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Sustainable Futures in Southern Africa's Mountains

Multiple Perspectives on an Emerging City

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Foreword by Francis Petersen and Martin Mandew

The University of the Free State (UFS) has come a long way since its establishment 117 years ago. During this period the University has, in the face of many challenges, continuously renewed itself, effectively adapting to and exerting influence on its internal and external environments. The University is now a multi-campus institution consisting of three sites of delivery, namely the Bloemfontein Campus, the South Campus (also located in Bloemfontein), and the QwaQwa Campus. Our theme for the next five years is *Towards a more inclusive, diverse, and engaged university driven by impact and visibility*.

Public universities are social institutions located within intersecting contexts that influence and shape how they function, develop and impact society. They exert influence on these contexts. Therefore, particular care must be taken to understand how these various and complex contexts are changing and to acknowledge the multiple ways universities may interact with them.

The University of the Free State has embarked on developing a response that will impact society positively. The United Nations' Sustainable Development Goals (SDGs) as encapsulated in the *United Nations' Transforming Our World: The 2030 Agenda for Sustainable Development* form the basis of this response. Broadly speaking, the SDGs aim to end poverty, protect the planet, foster social equity and ensure health and prosperity for all. The University's response will incorporate operations in terms of green sustainable campuses, the Academic Project in terms of quality education, research and engaged scholarship, and strategic partnerships with government, communities, and different sectors of the economy. It is most gratifying and befitting therefore that the Qwaqwa campus, under the auspices of the Afromontane Research Unit (ARU), is responding to the theme and focus of the University by spearheading and facilitating the publication of this very important book on Phuthaditjhaba as the city constitutes the primary and immediate context for the campus.

Uniqwa a contraction of 'University of Qwaqwa' is a term still used by locals to refer to the Qwaqwa campus of the University of the Free State. *Uniqwa* denotes the sense in which locals have a deep sense of ownership of the campus. It also indicates a sense in which the campus forms an integral part of QwaQwa in general and Phuthaditjhaba in particular. *Uniqwa* is not just a name—it is also a term of endearment. The area of QwaQwa, in which the city of Phuthaditjhaba is located, was given 'self-governing' status in 1971 under the 'separate development' policy of the apartheid government.

In terms of this policy, the area was designated a 'homeland' for the Southern-Sotho speaking groups.

The campus was established in 1982 as a satellite of the historically black University of the North (UNIN), now the University of Limpopo, situated 700km away. The campus was initially located at Tseki village and moved to its current location at Blue Gum Bush in 1988. The campus was initially conceived to be a polytechnic type of university offering both academic and technical training. When it became clear that no university in South Africa was, at the time, allowed to offer technical courses, the founders settled on UNIN offering academic degrees and diplomas at the satellite.

The campus was incorporated into the University of the Free State in 2003. The campus has come a long way since its humble beginnings as a satellite of the University of the North with 228 students in 1982. It now has a student population in excess of 7,000. Also, the campus is no longer conceptualised, viewed or managed as a satellite but rather as another site of delivery in a multi-campus institution. There has also been a concerted expansion of infrastructure and facilities on the campus since its incorporation into the University of the Free State to ensure equity across all three sites of delivery. Going hand in hand with this has been a refocusing and a repurposing of the academic project on the QwaQwa campus under the current leadership of the University. Key in this regard has been the objective to grow the postgraduate offerings and research output of the campus. The establishment of the Afromontane Research Unit (ARU) on the campus in 2015 as a differentiating feature of the University of the Free State within the higher education landscape in South Africa and on the African continent has been a key development towards the realisation of this strategic objective. The ARU has made great strides bringing to fruition a variety of local and international partnerships and collaborative projects.

It is worth mentioning the projects of the ARU that speak to the SDGs. The United Kingdom's and United States of America's University Staff Development Programmes provide opportunities for staff to undertake Ph.D. studies that are related to the sustainable development of Phuthaditjhaba. The Risk and Vulnerability Science Centre (RVSC) programme, comprised of individual projects, has a specific focus on the sustainable development of Phuthaditjhaba. The Japan-UFS-QwaQwa programme focusses on job creation through entrepreneurship and migration reversal in QwaQwa.

The University of the Free State appreciates the very beneficial and mutually valued relationship with United Nations University Institute for Environment and Human Security (UNU-EHS, Germany) and Eurac Research (Italy), together driving the Global Mountain Safeguard Research (GLOMOS) Programme. This is the first major output from this collaboration with the ARU. The 17 SDGs are a very ambitious project and can only be realised if all sectors of society, including universities, put shoulder to the wheel.

The future of the QwaQwa campus is inextricably bound to the future of Phuthaditjhaba and vice versa. The publication of this book is most welcome as it comes at a critical time and at an opportune moment as the University executes its theme of Visibility and Impact. We believe that practitioners,

lecturers, researchers, students and policy-makers will find this publication informative, challenging, illuminating, practical and not least of all, an enjoyable read.

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Foreword by Ntate Thaele Pule Thaele

In 1948, the National Party (NP) ascended to power and introduced apartheid ideology. Through this ideology, the incumbent government enforced separate development along racial and ethnic lines. Against this backdrop, in 1970 and 1971 the NP government promulgated the Bantu Homeland Citizenship Act and the Bantu Homeland Constitution Act, respectively. These laws established QwaQwa, a homeland designed to accommodate the Basotho ethnic group outside 'White' South Africa. Unlike other homelands across the country, QwaQwa, located in the eastern Free State, was the only homeland within South Africa which was under the tutelage of two Royal Houses: Bakoena ba Mopeli and Batlokoa ba Mota. Currently, QwaQwa is part of Maluti-a-Phofung municipality, with Phuthaditjhaba as the capital in the eastern part of Free State, almost equidistant from the cities of Durban, Johannesburg and Bloemfontein.

In QwaQwa, we were blessed with capable and visionary founding forebearers who laid a solid foundation that have stood the test of time. A lack of academic qualifications did not disadvantage our late founding great leaders whose unique visions, passion and commitment to quality development of our nation and their territory set them apart. Thanks to their work, Phuthaditjhaba was developed into an centre of education. We therefore honour our Marena—paramount chiefs—from Bakoena ba Mopeli and Batlokoa ba Mota Royal Houses. They were the leaders who embodied Botho and Ubuntu values of wisdom, integrity, honesty and humility. Through their hard work and charity, their magnanimous and ethical behaviour, they achieved great goals based on these shared values. Their work was always driven by our culture, our heritage and our motto *Unity is Strength*; they embraced all people regardless of tribe, language, race, gender or religion.

