife in the city provides lessons we can learn about the balance of nature upon which all living beings depend”.

To make cities more wildlife-friendly and fully appreciate the critical role of wildlife in urban ecosystems, cultural change is needed. We need to change our perception of urban wildlife, because when we protect animals and plants, we also protect the ecosystems that underpin our economies and well-being. Such an integrative approach will help to better understand how to live successfully alongside wildlife in an increasingly urbanised world.

- *Green networks and potential of rivers*

The in-depth interviews confirmed the important potential of rivers for enhancing green networks. However, the implementation of strategies to maintain or rehabilitate these corridors is less considered. Therefore, water management is more than necessary as an essential component of natural ecosystems.

Rivers form a dynamic ecosystem with a succession of habitats. They are paths used by both aquatic life and wildlife which use this network as a moving frame and even the most modest ones can generate biological flows both in the water and on the banks. When they are not disturbed, rivers offer a great diversity of habitats (wet meadows, reed beds, ponds, etc.).

Beyond the risks associated with development, occupying these spaces disrupts the functioning of the river but also undermine its potential and value. Hence, the proper functioning of the river is essential to ensure the continuity of its uses. Other functions associated with rivers include flood mitigation, purification, protection against erosion, sedimentation, thermal regulation, etc…

According to American Drivers (2017), giving rivers room and restoring healthy floodplains, or living them to their natural state can keep communities safe and improve the health of rivers by providing benefits including clean water; open space for agriculture, recreation and trails, and habitat for fish and wildlife.

- *Opportunity to design green infrastructure*

The findings also identified scope for developing and designing green infrastructure differently. Green spaces in urban areas should not be considered for aesthetic reasons only. By reconnecting, improving and maintaining green infrastructure, we can help ensure that this network of healthy ecosystems continues to support biodiversity and provide their many services, such as clean air and clean water, flood prevention, carbon

storage, improved health and well-being. Strategies for safeguarding the biosphere must be action-oriented and adapted to different levels of development.
The findings point-to the fact a different appreciation and perception of the presence of nature in the city is what could enable human populations to develop ecological awareness and encourage conservation efforts.

It is evident from both the literature review and empirical research that for successful strategy implementation, there is an urgent need to develop approaches to meet the diverse needs of wildlife and people but also bridge the gaps between development and conservation.

Urban biodiversity allows many people to have personal experiences with nature. It is accessible to all social classes and provides an opportunity to educate, learn about environmental processes and the importance of their conservation. Have a frequent experience with nature can shape human values and encourage better decision making.

- *Environmental Awareness*

Environmental awareness is another focus of the findings. It is vital for people to consider the health of the entire planet by taking measures in their communities and cities. Before the decision-making of the policies and institutions in place, people must come together to protect the habitats and organisms that live with them. The quality of biodiversity depends on the place and the management we give it in the city.

In conclusion, transforming strategies into action is a difficult task considering the regulation, policy, or government issues. However, a common interest will reinforce decisions.

Public implications for development and environmental impacts can greatly help to draw attention to different points of view. Some changes are also needed in environmental regulations. It must go beyond simple safety regulations and pollution control laws.

Biodiversity in cities is essential for all human beings, including future generations. Thus, objectives must be integrated on a larger scale (investment projects, legal framework, development policy, etc…)

Overall, the increasingly abundant literature on the subject shows that the quality of life of urban dwellers and even their health is closely linked to the quality of the biodiversity in which they live. The study has found that the incorporation of green networks in all development processes have many benefits for ensuring the sustainability of urban development.

5.3. RETURN TO RESEARCH QUESTIONS

The findings reported in the thesis are summarised by returning to the research questions and objectives posed in chapter 1 and recapitulating the work that has been done to answer them.

The aim of this thesis was to determine the effectiveness of green networks in improving urban sustainability and to contribute to ideas on the need to improve human-nature relationships for a sustainable future.

The results of this study deal with the research questions and objectives defined at the beginning of this study. The results not only corroborate the current literature on how to rethink urban and natural processes into a single whole system, but also provide valuable insights on the multiple benefits that integrating nature into development process can bring, such as food security, enhancement of natural assets, rehabilitation, biodiversity conservation and, most importantly, guaranteeing the sustainability of urban development.

The research question that the researcher wished to answer was: ***How can green networks contribute to sustainable urban development in African cities?***

The phenomenon of incessant growth in Africa combined with the needs of urbanisation raises social and environmental concerns. The rapid urbanisation and poverty faced by African cities remain constraints to biodiversity conservation. In addition to these constraints, there is also political instability, corruption, poor financial resources of local governments, as well as a lack of knowledge to deal with complex environmental issues.

Many cities in Africa are still developing, which is why it is still possible to avoid the mistakes of developed and industrialised countries by preventing the deterioration of the environment. Urban planning policies have for a long time consisted of organising spaces for populations to settle without carrying about the environment and its challenges. But today, in some cities, these policies seek to restore the destroyed environment. Planning is

a development that should be comprehensive and consider all the issues that may hinder this environment.

One specific objective of this study was to establish how green networks could respond to the current's urban planning challenges and assess whether these systems could be a benefit for improving sustainability in African cities.

Green networks can address health inequities, improve the environment, conserve biodiversity, and help mitigate climate change. Another advantage of green networks is to encourage tourism, promote the rehabilitation of degraded or abandoned lands and possibly serve as a place for social interaction. The study reveals that green networks can contribute to sustainable development in African cities by providing simultaneously economic, social, and environmental benefits.

The second objective of this study was to determine the relevance of green networks for urban areas and to apply these systems in cities.

Cities have remarkable biodiversity, and more ecosystem-based urban planning can reduce the degradation of natural ecosystems near cities, reduce air pollution, regulate stormwater drainage, and allow the treatment of wastewater.

Development in cities contributes to all the major causes of global biodiversity loss (the loss and fragmentation of natural environments, pollution, the introduction of invasive alien species, the overexploitation of natural resources and climatic changes). Given these facts, green networks are strategies for balancing urban development and biosphere's conservation.

The functional elements of natural ecosystems such as water, plant, wildlife, climate etc. are interlinked and relevant for green networks in cities. They have an ecological survival function. For example, wildlife is a pollinator and play a vital role in maintaining our ecosystems. The pollination helps in flowering plant reproduction and in the production of an important food source for people and wildlife (Ngo et al., 2017).

In addition, wildlife benefits from interconnected habitats and reverses the damage done to these natural habitats by urban development. Green networks will enhance environmental assets by reducing human impact on the environment and protecting urban populations from the effects of climate change.

The final specific objective of this study was to screen alternative approaches to how urban system can possibly emulate natural ecosystems in urban development action.

The approach aims to privilege systems found in nature in order to develop sustainable innovations over the long term in better harmony with the environment.
This approach inspired by the interactions that species develop between them and the overall functioning of natural ecosystems, provides enormous potential to maintain and enhance natural capital. By mimicking how organisms and non-human communities manage extreme environmental conditions for example, we obtain results such as risk reduction (climate change, drought, floods, etc.). These solutions, supported by the natural process enable better actions towards renewable energies and the management of soils, water and waste treatment.

As discussed, several profound considerations need to be considered, including innovative approaches to the ecological planning process and environmental awareness for the community to reconnect with the natural world.

The challenges regarding sustainability are many, but the potential of ecosystem services is immense. Although well integrated into urban landscape planning in developed countries, green spaces are poorly managed, planned and overtaken by housing needs and other grey infrastructure projects turning into environmental problems. This study serves as a basis for further studies.

5.4. RECOMMENDATIONS

Before the conclusion to this research is presented, two sets of recommendations have been identified based on the outcomes of the research. These relate to both the case study area and research topic.

5.4.1. Recommendations relating to the study

Given the environmental problems in cities, it is important for citizens to reconnect with nature despite the current urban growth. Cities should better integrate their green and blue infrastructure (rivers, lakes, parks, forest, etc.). For this reason, the following recommendations are made with regards to the future of the case study:

- Protect the actual green spaces to encourage biodiversity.

- Replicate as closely as possible the original vegetation cover. The vegetation rehabilitation will improve the ecological connectivity across the site.
- Encourage re-vegetation of riverbanks through assisted regeneration or direct planting and reintroduce suitable locally indigenous plant species while removing invasive alien vegetation to improve biodiversity in the TRUP area.
- Reconnect rivers with floodplains to enhance natural water storage and restore riparian vegetation to assist in reconnecting rivers with floodplains, to provide greater instream ecosystem complexity and maintain natural wetlands in order to create emergency flood capacity
- Manage stormwater through sustainable urban drainage systems (SUDs) by creating ponds to collect, store and clean water. These practices mimic natural processes like evaporation, infiltration, and plant transpiration which can affordably reduce the effect of urbanisation on the quality and quantity of stormwater runoff.
- Address littering issues by a regular clearing of litter catch fences at the upper and lower ends of the rivers in the study area.
- Develop a better management strategy for the floodplain given that TRUP is in the 1:100-year flood line. Construction must be kept away from wetlands.
- Create an urban park to harness the assets and natural qualities of the site.
- Make the sector well connected and accessible for the entire city offering a range of sustainable movement and transport options.
- Address the issues of access and use in more ecologically sensitive areas to ensure avifauna and fauna are not unduly disturbed.
- Upgrade the existing recreation facilities and manage the area as an open space for the enjoyment and recreation of all the community. Any development proposals in these areas would have to be carefully designed and should not compromise current ecological connectivity.
- Educate people about the impact of pollution and promote responsibility towards the rivers and initiate restoration projects at a local level, together with children and young people to reconnect people with nature, build a sense of community and stimulate shifts in behaviours.

5.4.2. Recommendations for further studies

Nature is all around us, we should plan a more meaningful relationship between man and nature. The urban system relies on the natural system, it is therefore important that urban policy recognises and integrates green spaces into the urban planning process.

The study has highlighted several researchable aspects that could be pursued further such as investing in research for new solutions mimicking natural systems while ensuring preventative measures and restoration initiatives.