Today, QwaQwa inhabitants stand together with the citizens of the Free State Province, neighbouring provinces, as well as Lesotho to express their gratitude to all Royal Houses, including Bakholokoe and Amandebele, the first groups to settle in the area today known as QwaQwa. We thank them for their role in providing the land on which QwaQwa's infrastructure and developments were built: from our local university campus, throughout Phuthaditjhaba and every village up until the Sentinel Peak of Mont-aux-Sources... We will forever be indebted to them for our magnificent structures and monuments!

In closing, all our Queens and Kings heartily thank everyone who contributed to this noble project of a book on Phuthaditjhaba, by the Afromontane Research Unit (ARU) of the University of the Free State and the Global Mountain Safeguard Research Programme (GLOMOS) of the United Nations University and Eurac Research. We hope that this book will spark further research that can drive sustainable futures for our beloved African mountain city as well as become a catalyst for further African-based, solution-oriented research for multiple benefits—not only for our lively city but also for the Free State Province and globally. Let today be the start of something exciting and may God Almighty abundantly bless us all with wisdom to continue to dream the impossible and seek the unknown so that we can achieve greatness as Africans... Never forget that you did not choose the path of awakening, your inner calling came from our forbearers who chose you!

> *Our children may learn about the heroes of the past. Our task is to make ourselves architects of the brightest future.—Jomo Kenyatta.*

Kgotso! Pula! Nala!

Phuthaditjhaba, Republic of South Africa Ntate Thaele Pule Thaele

Ntate Thaele Pule Thaele is a prominent QwaQwa social entrepreneur. His mission is to uplift his community through ethical servanthood and leadership and the transfer of Ubuntu/Botho values. His work is driven by the motto of 'unity is our strength'. He is currently enjoying his retirement while writing books, spending quality time with his family and working on various autodidactic projects.

Acknowledgements

Dr. Martin Mandew and Prof. Francis Petersen of the University of the Free State (UFS) are thanked for their ongoing support and for providing the preface to this publication. Dr. Glen Taylor (UFS Senior Director of Research Development) is thanked for providing the funding for the Open Access publication of this research and thus increasing the visibility of southern African mountain research internationally. We would also like to acknowledge the kind help of Dr. Tshepo Moloi at the University of the Free State in sourcing contributions for the book.

The editors would like to thank all the authors for their contributions. Additionally, the scientific committee, comprising Dr. Stefan Schneiderbauer, Prof. Joerg Szarzynski and Dr. Ralph Clark are thanked for conducting internal reviews. We also express our gratitude to the four anonymous reviewers provided by Springer for their useful comments on the manuscripts.

A special thanks is due to Dr. Ralph Clark, director of the Afromontane Research Unit (ARU) of the University of the Free State since 2018, for his tireless efforts to drive mountain research in southern Africa. Without his support this publication would not have been possible.

This book is an important outcome as part of the ARU's Risk & Vulnerability Science programme on the sustainable development of Phuthaditjhaba as an African mountain city; the Risk & Vulnerability Science programme is supported by the South African Department of Science & Innovation and the National Research Foundation.

Contents

Introduction

1

Andrea Membretti, Susan Jean Taylor, and Jess L. Delves

Abstract

This introductory chapters presents aims, approach and main contents of the edited volume, framing a practical discussion about sustainable development in Phuthaditjhaba, a southern-african informal town which is facing multilevel social, political and environmental challenges. By employing the United Nations Sustainable Development Goals (SDGs) throughout, the Goals serve as a common reference point which unites the written contributions and which can be employed by researchers, policy makers and practitioners alike. The book brings together diverse contributions from scholars and practitioners on Phuthaditjhaba and the area of the former homeland QwaQwa. Each chapter addresses the city from a different disciplinary perspective, with the overall objective of shedding light on the challenges and opportunities presented with regards to sustainable development.

Keywords

SDGs · Ruralopolis · African mountains · Informal city · Remotization · Urbanism

Around the world, where there are mountains, there are human settlements. Yet, mostly it is not possible for mountains to sustain intense human activities in steep or rugged terrain, leading to concentrations of infrastructure and settlements in foothills and valleys. These societies remain strongly interconnected with the mountain features of the wider landscape, which shape culture, social organization and economies. Although mountains offer many natural resources, they present unique and challenging environments, with extreme and fast-changing weather, multiple natural hazards and remote or isolated territories. These conditions often result in human communities that are both resilient and innovative with a strong local identity (Price 2013).

Mountain cities across the globe, and in particular those in developing regions, share common problems relating to their mountain setting. The rugged topography complicates infrastructure and

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service delivery as well as impedes mobility and thus connectivity. Historically, the industrialisation of countries has triggered migration flows away from mountain settlements (villages, towns, cities) as investments were focused in easily-accessible lowlands. Employment opportunities are therefore fewer in the mountains. Traditional livelihoods are typically agriculture-based, but mountain producers are often unable to compete in increasingly globalised commodity markets. In addition, agriculture-based livelihoods are sensitive to climate change and biodiversity loss and often the financial resources and technical know-how needed for adequate adaptation are limited. With services and employment increasingly concentrated in lowlands, many mountain settlements across the globe are experiencing trends of depopulation.

In some areas of the Global North however, the opposite is true, and people are returning to rural mountain areas to 'escape' dense metropolitan areas, and in response to unprecedented challenges for urban areas, as was seen in some places during the COVID-19 pandemic (Ahrend et al. 2022). In future, many lowland cities will become increasingly uninhabitable due urban heat island affect and sea-level rise (IPCC 2022). There are therefore signs, globally and currently in particular in wealthier regions, of a possible reversal of the abandonment of mountain areas, especially where mountains can offer essential services and economic opportunities for those who decide to stay or those who emigrate to mountains (Membretti and Lardies-Bosque 2022).

Phuthaditjhaba—the South African mountain city that is the subject of this book—not only shares the challenges of a mountain city but also that of an informal and rapidly growing city. This interaction creates a set of societal challenges relating to the growing population, high levels of inequality and demands for social justice, entrenched poverty, natural resource degradation and water and food insecurity. These circumstances, which are all also intertwined with the complex social and political history of the region, have been additionally aggravated by the COVID-19 pandemic.