This research, which has implications stretching far beyond the Two Rivers Urban Park, can serve as a point of departure for stimulating changes in policy, legislation and spatial planning regarding green networks to enhance the adoption and success of solutions inspired by nature. It is equally necessary to accelerate and support actions in the planning, implementation, and monitoring of restoration activities through relevant policies, plans and programs

Measures such as green spaces, street greenery, eco-bridge and green roofs are known to provide a variety of environmental benefits, as well as improve the liveability of cities, enhance their economic development and contribute positively to the health and social well-being of urban citizens. The author suggests giving a particular attention on the potential economic gains from solutions inspired by nature as components of sustainable urbanisation and how these gains can translate into benefits for the well-being of all.

Research is needed to look at ways and means of dealing with neglected land and abandoned areas in the city through urban regeneration in order to support the implementation and optimisation of sustainable infrastructure.

Further investigation of the principle of ecological emulation within sustainable urbanisation is recommended. Finally, attention must be paid to the implication of society in restoration actions, with the aim of reconnecting people with nature, raising awareness and provoking a public demand for restoration actions. Identifying and communicating the ecosystem restoration efforts, results and benefits can increase active public support and involvement.

5.5. CHAPTER SUMMARY

The objectives of this research have been identified and the findings of the data collected discussed. It has been concluded that services provided by nature are essential for human life. The results revealed that green networks can offer several environmental, economic, and social benefits. This is to recognise how green networks can guide development in the city while facilitating the human-nature relationship.

Besides, interventions such as the protection, restoration, rehabilitation, and enhancement of natural assets can only have a positive impact on the natural environment. It has been discussed that by enhancing existing solutions as well as exploring more solutions, for example mimicking how natural systems cope with environmental extremes, it is possible to address a variety of environmental, social, and economic challenges in sustainable ways. Inspiration and support from nature can stimulate socio-ecological harmony and promote biodiversity conservation through sustainable urban growth.

Both findings from the case study and literature show the importance of a paradigm shift in human-nature relationships. No significant differences were found between the different categories of participants regarding the inseparable interplay between human development and natural development. In contrast, the integration of urban and natural systems within a single system has been seen as an effective approach to ensure the sustainability of urban development. Thus, the key findings that emerged from the data analysis are in relation to the research aims.

In this chapter, the findings of the study across the chapters were synthesized to inform the conceptual development of the study. Following from this, chapter 6 entails an overview of the study and the final conclusion.

CHAPTER SIX
CONCLUSION OF THE RESEARCH

6.1. INTRODUCTION

This chapter aims to provide concluding remarks to the research. The main research objective from the onset was “to ascertain the effectiveness of green networks of cities in improving urban sustainability through the process of emulating natural systems”. The approach taken in the thesis is supported by the research findings presented in chapter 4 and 5.

In this final chapter, limitations encountered during the study are presented and recommendations are made for the entire research.

6.2. OVERVIEW OF THE STUDY

This research called for a rethinking of the relationship between humans and nature. The study argues that ‘green networks’ should not only include recreational spaces or aesthetic dimensions of space but also the broader natural and biophysical process that constitute ecosystems. It refers to an approach that tries to apply the methods of ecology to the city and adopts a "biocentric" concept associating the environment with nature.

Nature (plants, rivers, wetlands, lakes etc) in urban environments produces services that not only contribute to the well-being of people but are also necessary to preserve the ecosystems themselves. Preservation of this natural system is socially and economically relevant.

An in-depth analysis of the TRUP area was conducted in order to identify its environmental attributes such as fauna, flora, aquatic environments, and wetland systems. Site features and historical context also provided a strong contextual understanding of the site and its processes.

The research followed with the presentation and interpretation of the research findings. Table 6.1 presents a detailed overview of the findings related to the themes emerged from data analysis and the literature review.

Table 6.1: Findings related to the themes that emerged from the iterative thematic analysis of the raw data vs theme cited in the literature

FINDINGS	EVIDENCE IN COLLECTED DATA	EVIDENCE IN LITERATURE
The need for proper developmental planning and more research	*"And it's my understanding also from existing literature and existing research is that we do not yet fully understand the importance of our green open space in the urban environment."*	(Ives et al.2014;Mensah, 2014)
The need to focus on the ecosystem as a whole	*"Historically, urban and environment were seen as two separate points[.....]It's one whole system. Ideally, you want to see that all of these new understandings are influencing how we plan our green open space in the urban environment."*	(F. Kong et al., 2010; Na Xiu et al., 2016)
The importance of wildlife for functional biodiversity	*"Rebuilding habitat that has a balanced functional diversity of species is essential."*	(Hough, 2004:137)
The need for water management	*"…human beings need water to survive. So, our cities need huge amounts of water. But the irony is that we also need to get rid of all excess water in our city in a way that we can live free of hazards and dangers like flooding."*	(F. H. Kong et al., 2014)
The importance of plants and natural green space for the overall functioning of natural ecosystems.	*"…plant suitable locally indigenous species along banks."* *"Without the appropriate plants, we are losing whole sub species."*	(Low et al. 2005:90, Hough, 2004:87)
The opportunity to design and develop green infrastructure	*"… we have the opportunity to actively design for green infrastructure, which will be would be another key focus[…..]So, that's actually how I understand green infrastructure. It's consciously designed, as has been done with Twin Rivers."*	(Hough,2004)
The need for appropriate planning & Environmental awareness	*"Because once we educate ourselves and we even as urban planners or scientists, we start to study this so we can help our community become more aware and get them involved and excited about it.[….]as the urban planners and the urban manager, environmental managers, or the environmental scientists, we can learn from this case study."* *"If you don't plan that properly, you could end up with[….]big flood comes through in a takes out half the houses or it makes the place unliveable and that's not sustainable."*	(Roberts, 2010)
The role of water for natural ecosystems	*"The rivers need to be rehabilitated and restored to its best state to achieve its full potential as a natural system. Much work needs to be done to catch pollution before it enters the rivers."*	(Hough 2004:43)
The significant potential of rivers to connect green networks	*"Green networks are interconnected green open spaces and the rivers are interconnecting green corridors that link them. The interconnected environments make an interconnected habitat for biodiversity and for linked recreation."*	(UN-Habitat, 2012; Hough, 2004:2)
The potential of green habitat and plant mitigation in restoring the environment and combat climate change	*"We should keep as much as green land to help cool the temperature, provide oxygen and mitigate the urban heat island."* *"Green habitat restoration would heal the environment. Trees and plants are essential."*	(Johnson 2015; Doick et al. 2014; Bao et al. 2016; Mackey et al. 2012; Susca et al.2011;Oliveira et al. 2011)
The sustainable development as both opportunities and constraints	*"… Development is defined as the act of growing or improving but it turns out that not all that is put forward as development is actually improvement! Much is devastating! Hard surfaces, extensive roads with intrusive traffic and buildings that intrude into natural environments…![…]is our vision for sustainable development; it's resilient, it's responsive to social needs, it's responsive to the environmental needs, and it supports economic development. […] let's work with the constraints, let's turn them into opportunities."*	(Loh et al. 2008; UN-Habitat, 2012)
The regulation, policy, or government issues	*"One of the biggest challenges is that the most of it, most of the land is owned by the provincial government. And is used for institutional purposes […]So, the reason it hasn't been developed is because of institution infrastructure, deceived, and, you know, infrastructure constraints. But then, for me, one of the biggest issues is the government."*	(Meisel & Thiele, 2014; Okpala 2009; Mensah 2014:6)

Source: Author construct, 2020

The results of the study provided a better understanding of the biological reality of nature in the city by confirming, among other things, the multiple needs of a paradigm shift in the urban planning process but also the implementation of new solutions mimicking natural systems.

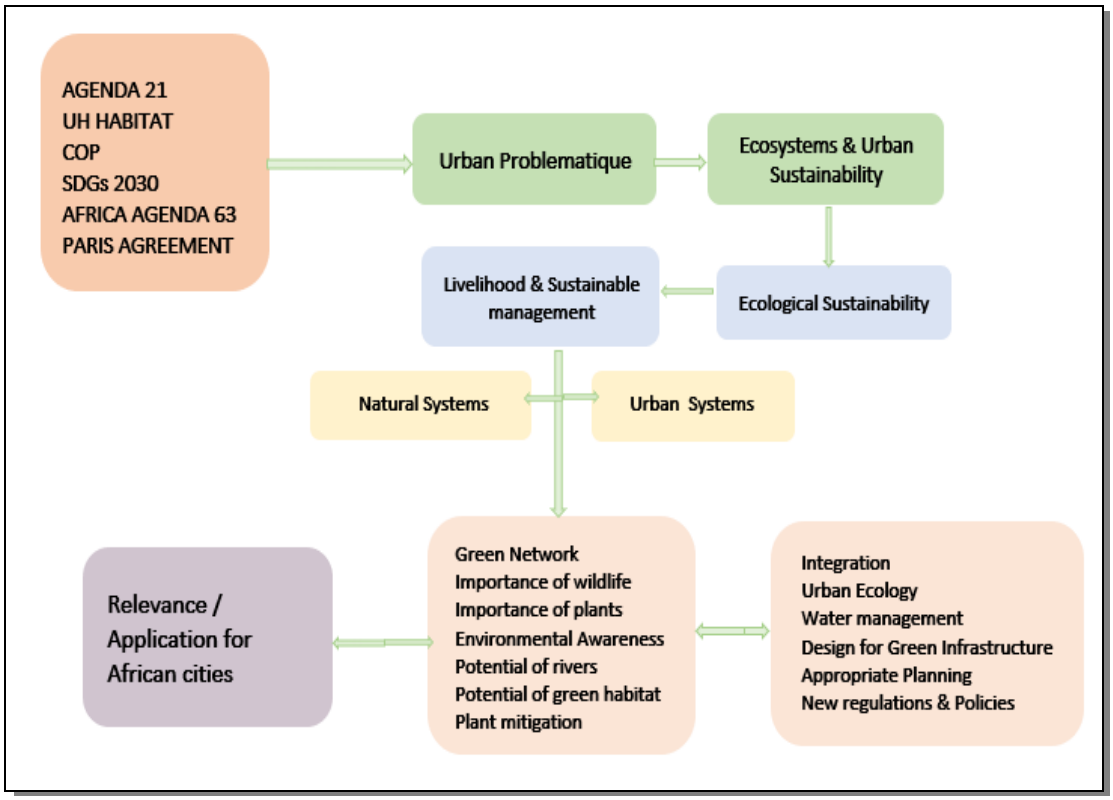

Figure 6.2: Revised Conceptual Framework

Source: Author construct, 2019

Figure 6.2 represents a revised version of the conceptual framework presented in Figure 3.4. This includes more a more nuanced understanding of the relationship between green urban networks and urban ecology; an essential outcome of this research and contribution to this body of knowledge. There is a need to understand the importance and relationship between green habitat, wildlife, and water. Environmental awareness is a critical requirement to better appreciate biodiversity and ecological integrity in urban areas and be develop the capability to mimic essential ecosystem systems. This is in order to enhance resilience in natural areas and other open spaces. The intersections within the framework demonstrate the relationship that exists between the concepts, ideas and practice.