Phuthaditjhaba: A *Ruralopolis* in the 'QwaQwa Sandwich'

Phuthaditjhaba—the former capital of the Apartheid homeland of QwaQwa—sits at 1,600 masl, in the foothills of the Maloti-Drakensberg mountains where the surrounding peaks reaching over 3,000 masl. It is in the Free State province of South Africa and borders KwaZulu-Natal province and the national border with Lesotho (Fig. 1.1). It is a vast settlement of approximately 200 km^2 that lacks a real urban centre and is instead characterised by a scattering of mostly small, single-storey, residential buildings that extend up the mountain slopes and across the hilly areas. Many inhabitants of this semi-urban sprawl depend on agriculture and pastoralism for subsistence or income, hence the conceptualisation of Phuthaditjhaba as a *ruralopolis*—comprising aspects of both rural and urban organisation, culture and economy (Qadeer 2000). Other important sectors providing employment are social services, private households, manufacturing and trade (both formal and informal), nevertheless, unemployment is around 50% and many households depend on government grants (MaP 2019). Meanwhile, the sectors with the highest economic contribution are 'wholesale and retail trade, catering and accommodation' (23.35%) and 'general government' (23.05%) (Denoon-Stevens and Mocwagae 2019).

Phuthaditjhaba is overshadowed by the nearby peaks of the Great Escarpment range, including the Drakensberg Amphitheatre with the Tugela falls, the second highest waterfall in the world, and Sentinel Peak. The city thus stands in a setting of exceptional natural beauty. However, these mountains limit the spatial expansion of the city to the west and south, while the rest of the city is encircled by protected conservation areas and private-owned farmland. These restrictions to urban expansion led to the nickname of the 'QwaQwa sandwich' (Delves et al. 2021).

The Mountains and the City

The city and its people are not only shaped by its complex historical, political, social and cultural past and present, but also by the mountain environment that surrounds it. Phuthaditjhaba

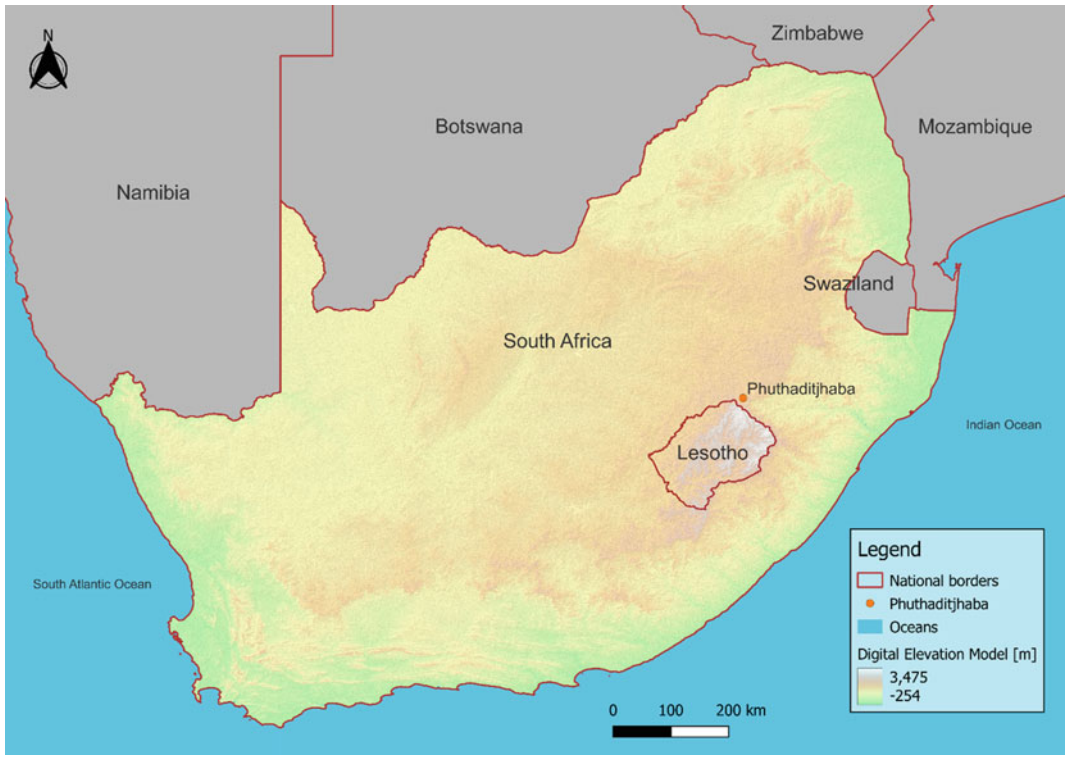

Fig. 1.1 Map showing the location of Phuthaditjhaba in southern Africa. Map creator: Stefano Terzi

depends on the mountains for fresh water, for pasture and cropland, and regionally also for tourism, energy production, biodiversity conservation and carbon capture.

The rugged and mountainous terrain makes infrastructural development and service provision both difficult and costly (Fig. 1.2). Inadequate service provision, in particular water, is one factor driving ongoing civil discontent which frequently manifests in protests, some of which cause damage to property and infrastructure, as was the case in 2019–2020 'QwaQwa Shutdown' protests (Toyana 2020). However, Phuthaditjhaba is located in southern Africa's primary water producing region, and a lack of water for domestic use is often blamed on poor municipal management, lack of investment and corruption in service contract allocation (Mocwagae 2020). In February 2018, the local municipality was placed under administration for financial

Fig. 1.2 The Maloti-Drakensberg mountains form a dramatic backdrop to the Phuthaditjhaba 'ruralopolis'. Photo credit: Serero Modise

mismanagement and refusing to make public its financial records.

Increasing Remoteness or 'Remotization'

Since democracy, the city has undergone a process of 'remotization' (Membretti et al. 2022a, b), that is, an increasing isolation from other economic and cultural centres of the country. During Apartheid, economic incentives were provided by the national government to encourage the establishment of white-owned businesses and job creation in the QwaQwa homeland (see Chap. 2, Marais). The city was a bureaucratic and administrative centre, with adequate investment in services, infrastructure and education. In 1994 QwaQwa was reintegrated into South Africa and by extension into global markets; the subsidies to white-owned businesses ended and South African trade unions won farer wages and working conditions for their workers. With cheaper labour available elsewhere, industry all but left Phuthaditjhaba and unemployment dramatically increased.

The challenges faced in Phuthaditjhaba are similar to those in many expanding informal urban areas in the developing world: the inequalities rooted in colonialism and neocolonialism, leading to underinvestment in services, to unemployment and poverty, with all the associated impacts on human and ecological well-being. In addition, the effects of climate change, biodiversity loss, human migration and COVID-19 pandemic on Phuthaditjhaba are still under-researched but will play a strong role in the future of the city (Schneiderbauer et al. 2022). All this said, the very location of Phuthaditjhaba at the foot of the Great Escarpment and Maloti-Drakensberg Mountains and in close proximity to a significant, yet fragile, system rich environmental resources, highlights the great potential of this place in terms of sustainable development. For sustainable development to be possible, policies are needed to radically remove inequalities in access to these resources, together with establishing formal measures for their responsible and sustainable management.