6.3. LIMITATIONS OF THE RESEARCH

The first limitation shown by this study is the selection of a single case study. This could be a major limitation in terms of generalisation of the research findings. However, the main objective of the research is to develop an understanding of the interrelation and potential

for sustainable coexistence between urban and natural systems and how green networks could contribute towards urban ecological sustainability. Thus, this research could equally well be considered and/or used as an example for the study of ecological networks in other African cities.

The second limitation is the permission to conduct interviews from the City of Cape Town. The researcher had to wait around 3 months for permission before starting data collection. Another major obstacle encountered in this research was the difficulty of obtaining favourable responses from all participants to take part in the research.

The third limitation concerns transcription. One of the interviews, for example, took place while walking on the studied area and due to strong winds, some parts of the recording are inaudible. Also, the researcher using English as a second language, some words and nuances of meaning were difficult to comprehend and time-consuming.

Finally, data collection could not be done over a long period of time due to distance and time. The researcher had to travel from Johannesburg to Cape Town to collect the data.

6.4. CONTRIBUTIONS OF THE RESEARCH

As previously mentioned in chapter 1, the research provided an opportunity to advance the understanding of nature in the urban area in the way that nature is treated with no negative environmental impacts.

With the increasing interest in protecting biodiversity, the study established the significant role played by green networks as an integral part of natural processes and presented approaches to the conservation of natural areas and open space systems.

Finally, this research promoted the principle of ecological emulation and has also contributed to the research process of sustainable urban development in Cape Town.

6.5. CONCLUDING REMARKS

This research has fostered integrated relationships between urban and natural systems by reversing the effects of urbanisation so that nature and humans can dwell together more symbiotically. An interesting research gap links the mitigation of regional and global biodiversity loss to the increasing demand for ecosystem services and green networks in cities.

In the current context, Cape Town could serve as an example of a city valuing the importance of urban ecology and the inseparable integration of nature into development, economic and planning debates. There is a need to find innovative ways to improve urban biodiversity and enhance the provision of nature-based services. This is relevant to the well-located site in the city, TRUP, where urban and natural systems coexist.

Development and human activities must seek to integrate nature actively and consciously without negative impact. Therefore, maintaining enough green space coverage in cities can make a significant contribution to mitigating the effects of climate change and biodiversity loss.

Urban ecological studies, the diversity of characteristic features of the ecosystem services they provide in Africa, are rare. According to ICLEI (2018) and UNEP (2016) *in "The State of Biodiversity in Africa" review,* African city governments are largely underprepared to meet the challenges of urbanisation. A large proportion of the urban population is still living in unplanned settlements with limited access to adequate municipal services such as water, sanitation, solid waste, electricity. While impacts are felt across the cities, deterioration of environmental conditions and major health and safety risks are increasing.

Further efforts are needed to ensure that sustainable development approaches are consolidated and promoted in Africa and around the world. It must be emphasised that these efforts contribute not only to the conservation of biodiversity but also have the potential to respond to societal challenges. Similar studies in other African cities should be conducted to identify climatic and socio-economic differences and their impacts on the green networks and ecosystem services they provide.

To promote the transition to a paradigm shift of how to coexist with nature in a harmonious manner, the natural environment should be restored and rehabilitated, protected and enhanced through a positive development that aims to improve the quality of life. This study concludes that African cities can be hedges of green networks with high biodiversity values and provide key services for ecosystems.

REFERENCES

A

Achankeng. 2003. Globalization , Urbanization and Municipal Solid Waste Management in Africa, University of Adelaide. : 1–22.

Aldiabat, K.M. & Le Navenec, C.-L. 2018. *The Qualitative Report Data Saturation: The Mysterious Step In Grounded Theory Method*. https://nsuworks.nova.edu/tqr/vol23/iss1/18 [19 June 2019]

American Drivers. 2017. Why We Need to Restore Floodplains | American Rivers. https://www.americanrivers.org/threats-solutions/restoring-damaged-rivers/benefits-of-restoring-floodplains/ [15 July 2019].

Anon. 2013. L'importance des zones humides / Eau et biodiversité (jardins, espèces protégées, zones humides, Natura 2000) / Gestion de l'eau / Environnement / Politiques publiques / Accueil - Les services de l'État dans le Gers. http://www.gers.gouv.fr/Politiques-publiques/Environnement/Gestion-de-l-eau/Eau-et-biodiversite-jardins-especes-protegees-zones-humides-Natura-2000/L-importance-des-zones-humides [10 June 2017].

Anon. Sustainable development goals - United Nations. http://www.un.org/sustainabledevelopment/sustainable-development-goals/ [16 March 2017].

Anon. 2015. Wetlands and Ecosystem Services. www.cbd.int [10 June 2017].

B

Bao, T., Li, X., Zhang, J., Zhang, Y. & Tian, S. 2016. Assessing the Distribution of Urban Green Spaces and its Anisotropic Cooling Distance on Urban Heat Island Pattern in Baotou, China. *ISPRS International Journal of Geo-Information*, 5(2): 12. http://www.mdpi.com/2220-9964/5/2/12/htm.

Bahri, A. 2012. *Integrated Urban Water Management*. Global Water Partnership Technical Committee (TEC), ed. TEC BACKGROUND PAPERS.

Basit, T.N. 2003. Manual or electronic? The role of coding in qualitative data analysis. *Educational Research*, 45(2): 143–154. https://doi.org/10.1080/0013188032000133548

Bazeley & Jackson. 2013. *Perspectives: Qualitative computing and NVivo*. http://download.qsrinternational.com/Document/Website/Qualitative-Data-Analysis-with-NVivo_Chapters-1-and-2.pdf [13 June 2019].

Benedict, M.A. and McMahon, E.T. 2012. Green Infrastructure: Linking Landscapes and Communities - Mark A. Benedict, Edward T. McMahon, Mark A. The Conservation Fund - Google Books. *Green infrastructure: linking landscapes and communities. Island Press.* https://books.google.co.za/books?hl=en&lr=&id=2xTJvYqzFNkC&oi=fnd&pg=PR5&dq=Green+Infrastructure:+Linking+Landscapes+and+Communities&ots=3nZgdLWTOq&sig=hwXdZbpLGUqxDmURA1IfI1H6Xk#v=onepage&q=GreenInfrastructure%3 Linking Landscapes and Commun [14 March 2017].

Bergin, M. 2011. NVivo 8 and consistency in data analysis: reflecting on the use of a qualitative data analysis program. *Nurse Researcher*, 18(3): 6–12.

http://rcnpublishing.com/doi/abs/10.7748/nr2011.04.18.3.6.c8457 [13 June 2019].

Bianzino, A.P., Chaudet, C., Rossi, D. & Rougier, J. 2012. A Survey of Green Networking Research. , Communicat(IEEE): pp.3-20.

Bilgili, B.C. & Gökyer, E. 2012. Urban green space system planning. *Landscape Planning*: 360. http://cdn.intechopen.com/pdfs/37556/InTech-Urban_green_space_system_planning.pdf.

Blatch, T. 2016. *Towards more integrated human-nature relationships: A local area spatial development framework for the Two Rivers Urban Park (TRUP) site*. University of cape town.

Blue Science. 2016. AQUATIC AND WATER QUALITY ASSESSMENT : SPECIALIST REPORT FOR THE TWO RIVERS URBAN PARK DEVELOPMENT, (October).

Bogdan, R. & Biklen, S. 2003. Qualitative research in education. *An introduction to theory and methods*: 110–120. http://www.eric.ed.gov/ERICWebPortal/recordDetail?accno=ED419813.

Bolger, D.T., Scott, T.A. & Rotenberry, J.T. 2001. Use of corridor-like landscape structures by bird and small mammal species. *Biological Conservation*, 102(2): 213–224. https://doi.org/10.1016/S0006-3207(01)00028-3

Borgström, S. F. H. 2014. *European environmental law review.* Kluwer Law International (Vol. 23). Kluwer Law International. http://www.kluwerlawonline.com/abstract.php?area=Journals&id=EELR2014004 [18 March 2017].

Borgström, Suvi, Similä & Jukka. Assessing Governance Structures for Green Infrastructure. http://nordiskmiljoratt.se/onewebmedia/NMT , 32014, Borgstrom, Simila.pdf [18 March 2017].

Bowler, D.E., Buyung-Ali, L., Knight, T.M. & Pullin, A.S. 2010. Urban greening to cool towns and cities: A systematic review of the empirical evidence. *Landscape and Urban Planning*, 97(3): 147–155. http://www.sciencedirect.com/science/article/pii/S0169204610001234 [3 April 2017].

Brundtland Report. 2019. Chapter 2. Towards Sustainable Development.

Bryman, A. & Bell, E. 2007. Business Research Methods. , 2nd editio(Oxford University Press.): 595. http://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Business+research+methods#0.

Buyantuyev, A. & Wu, J. 2010. Urban heat islands and landscape heterogeneity: linking spatiotemporal variations in surface temperatures to land-cover and socioeconomic patterns. *Landscape Ecology*, 25(1): 17–33. http://link.springer.com/10.1007/s10980-009-9402-4 [11 April 2017].

C

Cameron, R. 2014. *Every Last Drop: The Role of Spatial Planning in Integrated Urban Water Management in the City of Cape Town.* Master in City and Regional Planning. University of Cape Town, South Africa. (2003).

Castleberry, A. & Nolen, A. 2018. Thematic analysis of qualitative research data: Is it as easy as it sounds? *Currents in Pharmacy Teaching and Learning*, 10(6): 807–815. https://doi.org/10.1016/j.cptl.2018.03.019.

CFMP. 2003. Two Rivers Urban Park Contextual Framework and Phase 1 Environmental Management Plan.

City of Cape Town. (2016). *TWO RIVERS URBAN PARK Draft Green Corridor Concept Plan, (November).*

City of Cape Town. (2018). MSDF Review, Council Approved.

City of Cape Town. (2018). BIODIVERSITY REPORT 2018 Celebrating a decade of biodiversity management 2008-2018.

City Think Space. 2012. The Two River's Urban Park Local Area Sustainable Neighbourhood. , (March).

Chen, Y., Gu, W., Liu, T. & Yuan, L. 2017. Increasing the Use of Urban Greenways in Developing Countries : A Case Study on Wutong. *Environmental Research and Public Health*, (23 May 2017). https://doi.org/10.3390/ijerph14060554

Chu, E., Anguelovski, I. & Roberts, D. 2017. Climate adaptation as strategic urbanism: assessing opportunities and uncertainties for equity and inclusive development in cities. *Cities*, 60: 378–387. http://dx.doi.org/10.1016/j.cities.2016.10.016.

Cobbinah, P.B. & Darkwah, R.M. 2016. African Urbanism: the Geography of Urban Greenery. *Urban Forum*, 27(2): 149–165. http://dx.doi.org/10.1007/s12132-016-9274-z.

Cohen D, C.B. 2006. Qualitative Research Guidelines Project | Stratified purposeful | Stratified Purposeful Sampling. http://www.qualres.org/HomeStra-3813.html [24 April 2017].

Collis, J., & Hussey, R. 2003. *Business research: a practical guide for undergraduate and postgraduate students.* Palgrave Macmillan UK (Vol. 3rd).

Commision, E. 2013. COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS Green Infrastructure (GI) — Enhancing Europe's Natural Capital. *Brussels, 6.5.2013*, (COM(2013) 249 final): 13. http://ec.europa.eu/environment/nature/ecosystems/docs/green_infrastructures/1_EN_ACT_part1_v5.pdf [18 March 2017].

Corkery, L. & Marshall, N. 2011. Generation After Generation: Why and How We Value Open Space. *State of Australian Cities National Conference*.

Council, I., 2014. Local Development Plan. 2014. *Inverclyde local development plan 2014*.

Cumming, T.L., Shackleton, R.T., Förster, J., Dini, J., Khan, A., Gumula, M. & Kubiszewski, I. 2017. Achieving the national development agenda and the Sustainable Development Goals (SDGs) through investment in ecological infrastructure: A case study of South Africa. *Ecosystem Services*, 27(April 2016): 253–260. http://dx.doi.org/10.1016/j.ecoser.2017.05.005.

D

Da Silva, J., Kernaghan, S., & Luque, A. 2012. *A systems approach to meeting the challenges of urban climate change.* International Journal of Urban Sustainable Development, 3138(May 2014), 1–21. https://doi.org/10.1080/19463138.2012.718279

De Ketele, J.-M., & Roegiers, X. 2015. *Méthodologie du recueil d'informations : Fondements des méthodes d'observation, de questionnaire, d'interview et d'étude de documents (5th Ed.).* Retrieved from https://www.decitre.fr/media/pdf/feuilletage/9/7/8/2/8/0/7/3/9782807300378.pdf

Dilling, L., Daly, M.E., Kenney, D.A., Klein, R., Miller, K., Ray, A.J., Travis, W.R. & Wilhelmi, O. 2019. Climate Risk Management Drought in urban water systems : Learning lessons for climate adaptive capacity. *Climate Risk Management*, 23(August 2018): 32–42. https://doi.org/10.1016/j.crm.2018.11.001.

Doick, K.J., Peace, A. & Hutchings, T.R. 2014. The role of one large greenspace in mitigating London's nocturnal urban heat island. *Science of the Total Environment*, 493: 662–671. http://dx.doi.org/10.1016/j.scitotenv.2014.06.048.

Dudovskiy John. 2016. Snowball sampling. https://research-methodology.net/sampling-in-primary-data-collection/snowball-sampling/ [2 October 2017].

E

Elmqvist, T., Redman, C.L., Barthel, S. & Costanza, R. 2013. *Urbanization, Biodiversity and Ecosystem Services: Challenges and Opportunities*. http://link.springer.com/10.1007/978-94-007-7088-1.

Endlicher, W., Langner, M., Hesse, M., Mieg, H. a, Kowarik, I., Hostert, P., Kulke, E., Nützmann, G., Schulz, M., van der Meer, E., Wessolek, G. & Wiegand, C. 2007. Urban Ecology - Definitions and concepts. *Shrinking CIties: Effects on Urban Ecology and Challenges for Urban Development*, (December 2013): 1–15.

European Commission. 2015. *Towards an EU Research and Innovation policy agenda for Nature-Based Solutions & Re-Naturing Cities*. http://bookshop.europa.eu/en/towards-an-eu-research-and-innovation-policy-agenda-for-nature-based-solutions-re-naturing-cities-pbKI0215162/.

F

Fall, M. (Editor); & Coulibaly, S. (Editor); 2016. l'Urbanisation diversifiée : le cas de la Côte d'Ivoire. , 1: 209. http://documents.banquemondiale.org/curated/fr/404811472632967534/pdf/108096-PUB-FRENCH-PUBLIC-PUBDATE-8-29-16.pdf [3 May 2017].

Faragher, T. 2014. PROPOSAL FOR DESIGN AND DEVELOPMENT MECHANISMS FOR THE LIESBEEK. , (October).

Fatmi, H. 2016. From green spaces to green network for urban sustainability case of Kasserine city , Tunisia. , (February): 175–179.

Feyisa, G.L., Dons, K. & Meilby, H. 2014. Efficiency of parks in mitigating urban heat island effect: An example from Addis Ababa. *Landscape and Urban Planning*, 123: 87–95. http://www.sciencedirect.com/science/article/pii/S0169204613002399 [3 April 2017].

Forman, R.T. 2008. Urban Regions : Ecology and Planning Beyond the City. , (cambridge University Press): 1–45. http://shora.tabriz.ir/Uploads/83/cms/user/File/657/E_Book/Urban Studies/Urban Regions.pdf [18 April 2017].

Forman, R.T., 1995. *Land mosaics: the ecology of the landscapes and regions.*

Fourcade, M. et al., 2008. *The Meaning of "Theory".*

Francis, J.J., Johnston, M., Robertson, C., Glidewell, L., Entwistle, V., Eccles, M.P. & Grimshaw, J.M. 2010. What is an adequate sample size? Operationalising data saturation for theory-based interview studies. *Psychology & Health*, 25(10): 1229–1245. http://www.ncbi.nlm.nih.gov/pubmed/20204937 [19 June 2019].

Futura Planète.n.d. Définition Écosystème. http://www.futurasciences.com/planete/definitions/environnement-ecosysteme-135/ [5 June 2017].

G

Giljum, S., Hinterberger, F., Bruckner, M., Burger, E., Frühmann, J., Lutter, S., Pirgmaier, E., Polzin, C., Waxwender, H. & Kernegger, L. n.d. Overconsumption? Our use of the world's natural resources. https://www.foe.co.uk/sites/default/files/downloads/overconsumption.pdf [12 April 2017].

Given, L.M. 2016. *100 questions (and answers) about qualitative research*. Given, L.M. V. 4, ed. SAGE Publications.

Goddard, M.A., Dougill, A.J. & Benton, T.G. 2010. Scaling up from gardens: biodiversity conservation in urban environments. *Trends in Ecology and Evolution*, 25(2): 90–98. https://doi.org/10.1016/j.tree.2009.07.016

Guerrero, L.A., Maas, G. & Hogland, W. 2013. Solid waste management challenges for cities in developing countries. *Waste Management*, 33(1): 220–232. http://dx.doi.org/10.1016/j.wasman.2012.09.008.

H

Hamada, S., Tanaka, T. & Ohta, T. 2013. Impacts of land use and topography on the cooling effect of green areas on surrounding urban areas. *Urban Forestry & Urban Greening*, 12(4): 426–434. http://www.sciencedirect.com/science/article/pii/S161886671300068X [3 April 2017].

Hamza, M. & Zetter, R. 2000. Reconceiving the knowledge-base of planning education in the developing world. *International Development Planning Review*, 22(4): 433–455. http://www.scopus.com/inward/record.url?eid=2-s2.0-0039488354&partnerID=tZOtx3y1.

Hansen, R. & Pauleit, S. 2014. From multifunctionality to multiple ecosystem services? A conceptual framework for multifunctionality in green infrastructure planning for Urban Areas. *Ambio*, 43(4): 516–529. https://doi.org/10.1007/s13280-014-0510-2

Helme, N.A. 2016. SPECIALIST BOTANICAL AND ECOLOGICAL SCOPING PHASE INPUT : PROPOSED TWO RIVERS URBAN PARK DEVELOPMENT FRAMEWORK , CAPE. , (July).

Henning, E., Van Rensburg, W. & Smit, B. 2004. *Finding your way in qualitative research*. Van Schaik. https://books.google.co.za/books/about/Finding_your_way_in_qualitative_research.html?id=6J98AAAAIAAJ&redir_esc=y [26 April 2017].

Heritage, S.N., 2012. 2012. *Green Networks in Development Planning Green Networks and Development Plans*.