United Nations Sustainable Development Goals

This edited volume presents a practical discussion about sustainable development in Phuthaditjhaba which is facing multilevel social, political and environmental challenges. By employing the United Nations Sustainable Development Goals (SDGs) throughout, the Goals serve as a common reference point which unites the written contributions and which can be employed by researchers, policy makers and practitioners alike. The book brings together diverse contributions from scholars and practitioners on Phuthaditjhaba and the area of the former homeland QwaQwa. Each chapter addresses the city from a different disciplinary perspective, with the overall objective of shedding light on the challenges and opportunities presented with regards to sustainable development.

Phuthaditjhaba and QwaQwa are frequently referred to as 'under-researched'. This turns out to be a falsehood; there is plenty of important and innovative research taking place in and on the city and its surroundings. However, much of this research never reaches international forums, for a variety of reasons (see Box 3: Conducting research in Phuthaditjhaba: challenges and opportunities). A key motivation for this publication is therefore to showcase the variety and quality of the research on Phuthaditjhaba as well as to contribute to raising the profile of southern Africa's mountains—and their researchers and practitioners—in sustainability and development research internationally.

Chapters Summaries

Chapter 2—Lochner Marais

Marais explains the origins of the apartheid homelands system with particular reference to the homeland of QwaQwa in which Phuthaditjhaba, declared as the capital city, is located. The chapter explores the principal obstacles to progress and reflects on what city planners could do to promote sustainable development in the region.

Chapter 3—Kgosi Mocwagae and Verna Nel

Mocwagae & Nel link a need for participatory urban planning to successfully address the sustainable economic development of Phuthaditjhaba and its central business district (CBD). This qualitative study involved municipal officials, homeowners, business owners and property developers in an investigation of the Setsing CBD, a focal point of Phuthaditjhaba's economic, social and cultural life.

Chapter 4—Falko Buschke, Toka Mosikidi, Aliza le Roux, Lefu Mofokeng and Bram Vanschoenwinkel

Buschke et al. argue that biodiversity should be foregrounded as an important element of all local level decisions and explain how existing biodiversity plans of the Thabo Mofutsanyana District Municipality can be repurposed to address seven of the 17 UN SDGs.

Chapter 5—Dolapo Bola Adelabu and Angelinus Cornelius Franke

Adelabu and Franke demonstrate how bees can be managed to play a greater role in increasing crop yields in resource poor communities where the use of chemical fertilizers is limited due to a lack of finance of smallholder famers.

Chapter 6—Geofrey Mukwada and Sarudzai Mutana

Mukwada and Mutana assess the impact of urban drought on water security in Phuthaditjhaba and use historical climate data to determine how climate change has affected the two main dams which supply the city's water. They find that water supply is decreasing which poses a long term problem to water security in the region.

Chapter 7—Ntebohiseng Sekhele and Patricks Voua Otomo

Sekhele and Otomo explain how a chronic lack of water generates conflict in the region and contributes to ongoing poverty. They highlight the contradiction that Phuthaditjhaba sits in an important water-producing region but suffers from poor water availability, and suggest ways the city can tackle this growing crisis.

Chapter 8—Kgosi Mocwagae and Thulisile Mphambukeli

Mocwagae & Mphambukeli investigate the 2019–2020 water crisis that took place across QwaQwa, using data from a questionnaire administered to 571 households. The chapter uses these data to propose planning interventions for improved water access and provision in the region.

Chapter 9—Loice S. Nzombe, Rodwell Makombe and Oliver Nyambi

Nzombe, Makombe & Nyambi address gender and youth issues in Phuthaditjhaba through their investigation of self-representation of female bodies on social media in the (re)construction of identities. Their chapter offers a unique contribution to a field not often dealt with in the context of semi-urban spaces and systemic underdevelopment.

Chapter 10—Sarudzai Mutana and Geofrey Mukwada

Mutana & Mukwada discuss to what extent tourism could become an important pillar of sustainable development in Phuthaditjhaba in the future, bringing employment and economic revenue. They argue that the mountains hold potential for sustainable forms of tourism but that the fledgling industry currently lacks balance between economic, environmental and sociocultural benefits.

Chapter 11—Susan Jean Taylor

Taylor reflects on multiple urban greening benefits, thinking ahead to a climate change future where increased temperatures will negatively impact physical and mental health of urban residents. To counter this, she proposes a vast urban greening project in Phuthaditjhaba to combat the urban heat island effect and provide employment and even food for local communities.

Chapter 12—Louw van Biljon

Van Biljon explores the possibilities of a more creative town planning approach in Phuthaditjhaba, presenting a visionary imagining of the city 100 years hence, in 2121. Using the UN SDGs and three case studies as a guide, van Biljon rethinks planning goals which include communities for a sustainable future in Phuthaditjhaba.

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Phuthaditjhaba: The Rise and Fall of a Homeland Capital

2

Lochner Marais

Abstract

Grand Apartheid in South Africa created ten 'homelands', each of which had a capital city. These capitals became places of power and symbolism. The apartheid government allocated large subsidies to support industrial development in these capitals, through the regional industrial development programme. Phuthaditjhaba became the capital of the QwaQwa homeland, with a parliament building, houses for chief ministers, and public spaces and buildings named after leaders. However, with the incorporation of QwaQwa into South Africa after the transition to a democratic government, Phuthaditjhaba lost its capital status. Despite one statue being removed, most of its public places named after homeland leaders remained. Today, Phuthaditjhaba is part of the Maluti-a-Phofung Local Municipality and stands to benefit from funding from the intermediate city support programme. However, poor financial management, political infighting and allegations of corruption are preventing it from accessing these funds. City planners would do better to focus on Phuthaditjhaba's regional services function and the sustainable development role in the mountainous context and promote rural development.

Keywords

Apartheid · Governance · Phuthaditjhaba · Homeland · QwaQwa

2.1 Introduction

In the early 1990s South Africa had 13 capital cities. Three of these were the result of the unusual arrangement to split the country's capital into three: Cape Town (legislative), Pretoria (executive) and Bloemfontein (judicial). The other ten were capitals of the 'homelands' created under Grand Apartheid (the creation of ethnic nation states). When the ten homelands were integrated into South Africa after April 1994, their capitals lost their capital status, apart from Bisho and Mahikeng, which became provincial capitals of the Eastern Cape and North West Provinces, respectively.