Hong, W. & Guo, R. 2017. Indicators for quantitative evaluation of the social services function of urban greenbelt systems: A case study of shenzhen, China. *Ecological Indicators*, 75: 259–267. https://www.sciencedirect.com/science/article/pii/S1470160X1630749X [8 July 2018].

Hoornweg, D. & Pope, K. 2016. Population predictions for the world's largest cities in the 21st century. *Environment and Urbanization*: 095624781666355. http://journals.sagepub.com/doi/10.1177/0956247816663557 [17 March 2017].

Hoornweg, D., Sugar, L. & Trejos Gómez, C.L. 2011. Cities and greenhouse gas emissions: moving forward. *Environment and Urbanization*, 23(1): 207–227. http://eau.sagepub.com/content/23/1/207.abstract%5Cnhttp://eau.sagepub.com/cgi/doi/10.1177/0956247810392270.

Hough, M. 2004. *Cities and Natural Process: A Basis for Sustainability*. Second. London: Routledge.

Hough Michael. 1995. *Cities and Natural Process*. https://books.google.co.za/books?hl=fr&lr=&id=FNqCAgAAQBAJ&oi=fnd&pg=PP1&dq=MICHAEL+HOUGH+1995+CITY+AND+NATURAL+&ots=R5iOzAtHhS&sig=xO9MafKcxyt8MVYuDHb87FYaS0#v=onepage&q= [12 April 2017].

I

ICLEI. 2018. Urban Natural Assets for Africa: Rivers for Life (UNA. *Local Governments for sustainability)*.

IPCC. 2007. *Mitigation of climate change: Contribution of working group III to the fourth assessment report of the Intergovernmental Panel on Climate Change*.

Ives, C.D., Oke, C., Cooke, B., Gordon, A. & Bekessy, S.A. 2014. Planning for green open space in urbanising landscapes. , (October).

J

Jayaraman, T. & Kanitkar, T. 2016. Deepening the Climate Crisis. *COMMENTARY JANUARY EPW Economic & Political Weekly*, 16(3). https://www.researchgate.net/profile/Tejal_Kanitkar/publication/292463857_The_Paris_agreement_Deepening_the_climate_crisis/links/573c01fd08ae298602e45f8c.pdf [2 August 2017].

Joan Fitzgerald. 2010. *Emerald Cities: Urban Sustainability and Economic Development - Joan Fitzgerald - Google Books*. Oxford University Press. https://books.google.co.za/books?hl=en&lr=&id=WpdoAgAAQBAJ&oi=fnd&pg=PR7&dq=Emerald+Cities:+Urban+Sustainability+and+Economic+Development&ots=N_1RsU9G85&sig=CC32ywekvJ_ydkKAIy8QIk9fVF8&redir_esc=y#v=onepage&q&f=false [23 March 2017].

Johnson, C. 2015. Green networks: a solution to the Urban Heat Island effect. , 194: 205–214. http://library.witpress.com/viewpaper.asp?pcode=SC15-019-1.

K

Kaefer, F., Roper, J. & Sinha, P. 2015. A software-assisted qualitative content analysis of news articles: Example and reflections. *Forum Qualitative Sozialforschung*, 16(2).

De Ketele, J.-M. & Roegiers, X. 2015. Méthodologie du recueil d'informations: Fondements des méthodes d'observation, de questionnaire, d'interview et d'étude de documents. https://www.decitre.fr/media/pdf/feuilletage/9/7/8/2/8/0/7/3/9782807300378.pdf [26 April 2017].

Klopp, J.M. & Petretta, D.L. 2017. The urban sustainable development goal: Indicators, complexity

and the politics of measuring cities. *Cities*, 63: 92–97. http://linkinghub.elsevier.com/retrieve/pii/S0264275116303122.

Kong, F., Yin, H., Nakagoshi, N. & Zong, Y. 2010. Urban green space network development for biodiversity conservation: Identification based on graph theory and gravity modeling. *Landscape and Urban Planning*, 95. http://ac.els-cdn.com/S0169204609002333/1-s2.0-S0169204609002333-main.pdf?_tid=19688500-1eba-11e7-bdc1-00000aab0f6b&acdnat=1491917209_82d10441fb1cc8f55a897e99b5487cf0 [11 April 2017].

Kong, F.H., Yin, H.W., James, P., Hutyra, L.R. & He, H.S. 2014. Effects of spatial pattern of greenspace on urban cooling in a large metropolitan area of eastern China. *Landscape and Urban Planning*, 128: 35–47. https://doi.org/10.1016/j.landurbplan.2014.04.018

Konijnendijk, C.C., Annerstedt, M., Nielsen, A.B. & Maruthaveeran, S. 2013. Benefits of Urban Parks - A systematic review. *International Federation of Parks and Recreation Administration*, (January): 1–68.

Kowalewska, A. 2011. Sustainable urban green network concept for the city of Gdynia , Poland. : 1–7.

Kurtas, n.d. S. Research Guides: UN Documentation: Environment: Major Conferences and Reports. http://research.un.org/en/docs/environment/conferences [22 March 2017].

Kwame, O.H. 2014. The state of biodiversity in Ghana: Knowledge gaps and prioritization. *International Journal of Biodiversity and Conservation*, 6(9): 681–701. http://academicjournals.org/journal/IJBC/article-abstract/642B73847885.

L

Lapan, S.D., Quartaroli, M.T. & Riemer, Frances Julia. 2012. *Qualitative research : an introduction to methods and designs*. First Edit. Frances J Riemer, ed. Jossey-Bass.

Leacock Coreen J., C., Warrican S. Joel. & Rose Gerald St. C. 2015. *Research methods for inexperienced researchers : guidelines for investigating the social world*. Kingston: Ian Randle Publishers. http://cput.worldcat.org/title/research-methods-for-inexperienced-researchers-guidelines-for-investigating-the-social-world/oclc/897489771 [24 April 2017].

Lee, Y.C. & Kim, K.H. 2015. Attitudes of citizens towards urban parks and green spaces for urban sustainability: The case of Gyeongsan City, Republic of Korea. *Sustainability (Switzerland)*, 7(7): 8240–8254. https://doi.org/10.3390/su7078240

Leopold, A. 2014. The Land Ethic. In *The Ecological Design and Planning Reader*. Washington, DC: Island Press/Center for Resource Economics: 108–121. http://link.springer.com/10.5822/978-1-61091-491-8_12 [18 April 2017].

Leopold, A.C., Pickett, S.T.A., Ostfeld, R.S., Shachak, M. & Likens, G.E. 1949. The land ethic of Aldo Leopold. *Journal of Forestry*: 5–7. https://doi.org/10.1002/9780470751664.ch14

Lestan, K.A., Eržen, I. & Golobič, M. 2014. The role of open space in urban neighbourhoods for health-related lifestyle. *International Journal of Environmental Research and Public Health*, 11(6): 6547–6570. https://doi.org/10.3390/ijerph110606547

Les services de l'État dans le Gers. 2013. L'importance des zones humides / Eau et biodiversité (jardins, espèces protégées, zones humides, Natura 2000) / Gestion de l'eau / Environnement / Politiques publiques. http://www.gers.gouv.fr/Politiques-publiques/Environnement/Gestion-de-l-

eau/Eau-et-biodiversite-jardins-especes-protegees-zones-humides-Natura-2000/L-importance-des-zones-humides [10 June 2017].

Lisa M. Given. 2008. *The SAGE Encyclopedia of Qualitative Research Method*. http://www.yanchukvladimir.com/docs/Library/Sage Encyclopedia of Qualitative Research Methods- 2008.pdf [19 June 2019].

Liu, K., Siu, K.W.M., Gong, X.Y., Gao, Y. & Lu, D. 2016. Where do networks really work? The effects of the Shenzhen greenway network on supporting physical activities. *Landscape and Urban Planning*, 152: 49–58. http://dx.doi.org/10.1016/j.landurbplan.2016.04.001.

Liu, K., Su, H., Zhang, L., Yang, H., Zhang, R. & Li, X. 2015. Analysis of the Urban Heat Island Effect in Shijiazhuang, China Using Satellite and Airborne Data. *Remote Sensing*, 7(4): 4804–4833. http://www.mdpi.com/2072-4292/7/4/4804/ [3 April 2017].

Lofvenhart, K., Bjorn, C. & Ihse, M. 2002. Biotope patterns in urban areas: a conceptyual model integrating biodiversity issues in spatial planning. *Landscape and Urban Planning*, 58(2–4): 223–240.

Loh, J., Goldfinger, S., Bourne, G., Atkin, M., Mcrae, L., Ewing, B., Moran, D. & Backer, W. De. 2008. Living Planet Report 2008. *Apollo The International Magazine Of Art And Antiques*: 45. https://doi.org/10.1080/09528820802312343

Low, N., Gleeson, B., Green, R. & Radovic, D. 2005. *The Green City: Sustainable Homes, Sustainable Suburbs*. UNSW Press. http://www.loc.gov/catdir/toc/ecip055/2004029443.html.

Luber, G. & McGeehin, M. 2008. Climate Change and Extreme Heat Events. *American Journal of Preventive Medicine*, 35(5): 429–435. http://www.sciencedirect.com/science/article/pii/S0749379708006867 [3 April 2017].

Luo, Z., Tang, S., Jiang, Z., Chen, J., Fang, H. & Li, C. 2016. Conservation of Terrestrial Vertebrates in a Global Hotspot of Karst Area in Southwestern China. *Scientific Reports*, 6(May): 1–12. http://dx.doi.org/10.1038/srep25717.

M

MAA & ARCON. 2016. TWO RIVERS URBAN PARK CAPE TOWN BASELINE HERITAGE STUDY. , (October).

Madell, CV. 2013. "*The State of Planning in Africa. An Overview*". African Planning Association. Giz, UN-Habitat. HS Number: HS/010/14E. UN-Habitat Publication. HS Number: HS/010/14E.

Madell, CV. Chapter 6, 2012. "Striving towards sustainable development through a mosaic of land use patches and corridors": Hangzhou, China" and "Commitment to biodiversity and ecosystem habitats: Zagreb, Croatia". In UN-Habitat. 2012. *"Urban Patterns for a Green Economy. Working with Nature"* ISSN/ISBN Number 978-92-1-133398-5. Editor Victoria Quintan. Publisher UNON Publishing Services. ISBN (Volume) 978-92-1-132462-4.

McHarg, I. L. (1969). *Design with nature*. *Design*. https://doi.org/10.1111/j.1399-0004.2010.01592.x

Mackey, C.W., Lee, X. & Smith, R.B. 2012. Remotely sensing the cooling effects of city scale efforts to reduce urban heat island. *Building and Environment*, 49: 348–358. http://www.sciencedirect.com/science/article/pii/S0360132311002472 [3 April 2017].

Mader, A. 2010. Local Action for Biodiversity, an ICLEI and IUCN Program.

Magdelaine, C. 2014. L'îlot de chaleur urbain - notre-planete.info. *03/10/2014*. https://www.notre-planete.info/terre/climatologie_meteo/ilot-chaleur-urbain.php# [3 April 2017].

Maine-et-Loire, S.E. 2017. La définition du développement durable. http://www.maine-et-loire.gouv.fr/la-definition-du-developpement-durable-r179.html [22 March 2017].

Malek, N.A., Mariapan, M., Shariff, M.K.M., Aziz, A. 2008. Assessing the Quality of Green Open Spaces: A review. : 1–16.

Marshall, R.E. & Farahbakhsh, K. 2013. Systems approaches to integrated solid waste management in developing countries. *Waste Management*, 33(4): 988–1003. http://dx.doi.org/10.1016/j.wasman.2012.12.023.

Matthew McConnachie, M., Shackleton, C.M. & McGregor, G.K. 2008. The extent of public green space and alien plant species in 10 small towns of the Sub-Tropical Thicket Biome, South Africa. *Urban Forestry and Urban Greening*, 7(1): 1–13.

McConnachie, M.M., Shackleton, C.. & McGregor, G.K. 2008. The extent of public green space and alien plant species in 10 small towns of the Sub-Tropical Thicket Biome, South Africa. *Urban forestry & urban greening, 7(1), 1-13.*, (5): 916–921.

McHarg, I.L. 1969. *Design with nature*. http://www.ncbi.nlm.nih.gov/pubmed/21156334.

Mcmichael, A.J. 2000. The urban environment and health in a world of increasing globalization : issues for developing countries. , 78(00).

McPhearson, T., Pickett, S.T.A., Grimm, N.B., Niemelä, J., Alberti, M., Elmqvist, T., Weber, C., Haase, D., Breuste, J. & Qureshi, S. 2016. Advancing Urban Ecology toward a Science of Cities. *BioScience*, 66(3): 198–212. https://doi.org/10.1093/biosci/biw002

Meisel, F. & Thiele, N. 2014. Where to dispose of urban green waste? Transportation planning for the maintenance of public green spaces. *Transportation Research Part A: Policy and Practice*, 64: 147–162. http://dx.doi.org/10.1016/j.tra.2014.03.012.

Mell, I.C. 2009. Can green infrastructure promote urban sustainability? *Proceedings of the ICE - Engineering Sustainability*, 162(March): 23–34. https://doi.org/10.1680/ensu.2009.162.1.23

Mell, I.C., Henneberry, J., Hehl-Lange, S. & Keskin, B. 2013. Promoting urban greening: Valuing the development of green infrastructure investments in the urban core of Manchester, UK. *Urban Forestry and Urban Greening*, 12(3). https://doi.org/10.1016/j.ufug.2013.04.006

Mensah, C.A. 2014. Urban green spaces in Africa: Nature and challenges. *International Journal of Ecosystem*, 4(1): 1–11. https://doi.org/10.5923/j.ije.20140401.01

Moseley, D., Marzano, M., Chetcuti, J. & Watts, K. 2013. Landscape and Urban Planning Green networks for people : Application of a functional approach to support the planning and management of greenspace. *Landscape and Urban Planning*, 116: 1–12. http://dx.doi.org/10.1016/j.landurbplan.2013.04.004.

Mumford, L. 1937. What is a City? *Architectual Record*: 59–62.

N

Na Xiu, Maria, I. & Bosch., C.K. van den. 2016. The Challenges of Planning and Designing Urban Green Networks in Scandinavian and Chinese Cities. *Journal of Architecture and Urbanism*, Volume: 40(25 Sep 2016): pp 163-176.

National Planning Commission. 2009. *National Development Plan*. https://doi.org/ISBN:978-0-621-41180-5

Ngo, H.T., Estrada, Y.O., Design, G., Percival, R., Design, R., Haas, M., Design, M.H., Lyon, S. & Soul, S. 2017. *THE ASSESSMENT REPORT ON POLLINATORS, POLLINATION AND FOOD PRODUCTION OF THE INTERGOVERNMENTAL SCIENCE-POLICY PLATFORM ON BIODIVERSITY AND ECOSYSTEM SERVICES Technical Support Photo credits*. www.ipbes.net [6 July 2019].

Niemelä, J. 2014. Ecology of urban green spaces: The way forward in answering major research questions. *Landscape and Urban Planning*, 125: 298–303. http://dx.doi.org/10.1016/j.landurbplan.2013.07.014.

Noss, R. 2004. Can urban areas have ecological integrity? *Proceedings of the 4th International Urban Wildlife Symposium*: 3–8. http://cals.arizona.edu/pubs/adjunct/snr0704/snr07041a.pdf.

O

Odum, E.P. & Barrett, G.W. 1971. Fundamentals of Ecology. Volume 3. *Thomson, Brooks/Cole*.

Okpala, D. 2009. Regional Overview of the Status of Urban Planning and Planning Practice in Anglophone (Sub-Saharan) African Countries.

Oliveira, S., Andrade, H. & Vaz, T. 2011. The cooling effect of green spaces as a contribution to the mitigation of urban heat: A case study in Lisbon. *Building and Environment*, 46(11): 2186–2194. http://www.sciencedirect.com/science/article/pii/S0360132311001363 [3 April 2017].

P

Pagano, T.C. & Sorooshian, S. 2014. Hydrologic cycle Thomas Pagano and Soroosh Sorooshian Dr Michael C MacCracken and Dr John S Perry Editor-in-Chief. , (May).

Palinkas, L.A., Horwitz, S.M., Green, C.A., Wisdom, J.P., Duan, N., Hoagwood, K., Author Lawrence Palinkas, C.A. & Lomas Feldman Professor of Social Policy, F. 2015. Purposeful sampling for qualitative data collection and analysis in mixed method implementation research HHS Public Access. *Adm Policy Ment Health*, 42(5): 533–544.

Pallemaerts, M. 2003. Is Multilateralism the Future ? Sustainable Development or Globalisation as ' A ... *Sustainable Development*: 1–2.

Paredis, E. 2011. *Sustainability transitions and the nature of technology*. Foundations of Science (Vol. 16). https://doi.org/10.1007/s10699-010-9197-4

Park, K.J., Mochar, F. & Fuentes-montemayor, E. 2012. Urban Biodiversity : Successes and Challenges : Bat activity in urban green space. , 25(online).

Park[1], K.J., Mochar[2], F. & Fuentes-Montemayor, E. 2012. Urban Biodiversity: Successes and Challenges: Bat activity in urban green space. *The Glasgow Naturalist Urban Biodiversity: Successes and Challenges*, 25(4).

Patton, M. Q. 1990. Patton, M.Q. 1990. *Qualitative evaluation and research methods (2nd ed.).* Newbury Park, SAGE Publishers. https://doi.org/10.1002/nur.4770140111

Patton, M. Q. 2002. *Qualitative Evaluation and Research Methods.* https://doi.org/10.1002/nur.4770140111

Parnell, S. 2016. Defining a Global Urban Development Agenda. *World Development*, 78: 529–540. https://doi.org/10.1016/j.worlddev.2015.10.028

Peng, Y., Qian, J., Ren, F., Zhang, W. & Du, Q. 2016. Sustainability of land use promoted by construction-to-ecological land conversion: A case study of Shenzhen City, China. *Sustainability (Switzerland)*, 8(7). https://doi.org/10.3390/su8070671

Phillippi, J. & Lauderdale, J. 2018. A Guide to Field Notes for Qualitative Research: Context and Conversation. *Qualitative Health Research*. https://doi.org/10.1177/1049732317697102

Pieterse, E., Parnell, S. & Haysom, G. 2018. African dreams: locating urban infrastructure in the 2030 sustainable developmental agenda. *Area Development and Policy*, 00(00): 1–21. https://www.tandfonline.com/doi/full/10.1080/23792949.2018.1428111.

Planète Sciences. 2003. Définition d'un ecosystème. http://www.planete-sciences.org/enviro/archives/rnste6/ateliers/ecosystemes/ecosystemes.htm [5 June 2017].

Pugh Cedric. 2013. *Sustainable Cities in Developing Countries - Cedric Pugh - Google Books*. https://books.google.co.za/books?hl=en&lr=&id=5DVdAgAAQBAJ&oi=fnd&pg=PP1&dq=sustainable+cities+in+developing+countries+cedric+pugh&ots=crPmviZ_yI&sig=2tKrCleozpeXgukxzllnrFshbRU#v=onepage&q= [20 March 2017].

R

Ritchie, J. & Lewis, J. 2014. Qualitative Research Practice: A Guide for Social Science Students and Researchers. *Qualitative Research*: 356. http://books.google.co.uk/books?id=e6EO83ZKGYoC.

Roberts, D. 2010. Prioritizing climate change adaptation and local level resilience in Durban, South Africa. *Environment and Urbanization*, 22(2): 397–413. http://journals.sagepub.com/doi/10.1177/0956247810379948 [4 April 2017].

Ryan. 2009. *Making visible the coding process: Using qualitative data software in a poststructural study*. https://eprints.qut.edu.au/26768/1/26768.pdf [13 June 2019].