Capital cities not only host the bureaucracies involved in making and executing laws, they are also symbols of power. They are places where the nation-state "projects its power through the urban landscape and spatial layout of the capital city", a power "manifested in the capital's architecture, in its public monuments, and in the

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names of its streets and public spaces" (Bekker and Therborn 2012, p. 1). Like European capitals, most African capitals display power in this way, and many of their power symbols are reminders of a colonial past. Notable studies in the literature on capital cities are Christopher (1985), Therborn (2002), Cochrane (2006) and Bekker and Therborn (2012). Less common in the literature are case studies of cities that have lost their capital status (Marais and Twala 2021). Phuthaditjhaba's capital status is further complicated by the location of the city in the mountains and in the economic periphery of South Africa.

The aim of Verwoerdian[1] apartheid in creating the ten homelands or ethnic states was to minimise the number of black people in 'white South Africa' and give them a place where they could have political rights. To achieve these two aims, the government brought in influx control, forced removals and channelled urbanisation. These mechanisms slowed urbanisation but did not prevent it. By 1994, the ten homelands consisted of four 'independent national states' (Transkei, Bophuthatswana, Venda and Ciskei) and six 'self-governing national states' (Lebowa, Gazankulu, KwaNdebele, KaNgwane, KwaZulu and QwaQwa). The African National Congress (ANC), one of the main black opposition organisations in South Africa, rejected the idea of these homelands as the place for black people's political aspirations. For the ANC, South Africa was one political entity and these homelands had to become part of the post-apartheid regional dispensation.

Grand Apartheid required QwaQwa to provide a political home for the Sesotho-speaking population of the Free State, although the government recognised the limitations of making QwaQwa an independent state, and its Chief Minister, TK Mopeli, was not in favour of independence, as he considered QwaQwa critical in a future regional dispensation of South Africa. Phuthaditjhaba (seSotho, meaning 'meeting place of the tribes', formerly Witsieshoek) was made the capital. The government used channelled urbanisation to redirect the Sesotho-speaking black population to QwaQwa, and it became a dumping ground for 'forced removals'.

Three decades later, some implications of these changes are evident. This chapter focuses on Phuthaditjhaba, its rise and demise as a capital city, its planning challenges, and its future sustainability. Pickles and Woods (1992) argue that academic literature tends to undervalue the urban areas in homelands because of the focus on forced removals, resettlement camps, rural areas and the dearth of economic activity in these places. This trend was established before the political changes since 1994. This chapter attempts to restore some balance by focusing on Phuthaditjhaba, its rise and demise as a capital city, its planning challenges, and its future sustainability. Today, Phuthaditjhaba forms part of the Maluti-a-Phofung Local Municipality (which includes the towns of Harrismith and Kestel, traditional land areas and commercial farms) and hosts the headquarters of the local municipality and the Thabo Mafutsanyane District Municipality. It is thus in a position of considerable regional importance.

2.2 Phuthaditjhaba as Capital

The South African government declared QwaQwa a self-governing homeland on 1 November 1974. Its population increased rapidly, from just over 14,000 in 1970 to 340,000 by 1991, 25,000 of them living in Phuthaditjhaba itself (Krige 1995). This led to various land expansions in QwaQwa. In 1987, the government attempted to incorporate a second urban area, Botshabelo in the central Free State, into QwaQwa (Twala and Barnard 2006). This incorporation failed after the Appeal Court ruled against it in 1988. Self-government required a capital where the government could take legislative and executive decisions and implement them. As the only proclaimed urban settlement in the area, Phuthaditjhaba became the capital city. Four factors drove the initial development of Phuthaditjhaba as capital: the new 'country' of

[1] Dr HF Verwoerd was a an apartheid state prime minister and the designer of Grand Apartheid.

QwaQwa had to acquire a bureaucracy, the built environment had to be constructed, national symbols had to be created, and an appropriate economy had to be developed by focusing on the capital. Obviously, sustainable development did not exist when the city started to develop (Rogerson 1999).

Self-government required a bureaucracy. To set this up entailed electing an assembly, appointing a cabinet and making laws. The legislature had 60 members, of whom 40 were designated to the two traditional chiefs in the area and 20 were elected members (Twala 1998).[2] Establishing the legislative and bureaucratic environment required office space, a parliament building and bureaucrats. The parliament building was erected on the small hill overlooking Phuthaditjhaba. At the same time, the QwaQwa government built various ministerial homes (with extensive security) and a 'white suburb' where delegated officials from the South African government resided. The parliament building overlooking the city is the ultimate symbol of power. The building's modernist 1980s architecture was intended to emphasise the importance of self-governance. A statue of Chief Minister TK Mopeli was erected at the entrance.

Two other prominent symbols of power and nationalism were the national stadium, named after Charles Mopeli (the father of the Chief Minister, TK Mopeli) and the Mofumahadi Manapo Mopeli Hospital (named after TK Mopeli's mother). Another was the Elizabeth Ross hospital, named after a missionary in the area and reflecting the colonial history. Another symbol of power came with the creation of a football club, QwaQwa Stars, worthy of playing in the Premier Soccer League in South Africa. The club, founded by local businessman Mike Mokoena, was launched in 1977 and received premiership promotion in 1986. To add to its national importance, the capital city attracted high-level services in the form of a teacher training college and a university, a satellite campus of the University of the North, established by the QwaQwa government in Phuthaditjhaba in 1982. The cultural links with the broader Sotho languages (including Tswana) were the basis of this arrangement with the University of the North.

Establishing an economy for the people of QwaQwa was a priority. The apartheid government's Regional Industrial Development Programme (1981) provided the foundation. The programme provided a wage subsidy to help industries relocate to QwaQwa. QwaQwa benefited extensively from the subsidy and the QwaQwa Development Corporation was instrumental in realising large-scale industries. By 1982, it had established 35 factories employing 2,100 people. By 1988, two more industrial parks had become operational and Phuthaditjhaba now boasted 200 factories. Between 1988 and 1991, the QwaQwa government directed new factories to Industriqwa, an industrial area closer to Harrismith. By 1991, 293 factories were operating, employing nearly 30,000 people. However, local value chains were minimal, wages were low, employees were primarily women, worker conditions were mostly inadequate and the QwaQwa government did not allow unions. In some cases, the industrialists made profits from the wage subsidy by not paying it entirely to the workers (Bank 1994). Slater (2002) says that people living in Phuthaditjhaba had a better chance than those in the traditional areas of getting jobs in these manufacturing plants. In addition to the industrial development, Phuthaditjhaba developed an important regional services function serving the rural hinterland. Shopping centres, hospitals, colleges and the university contributed to the regional function. Phuthaditjhaba gave entrepreneurs opportunities, as they relied on "the secure incomes of the emerging class of urban workers" (Slater 2002, p. 600). These entrepreneurs could use this certainty to expand their services to cater to the regional needs. For air transport a landing strip was available, but plans to develop it into a fully fledged airport did not materialise.