S.T.A. Pickett. 2015. Urban ecosystem. *Encyclopædia Britannica, inc.* https://www.britannica.com/science/urban-ecosystem [11 July 2019].

S

Saillard, E.K. 2011. FORUM : QUALITATIVE SOCIAL RESEARCH Systematic Versus Interpretive Analysis with Two CAQDAS Packages : NVivo and MAXQDA. *Forum Qualitative Sozialforschung / Forum: Qualitative Social Research*, 12(1).

SANBI. 2013. Ecological infrastructure provides cost effective, long-term solutions to service delivery. http://biodiversityadvisor.sanbi.org/wp-content/uploads/2014/07/2013_Ecological-infrastructure-factsheet.pdf [2 August 2017].

Sandstro¨m, U.G. 2002. Green Infrastructure Planning in Urban Sweden. *Planning Practice and*

Research, 17(4): 373–385. http://www.tandfonline.com/doi/abs/10.1080/02697450216356 [16 March 2017].

Satterthwaite, D. 2007. *Adapting to climate change in urban areas: the possibilities and constraints in low-and middle-income nations*. https://books.google.co.za/books?hl=en&lr=&id=d1nWyVjHWTIC&oi=fnd&pg=PR6&dq=Satterthwaite+D,+Huq+S,+Pelling+M,+Reid+A,+Romero-+Lankao+P.+2007.+Adapting+to+climate+change+in+urban+areas:+the+possibilities+and+constraints+in+low-+and+middle-income+nations.+London+(UK):+IIED,+Human+Settlements+Discussion+Paper+Series+–+Climate+Chan&ots=nMo91Sxl4f&sig=wQ8CuPuTa8-nK455kOhxNhHgPUI [22 March 2017].

Satterthwaite, D. 2017. Will Africa have most of the world's largest cities in 2100? *Environment and Urbanization*: 095624781668471. http://journals.sagepub.com/doi/10.1177/0956247816684711.

Saunders, M., Lewis, P. & Thornhill, A. 2009. *Research Methods for Business Students*. https://doi.org/10.1007/s13398-014-0173-7.2

Schäffler, A. & Swilling, M. 2013. Valuing green infrastructure in an urban environment under pressure - The Johannesburg case. *Ecological Economics*, 86: 246–257.

Schurink, W.J. 2003. Qualitative Research In Management And Organisational Studies With Reference To Recent South African Research. *SA Journal of Human Resource Management*. https://doi.org/10.4102/sajhrm.v1i3.25

Scott, M., Lennon, M., Haase, D., Kazmierczak, A., Clabby, G. & Beatley, T. 2016. Nature-based solutions for the contemporary city/Re-naturing the city/Reflections on urban landscapes, ecosystems services and nature-based solutions in cities/Multifunctional green infrastructure and climate change adaptation: brownfield greening as an a. *Planning Theory and Practice*, 17(2): 267–300. http://dx.doi.org/10.1080/14649357.2016.1158907.

Shackleford Hayley. Finding Answers in the Ambiguity of "The Land Ethic" – The Morningside Review. https://morningsidereview.org/essay/finding-answers-in-the-ambiguity-of-the-land-ethic/ [18 April 2017].

Shackleton, C.M., Blair, A., De Lacy, P., Kaoma, H., Mugwagwa, N., Dalu, M.T. & Walton, W. 2015. How important is green infrastructure in small and medium-sized towns? Lessons from South Africa. *Landscape and Urban Planning*, (January): 10–12. https://doi.org/10.1016/j.landurbplan.2016.12.007

Shen, L.-Y., Ochoa, J.J., Shah, M.N. & Zhang, X. 2011. The application of urban sustainability indicators e A comparison between various practices. *Habitat International*, 35: 17–29. http://colbun.utalca.cl/redcauquenes/Papers/aplication [7 April 2017].

Shinn, D.H. 2016. The Environmental Impact of China' s Investment in Africa. , 49(1): 1–44. da Silva, J., Kernaghan, S. & Luque, A. 2012. A systems approach to meeting the challenges of urban climate change. *International Journal of Urban Sustainable Development*, 3138(May 2014): 1–21.

Spangenberg, J.H., Pfahl, S. & Deller, K. 2002. Towards indicators for institutional sustainability: Lessons from an analysis of Agenda 21. *Ecological Indicators*, 2(1–2): 61–77. https://doi.org/10.1016/S1470-160X(02)00050-X

Spencer, C. & Blades, M. 2006. Children and their Environments Learning , Using and Designing Spaces. *Children*, (1989): XIV, 279 S. http://www.gbv.de/dms/bs/toc/490279139.pdf.

SPLUMA. 2013. Act No. 16 of 2013: *Spatial Planning and Land Use Management Act, 2013., (16),* 37. https://doi.org/102GOU/B

Stanley, B.W., Stark, B.L., Johnston, K.L. & Smith, M.E. 2012. Urban Open Spaces in Historical Perspective: A Transdisciplinary Typology and Analysis. *Urban Geography*, 33(8): 1089–1117. http://www.tandfonline.com/doi/abs/10.2747/0272-3638.33.8.1089.

Stanway, D. 2018. China needs 'extraordinary measures' to revitalize countryside: minister | Reuters. *Reuters*. https://www.reuters.com/article/us-china-agriculture/china-needs-extraordinary-measures-to-revitalize-countryside-minister-idUSKBN1HH01Z [8 July 2018].

S.T.A. Pickett. 2015. Urban ecosystem. https://www.britannica.com/science/urban-ecosystem [July 11 2019]

Stone Jr, B., Vargo, J., Liu, P., Habeeb, D., Delucia, A., Trail, M., Hu, Y. & Russell, A. 2014. Avoided Heat-Related Mortality through Climate Adaptation Strategies in Three US Cities. http://www.urbanclimate.gatech.edu/pubs/Stone_2014.pdf [3 April 2017].

Susca, T., Gaffin, S.R. & Dell'Osso, G.R. 2011. Positive effects of vegetation: Urban heat island and green roofs. *Environmental Pollution*, 159(8): 2119–2126. http://www.sciencedirect.com/science/article/pii/S0269749111001539 [3 April 2017].

Sustainable development goals - United Nations. n.d.. Retrieved, from http://www.un.org/sustainabledevelopment/sustainable-development-goals/Svinicki [16 March 2017]

Svinicki, M.D. 2010. A Guidebook On Conceptual Frameworks For Research In Engineering Education.

T

Thanasegaran, G. 2009. Reliability and validity issues in research . , (Integration & Dissemination 4.1): 35–40. http://aupc.info/wp-content/uploads/35-40-ganesh.pdf [24 April 2017].

Tzoulas, K., Korpela, K., Venn, S., Yli-pelkonen, V., Ka, A., Niemela, J. & James, P. 2007. Promoting ecosystem and human health in urban areas using Green Infrastructure : A literature review. , 81: 167–178. https://doi.org/10.1016/j.landurbplan.2007.02.001

U

UN-Habitat. 2014. *The State of African Cities 2014: Re-imagining sustainable urban transitions*. Nairobi & K. UNHABITAT., eds. http://www.eurekaselect.com/52219/volume/1.

UN-Habitat. 2012. *URBAN PATTERNS FOR A GREEN A GREEN ECONOMY*. Department of Economic and Social Affairs. https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.Pdf

UN-Habitat & Africa Planning Association. 2013. The State of Planning in Africa: An Overview. : 36.

UN. 2014. Department of Economic and Social Affairs. https://esa.un.org/unpd/wup/publications/files/wup2014-highlights.Pdf [4 April 2017].

UNEP. 2016. The St*ate of Biodiversity in Africa: A mid-term review of progress towards the AICHI Biodiversity targets.* WCMC, Cambridge, United Kingdom.

UNEP. 2002. STATE OF THE ENVIRONMENT AND POLICY RETROSPECTIVE: 1972–2002. *ReVision*: 240–269.

United Nations, Department of Economic and Social Affairs, P.D. 2014. World Urbanization Prospects. *United Nations*, 12: 32. https://doi.org/10.4054/DemRes.2005.12.9

United Nations. 2012. Resilient people, resilient planet: a future worth choosing. , New York:(Secretary-General's High-level Panel on Global Sustainability.). http://en.unesco.org/system/files/GSP_Report_web_final.pdf [4 May 2017].

United nations. 2016. The Sustainable Development Goals Report. https://unstats.un.org/sdgs/report/2016/ [18 March 2017].

United Nations.n.d. United Nations. http://www.un.org/en/ [22 March 2017].

US EPA, O. Why are wetlands important? https://www.epa.gov/wetlands/why-are-wetlands-important [10 June 2017].

W

Wackernagel, M., Moore, D., Galli, A., Zokai, G., Sereke, F., Lazarus, E., … Potvin, J. (n.d.). *ATLAS DE L'EMPREINTE ÉCOLOGIQUE ET DE LA BIO CAPACITÉ DES PAYS MEMBRES DE LA FRANCOPHONIE*. Retrieved from https://www.francophonie.org/IMG/pdf/571_atlas_empreinte_ecolo_franc_fr_web.pdf

WCED. 1987. Our Common Future: Report of the World Commission on Environment and Development. *Medicine, Conflict and Survival*, 4(1): 300. https://doi.org/10.1080/07488008808408783

Wetlands and Ecosystem Services. 2015. www.cbd.int

Weiss, R.S. 1994. *Learning from strangers : the art and method of qualitative interview studies*. Free Press. https://books.google.co.za/books/about/Learning_from_Strangers.html?id=SLm6AAAAIAAJ&redir_esc=y [26 April 2017].

Welsh, E. 2002. Dealing with Data: Using NVivo in the Qualitative Data Analysis Process | Welsh | Forum Qualitative Sozialforschung / Forum: Qualitative Social Rese... *Analysis*, 3(2).

Western Cape Government. Two Rivers Urban Park – Towards a sustainable integrated urban development | Western Cape Government. https://www.westerncape.gov.za/general-publication/two-rivers-urban-park-–-towards-sustainable-integrated-urban-development [28 April 2017].