A further attempt at promoting modernity was the creation of a modern urban settlement by

[2] Critics of the system rightfully point out that this was not a democratic dispensation and that as little as 10% of adult people voted in the elections. Furthermore, by 1990 55% of the QwaQwa budget came from the South African government (Pickles and Woods 1992).

modernising housing delivery in Phuthaditjhaba. Various planning documents provided the framework for urban settlement and infrastructure. By the early 1990s, urban class differentiations had become apparent. As evidence, Pickles and Woods (1992) note the Chief Minister's compound with its security fence and some newer suburbs to serve the emerging middle class. The white suburb, set apart for the seconded South African government officials, was evidence of differentiation by both class and race. The QwaQwa Development Corporation played a crucial role in developing middle-class housing (albeit with the help of a large subsidy). Strict urban land-use control was applied and harsh treatment of people invading land illegally was common (Terreblanche 1991). The early planning documents provided low urban densities with an average of 500m^2 per stand (Du Toit 1980). By the mid-1980s, Phuthaditjhaba had a town council consisting of nine councillors (one for each of the wards) and although residents had to pay a fixed amount for services, the council did not levy a land tax. The complex land arrangements made it impossible to provide full title. However, residents received a letter confirming their land rights and the QwaQwa Development Corporation and commercial banks financed houses within this arrangement. The council had limited power and used seconded staff from other government departments (including seconded staff from the South African government) and the QwaQwa government was far more dominant than the town council. Providing water and service to the city was a high priority. The completion of the Fika Patso dam in 1987 was a milestone in this regard (Die Volksblad 1987).

By 1990, Phuthaditjhaba was well established as the capital of QwaQwa. The homeland government was in control and the local symbols and architecture proclaimed it a 'modern' state. Although primarily based on the South African government's industrial subsidies, a robust urban economy developed. The reintegration of QwaQwa into South Africa would change the urban landscape and cancel Phuthaditjhaba's symbolic role as a capital city.

2.3 Loss of Capital Status

The reintegration of former homeland areas into South Africa was a bumpy process. Particularly notable was the Bisho massacre on 7 September 1992, when the Ciskei army defended its 'independence' by killing 28 people in a march of 80,000 protesters who wanted Ciskei to be reintegrated into South Africa (Bond and Mottiar 2013). The reintegration of QwaQwa into South Africa and the dismantling of Phuthaditjhaba's capital status did not go smoothly. The ANC planned a protest similar to Bisho's, to be held at the QwaQwa agricultural show on 10 September 1992. However, fewer than 400 protestors arrived and there were no violent clashes (Smith and Coetzee 1992). The animosity between the QwaQwa government and the ANC was manifest during the 1990–1994 transition period. The Chief Minister clung to his belief in a confederal arrangement in which QwaQwa would be a critical region; the ANC was adamant that QwaQwa should be reincorporated into South Africa. Strikes were prevalent during this period. Early in 1990, for example, 21,000 factory workers and 10,000 public officials went on strike demanding better work conditions and the right to belong to unions (Bank 1994), and in July 1992 government officials came out on strike demanding that the Phuthaditjhaba Council suspend the town clerk (Die Transvaler 1992).

The integrations after the democratic transition in 1994 remained bumpy. The relationship between the newly elected provincial government, with the ANC in the majority, and Mopeli's Dikwankwetla Party of South Africa (DPSA) was not good. Mopeli, unlike many other homeland leaders, did not join the ANC but contested the 1994 elections under the banner of the DPSA. The DPSA could not get a seat in the provincial or national legislature but won various local seats. For example, during the 2016 local government election, it won four seats on the local council. The Free State Provincial Government was responsible for the reincorporation of QwaQwa into South Africa. Its first step was to appoint an administrator to manage the

process (The Citizen 1994) and ensure political oversight (Nieman 1994). These high-level appointments showed how seriously the provincial government took the reincorporation. Next, the Free State's first premier, Mr Lekota, wanted to remove symbols of power associated with Mr Mopeli and his family (just as in 1994 the statue of Prime Minister HF Verwoerd was removed from the Free State Provincial Government Offices in Bloemfontein and the name of the building was changed to Lebohang). He targeted the Charles Mopeli Stadium and the Mofumahadi Manapo Mopeli hospital (Smith 1994) for possible name changes. Ultimately he did not succeed and these symbols from the homeland era remain. The statue of TK Mopeli at the parliament building was removed, but it is not clear whether the Free State Provincial Government was responsible for this.

The next question was how to deal with the bureaucracy of the former homeland. The Free State Provincial Government incorporated the staff of Mr Mopeli into the office of the premier—a sign of trying to ensure central control. There was an initial idea that the provincial government would spread some provincial government functions across the Free State, with some functions allocated to Phuthaditjhaba. Ultimately, however, many officials relocated, as most government functions were centralised in Bloemfontein, the provincial capital. This relocation meant that the city lost some of its middle-class residents to Bloemfontein. Later, realising the importance of the votes from QwaQwa, the ANC took a more reconciliatory approach by favouring traditional leadership. The Free State's first premier's initial uncompromising approach in 1994 made way for a reconciliatory approach from later premiers. For example, in 2014 the Free State's premier opened a traditional leadership sitting (Moloi 2014). Finally, with the demarcation of new municipal boundaries in 2001, Phuthaditjhaba became the headquarters of Maluti-a-Phofung and the Thabo Mafutsanyane District Council, which occupied the administrative building of the former QwaQwa homeland.

The above changes had negative economic implications. Losing the capital status meant losing the economic value that came with it. The ANC government found the Regional Industrial Development Programme unsustainable and with the loss of this subsidy many of the industrial parks across South Africa collapsed. The industrial parks in Phuthaditjhaba, however, survived. In 2018 the Department of Trade and Industry allocated about R50m for the upgrade of Phuthaditjhaba's industrial area (Die Volksblad 2019) and the current occupancy levels are at about 65%. There are several reasons why industry survived in Phuthaditjhaba (Marais et al. 2005). The location, halfway between Gauteng and Durban and on the main route between the two, is advantageous; the labour costs are lower than those of Gauteng and Durban, despite the minimum wage being the same across South Africa; and the price of industrial floor space remains substantially lower than elsewhere in South Africa. The lower tariffs for floor space have been achieved by not asking cost recovery rates. This is one of the main reasons why the Department of Trade and Industry had to provide capital in 2018.