Wolch, J.R., Byrne, J. & Newell, J.P. 2014. Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. *Landscape and Urban Planning*, 125: 234–244. http://dx.doi.org/10.1016/j.landurbplan.2014.01.017.

Worcester Polytechnic Institute. 2011. Black River Corridor : Visions for Restoration and Recreational Use.

X

Xiu, N., Ignatieva, M., van den Bosch, C.K., Chai, Y., Wang, F., Cui, T. & Yang, F. 2017. A socio-ecological perspective of urban green networks: the Stockholm case. *Urban Ecosystems*.

http://link.springer.com/10.1007/s11252-017-0648-3.

Y

Yin, R.K. 2003. Case study methodology R.K. Yin (2003, 3rd edition). Case Study Research design and methods. Sage, Thousand Oaks (CA).. In *Case Study Research: design and methods*. 19–39; 96–106.

Yin, R.K. 2009. *Case study research : design and methods / Robert K. Yin*. Applied social research methods series: 5. http://search.ebscohost.com/login.aspx?direct=true&db=cat00012a&AN=bourne.546123&site=eds-live&scope=site%5Cnhttp://search.ebscohost.com/login.aspx?direct=true&db=cat00012a&AN=bourne.820630&site=eds-live&scope=site%5Cnhttp://search.ebscohost.com/login.asp.

Yin, R.K. 2014. *Case Study Research: Design and Methods*.(Fifth edit. Vol. 26). https://doi.org/10.1097/FCH.0b013e31822dda9e

Yin, R.K. 2006. Mixed Methods Research: Are the Methods Genuinely Integrated or Merely Parallel? *RESEARCH IN THE SCHOOLS*, Vol. 13, N(Mid-South Educational Research Association): 41–47.

Yuan, F. & Bauer, M.E. 2007. Comparison of impervious surface area and normalized difference vegetation index as indicators of surface urban heat island effects in Landsat imagery. *Remote Sensing of Environment*, 106(3): 375–386. http://www.sciencedirect.com/science/article/pii/S0034425706003191 [3 April 2017].

Z

Zaman, A.U. & Lehmann, S. 2013. The zero waste index: A performance measurement tool for waste management systems in a ‘zero waste city’. *Journal of Cleaner Production*, 50: 123–132. http://dx.doi.org/10.1016/j.jclepro.2012.11.041.

APPENDIX A: RESEARCH APPROVAL FROM THE CITY OF CAPE TOWN

CITY OF CAPE TOWN
ISIXEKO SASEKAPA
STAD KAAPSTAD

Date: 26 April 2019
To: DIRECTOR: ORGANISATIONAL POLICY & PLANNING
Ref: OPPRR-0103

Research Approval Request

In terms of the City of Cape Town System of Delegations (March 2019) - Part 29, No 1 Subsection 4, 5 and 6 "Research:

(4) To consider any request for the commissioning of an organizational wide research report in the City and to approve or refuse such a request.

(5) To grant authority to external parties that wish to conduct research within the City of Cape Town and publish the results thereof.

(6) To after consultation with the relevant Executive Director: grant permission to employees of the City of Cape Town to conduct research, surveys etc. related to their studies, within the relevant directorate.

The Director: Organisational Policy & Planning is hereby requested to consider, in terms of sub-section 5, the request received from

Name	: Faubert Souza
Designation	: Master's Degree student
Affiliation	: The Department of Town and Regional Planning at the Cape Peninsula University of Technology (CPUT)
Research Title	: Green networks for sustainable development in African cities: A case study of the Two Rivers Urban Park (TRUP), Cape Town, South Africa

Taking into account the recommendations below (see Annexure for detailed review):

Recommendations

That the CCT via the Director: Organisational Policy & Planning grant permission to Faubert Souza, in her capacity as is a Masters (MTech) student in the Department of Town and Regional Planning at the Cape Peninsula University of Technology (CPUT), to conduct research in the City of Cape Town subject to the following conditions:

- Interview with one City official (Mr. Ben de Wet), as identified by DWS only;
- Participation be on a voluntary basis;
- Interviews not exceed one hour and no more than one interview with the identified official/s be conducted;
- Anonymity of the City official/s interviewed;
- Clear acknowledgement in the report that the views of the CCT officials are not regarded as official CCT policy;
- No publication of the research without prior written consent from the City of Cape Town; and
- Submission of the completed research to the Director: Organisational Policy & Planning, the Director: Water & Sanitation and Manager: Research –Organisational Policy & Planning, within 3 months of completion.

Delegated authority:

Approved ☑ Comment: _____

Not Approved ☐ Comment: _____

Hugh Cole: Director: Organisational Policy & Planning:

Date: 2/5/2019

Acceptance by Applicant:

I FAUBERT SOUZA confirm that I agree to abide by the conditions as stipulated above.

Applicant: MJC FAUBERT SOUZA

Date: 03/05/2019

CCT departments: No interviews or data to be provided unless acceptance of the conditions under which the research permission is granted.

Kindly return signed copy to Jameyah.armien@capetown.gov.za

CIVIC CENTRE IZIKO LEENKONZO ZOLUNTU BURGERSENTRUM
12 HERTZOG BOULEVARD CAPE TOWN 8001 PRIVATE BAG X9181 CAPE TOWN 8000
www.capetown.gov.za

Making progress possible. Together.

APPENDIX B: ETHICS CONSENT FORM

Cape Peninsula
University of Technology

Research Title	*Green Networks for sustainable development in African cities: A case study of the Two Rivers Urban Park, Cape Town, South Africa.*
Research Investigator	Marie Faubert Souza

CONSENT TO TAKE PART IN RESEARCH

Thank you for agreeing to be interviewed as part of the above research project. This consent form is necessary for us to ensure that you understand the purpose of your involvement and that you agree to the conditions of your participation. Kindly read the information sheet and sign this form to certify that you approve the following:

I..... voluntarily agree to participate in this research study.

- I understand that even if I agree to participate now, I can withdraw at any time or refuse to answer any question without any consequences of any kind.
- I have had the purpose and nature of the study explained to me in writing and I have had the opportunity to ask questions about the study.
- I understand that I will not benefit directly from participating in this research. I agree to my interview being audio-recorded.
- I understand that all information I provide for this study will be treated confidentially.
- I understand that in any report on the results of this research my identity will remain anonymous.
- This will be done by changing my name and disguising any details of my interview which may reveal my identity or the identity of people I speak about.
- I understand that disguised extracts from my interview may be quoted in a dissertation and/or relevant conference presentations of published papers.
- I understand that signed consent forms and original audio recordings will be retained in secured location at the researcher's place of residence and only the researcher and supervisors of this research will have access to the data.
- I understand that I am free to contact any of the people involved in the research to seek further clarification and information.

Signature of research participant

Date

Signature of researcher

Date

APPENDIX C: INTERVIEW QUESTIONNAIRE GUIDE

GREEN NETWORKS FOR SUSTAINABLE DEVELOPMENT IN AFRICAN CITIES:
A CASE STUDY OF THE TWO RIVERS URBAN PARK (TRUP), CAPE TOWN, SOUTH AFRICA.

The following Interview Questionnaire Guide has been developed for administering research participants and to obtain detailed information on their knowledge and experiences on the subject.

Main Research Question:
How can green networks contribute to sustainable urban development in African cities?

Interrelated Research sub questions:

a) What are the functional elements of natural ecosystems such as water, plant, wildlife, climate etc. and how relevant are these for green networks in cities?
b) What are the functional components of urban green networks and how can these be integrated and emulate natural ecosystems?

Target Interviewees: Environmentalists and natural environmental practitioners, urban planners, engineers, NGOs & CBOs, public sector officials, developers, etc.

QUESTIONNAIRE
1. What are your thoughts on the green open space provided in TRUP?
2. What is the ecological role of natural vegetation such as trees and plants in urban parks? **2.1.** What are your thoughts on the benefits of greenery for TRUP within the context of the broader ecology?
3. How critical is the role of Wildlife in the development of urban green networks and why?
4. It is believed that water plays a crucial role for natural ecosystems. Please indicate whether or not you agree with this premise and elaborate on your position in relation to the role of TRUP in achieving this objective.
5. We know that agriculture is one source of urban systems which provides food. What is the required level of agriculture for the development of urban systems and what potential exists for TRUP?
6. What are the opportunities and constraints to the sustainable development of the TRUP area?
7. What are your views of the different development proposals for TRUP, would this result in further separating the natural environment from human development?
8. Pollution is no doubt hazardous for human beings. What are your concerns regarding waste management in the TRUP?
9. What is your view on the impact of climate on large urban areas such as TRUP? **9.1.** How can adaptation to climate change be enabled and the impact mitigated?
10. Could you indicate whether you believe that the river is an asset to this site? **10.1.** How can water help to enhance the green networks?
11. How does the Black River differ from the Liesbeek River in terms of their functionality as urban and ecological systems?
12. In your opinion, indicate if you believe that the proposed spatial development proposals for TRUP would enhance or curtail the function of natural systems?
13. How can urban and natural systems be brought together in this site in order to be inclusive in a harmonious manner? **13.1.** What are the different ways to connect the TRUP entire area?
14. What measures can be done to rehabilitate the Black River and the Liesbeek River?
15. Please elaborate if you believe that the TRUP project can respond to the South African National Development Plan 2030 and contribute to the United Nations Sustainable development goals.

APPENDIX D: LIST OF RESPONDENTS

RESPONDENT 1: Architecture & Planning Professional

RESPONDENT 2: Environmental Sustainability

RESPONDENT 3: Resilience Specialist

RESPONDENT 4: Environmentalist and Natural Environmental Practitioner

RESPONDENT 5: Environmental Organisation: Friends of Liesbeek

RESPONDENT 6: Urban Planner

RESPONDENT 7: Water and Sanitation Specialist

RESPONDENT 8: City Councillor

RESPONDENT 9: Environmental Planner

RESPONDENT 10: TRUP Association & Observatory Civic Association