Despite the problems of homeland development under Grand Apartheid, the ANC government prioritised rural development (Harmse 2010). In November 2000 it introduced the Integrated Sustainable Rural Development Programme (ISRDP). QwaQwa was one of 13 nodes in the ISRDP, which included other former homeland areas. Although the programme focused mainly on rural concerns, Phuthaditjhaba also benefited from the improved rural roads and rural economic activity. The national government conceptualised the programme in close relationship with the Maluti-a-Phofung Local Government, including prioritising the area in provincial planning. For example, the Free State Provincial Government declared the Mofumahadi Manapo Mopeli Hospital a regional hospital, which boosted Phuthaditjhaba's regional functional role. Changes in the educational landscape saw the University of the North campus being transferred to the University of the Free State (which has its main campus in Bloemfontein). The sports scene saw changes too. In 2002, the Premier Soccer League bought the QwaQwa Stars club in a bid to reduce pressure on fixtures by reducing

the number of teams in the League. The owner reignited the club under the name 'Free State Stars', but with Bethlehem as its headquarters.

As a result of all these disruptions, Phuthaditjhaba has suffered from large-scale political infighting, corruption and poor administration in the Maluti-a-Phofung local municipality (De Klerk 2000; Van Wyk 2000; Van Rooyen 2018). At the time of writing, the municipality is under administration, which means that an administrator appointed by the Free State Provincial Government takes decisions and not the council. Maluti-a-Phofung has been unable to produce municipal financial statements since the 2015/16 financial year (Gericke 2018).

2.4 The Future

As part of Maluti-a-Phofung, today Phuthaditjhaba is one of 39 intermediate city municipalities (ICMs) that could potentially access support from the ICM support programme (Marais and Nel 2019). The programme provides support for the development of strategic infrastructure in these cities. In practice it ringfences infrastructure funds but on the condition that the local government apply strategic planning and adhere to good governance. This potential depends mostly on the city's ability to contribute to the United Nation's Sustainable Development Goals, follow the principles in the Integrated Urban Development Framework (IUDF), provide adequate regional services, and overcome the current political turmoil in the local government.

Although most of the sustainable development goals have implications for urban areas, Goal 11 refers explicitly to sustainable cities and communities. The notion of 'sustainable communities' is one of nine policy levers in the IUDF (Department of Cooperative Government and Traditional Affairs 2016). The other eight levers are integrated urban planning and management, integrated transport and mobility, integrated sustainable settlements, integrated urban infrastructure, efficient land management and governance, inclusive economic development, effective urban governance and sustainable finances. The IUDF specifically focuses on the transformation of urban spaces and what to ensure urban access, the management of growth, good governance and spatial transformation. Considering the internal political strife, poor financial management and very little adherence to some of the critical spatial planning requirement in the IUDF, the sustainable development of Phuthaditjhaba as an urban area seems to be an uphill battle. Although complying with the principles in the IUDF and achieving the sustainable development goals is complex, four aspects would enable Maluti-a-Phofung and Phuthadithaba to make progress: institutional stability, sustainable municipal financial management, building on its regional services role, and ensuring an appropriate economy. The United Nations Sustainable Development Goal (SDG) 11 with its focus on inclusivity, managing growth and emphasising urban governance should further help Phuthaditjhaba to achieve these outcomes.

Institutional stability is central to the SDGs and the IUDF. The IUDF refers to efficient urban governance, and one of the aims of Goal 11 is the creation of sustainable development strategies. Poor municipal management, large-scale political infighting and corruption remain a challenge for Maluti-a-Phofung. The fierce infighting and the rapid turnover of mayors, municipal managers and administrators are not conducive to good governance in the local municipality. Many political fights are related to resource distribution and accessing state money (often referred to as 'state capture' in South Africa). Although the Integrated Development Plans could be aligned with sustainable development strategies, linking them with the SDGs, there is little evidence that this is happening in Maluti-a-Phofung. An ineffective council unable to implement and monitor its plans makes it hard to achieve the city's overarching goal of sustainability.

Development plans require sustainable municipal financial management. The municipality's inability to produce financial statements since the 2015/16 financial year points to large-scale corruption and bargaining for power positions. Media reports reflect concerns about

accountability, the administrator needing extra security, and council being unable to meet.[3] Leadership positions are being exploited to distribute resources to family and friends. Such nepotism and abuses of power excludes Maluti-a-Phofung from benefiting from the support programme for ICMs.

One of the critical contributions of Phuthaditjhaba to the development of QwaQwa has been the provision of higher-order economic and social services as part of its regional services role. High school and even post-school education is available in Phuthaditjhaba. An excellent regional hospital further strengthens this vital role. Decision-makers need to realise the value of Phuthaditjhaba for rural development. This aspect was undervalued in the ISRDP and the IUDF pays it only scant attention.

The homeland government prioritised Phuthaditjhaba for QwaQwa's economic development. More recently the focus has shifted to nearby Harrismith. The allocation of a Special Economic Zone (although mostly defunct) to Harrismith is one example. Although at 65% the occupancy level of Phuthaditjhaba's existing industrial area is still substantially higher than that of many similar industrial areas in South Africa (many have closed down completely), it does point to the difficulty of maintaining such spaces in the economic periphery of South Africa. In addition to being physically located at the margins of South Africa and economically at its periphery, even within the municipality there is evidence of increased spatial marginality.

2.5 Conclusion

This chapter discussed the rise and demise of Phuthaditjhaba as the capital city of QwaQwa. Under Grand Apartheid, the homeland policy provided the opportunity to develop ten homeland capitals, of which Phuthaditjhaba was one. The development and characteristics of these homeland towns and cities seldom received adequate attention from scholars, as most research emphasised their rural nature and the forced removals associated with homeland populations. Like most capitals, Phuthaditjhaba retains homeland power symbols: a parliament building overlooking the city, a Chief Minister's compound, and public buildings named after the Chief Minister and his family. The industrial subsidies under apartheid provided an economic base and contributed the presence of bureaucrats in the city to develop an urban middle class in the 1980s.

The incorporation of QwaQwa into South Africa and the Free State provincial government in 1994 was difficult. There were early attempts to change the homeland symbols. But, other than the statue of TK Mopeli, now removed, many of the homeland symbols remain. The Free State provincial government quickly incorporated the QwaQwa government staff into its structures and relocated many to Bloemfontein. The location of the headquarters of Maluti-a-Phofung and the district municipality in Phuthaditjhaba has kept some bureaucrats in the city. Although the occupancy of the industrial estates has declined, the post-apartheid government has invested a large sum of money in upgrading them. It is doubtful whether this will counter the declining occupancy in the long term, but it does prove national commitment to a peripheral place. The implementation of the Integrated Sustainable Rural Development Programme (ISRDP) in QwaQwa did not directly benefit Phuthaditjhaba. There were, however, some indirect benefits: better access to the city for the rural population, better services, and rural economic development that has benefited the urban economy.

Maluti-a-Phofung has been included as one of 39 intermediate city municipalities (ICMs) in South Africa. Its inclusion in this list could give it access to new financial sources. However, the poor state of governance and financial management means that Phuthaditjhaba is unlikely to access these funds. The economic focus in the municipality is shifting to Harrismith. In my view, Phuthaditjhaba's potential lies in its regional services function. Serving the rural hinterland and playing an essential role in rural development is central to this function. The

[3] The media reports cited in this chapter were obtained from the SA Media database.

existing hospitals, education centres and shopping centres all play a role in this. However, the notion of a regional services function remains underdeveloped. Local strategies and plans could aim to build on Phuthaditjhaba's existing regional services and expand their regional role and function. In Phuthaditjhaba, achieving the sustainable development of the IUDF, and therefore the SDGs and in particular SDG11, will be difficult. The current political climate, poor financial performance and continued corruption are likely to affect strategic planning and complying to these goals negatively. At the same time, the cities peripheral and mountainous location will place increased pressure to comply to these goals.

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The United Nations Sustainable Development Goals

Andrea Membretti, Susan Jean Taylor and Jess L. Delves

In 2015, all United Nations Member States adopted the 2030 Agenda for Sustainable Development. The Agenda is a plan to first and foremost eradicate poverty by 2030 and to "take the bold and transformative steps which are urgently needed to shift the world onto a sustainable and resilient path" (UNGA 2015: 1). The 2030 Agenda builds significantly upon the Millennium Development Goals by encompassing a far broader sustainability agenda which requires coordinated global action. To guide this action, the 2030 Agenda created the 17 United Nations Sustainable Development Goals (SDGs) and 169 targets for sustainable development (Fig. 2.1).

The SDGs are "integrated and indivisible" and reflect the interdependent nature of the

Fig. 2.1 The 17 United Nations Sustainable Development Goals. The content of this publication has not been approved by the United Nations and does not reflect the views of the United Nations or its officials or Member States. https://www.un.org/sustainabledevelopment/

many aspects of economic, social and environmental sustainability (UNGA 2015: 1). In 2017, specific targets and associated indicators were designed which are used to measure global, national and subnational progress towards each target and their SDGs (UNGA 2017). The universal nature of the goals facilitates comparison on multiple scales of progress in achieving the goals for developed and developing countries and regions. They provide a boundary object that can unite efforts for driving sustainable development between diverse stakeholders acting at multiple levels throughout society, the economy and politics. It is as such a boundary object that the SDGs are applied in this book.

Planning for the Expansion of Phuthaditjhaba CBD Through UN Sustainable Development Goals

3

Kgosi Mocwagae and Verna Nel

Abstract

In the 1980s, the QwaQwa government established the Phuthaditjhaba Central Business District (CBD), locally known as Setsing. Currently, measuring approximately 60 ha, Setsing hosts a mixture of formal businesses in shopping complexes and a large informal sector trading on pavements. Setsing is enclosed by four of 13 township sections of Phuthaditjhaba that have limited vacant land for expansion. The enclosing townships consist of privately-owned residential homes, without any municipal land available to expand the CBD needed to address the business demands of Setsing. Sustainable Development Goal (SDG) 11 on making cities inclusive, safe, resilient, and sustainable is applied to address the issues stated in the study. The study employed exploratory qualitative research methods to determine the land use planning practices to allow the CBD to expand into the enclosing township sections and unlock economic value for property owners in these sections. The study participants included municipal officials, homeowners, business owners and property developers. Content analysis was used to determine land use management practices that will allow Setsing to expand and create possible spin-offs for the local economy. The chapter makes three contributions to Setsing through the UN Sustainable Development Goals. The first contribution is that homeowners felt that zoning interventions could assist with the expansion of Setsing. The second contribution plans for densification through increasing basic infrastructure to support the consideration of multi-storey buildings. The last contribution is the development of a new CBD with careful consideration that will not lead to a negative effect on livelihoods in the existing CBD.

Keywords

Central Business District · Land use planning · Sustainable development

3.1 Introduction

Central Business Districts (CBDs) are at the heart of towns and cities in terms of economic trade conducted by formal and informal businesses. This chapter explores the Setsing CBD in more detail, looking at how land use planning practices can be utilised to ensure sustainable expansion to unlock economic value. Setsing has experienced

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growth in the demand for land for formal businesses and informal trade over the years. This resulted in a contestation between formal business and informal trade taking place on sidewalks dedicated to pedestrian movement.

3.1.1 Aim of the Study

The aim of this study is to explore planning for the expansion of the Phuthaditjhaba CBD through UN Sustainable Development Goals. The aim of the study was firstly supported by the inclusion of SDG 11 on sustainable cities and communities. The second support to the aim of the study was the New Urban Agenda (NUA), with eight focal points for human settlements. The third support relates to the seven goals of African Agenda 2063's first aspiration. The fourth support is the National Development Plan (NDP), which contains 15 chapters with the key issues it intends to address. However, only Chaps. 3, 4, 5, 6 and 8 were relevant to this study. The fifth support is the Integrated Urban Development Framework in responding to urbanisation that focuses on large urban centres but offers relevant guidelines for smaller urban centres such as Phuthaditjhaba. Lastly, support is offered by the Spatial Planning and Land Use Management Act No. 16 of 2013 as legislation for spatially sound development with context-specific land use management.

The background of the study area will be discussed first. This is followed by the methodology of how the study was conducted. The third section discusses the sustainable development concepts and effects in Africa, followed by the fourth section on sustainable development policy. This will also include a discussion of the Sustainable Development Goals (SDGs), the New Urban Agenda, Agenda 2063, the National Development Plan (NDP), the Integrated Urban Development Framework (IUDF) and the Spatial Planning and Land Use Management Act. The findings will be discussed from observations and participant interviews about the current challenges Setsing is facing. The final discussion outlines findings in keeping with the literature and policy to propose options for the issue at hand.

3.2 Background of Study Area

Phuthaditjhaba is a town in QwaQwa, a mountainous region in the eastern Free State bordering Lesotho. The town is surrounded by villages creating a peri-urban region around it. QwaQwa was established in 1974 under the apartheid regime as a homeland for the southern Sotho (often called Basotho) people in South Africa. Since December 2000, QwaQwa was incorporated as the urban centre of the Maluti-a-Phofung (MAP) Local Municipality, which also includes Harrismith, Tshiame and Kestell. The Basotho forcefully sent to QwaQwa came from farms and towns in the Free State and across the country. Those from farms were settled in rural villages. Furthermore, Phuthaditjhaba was established as a town to accommodate those from towns. Villagers received employment and land from local chiefs, and those in Phuthaditjhaba received preferential employment for civil work and industrial production.

Phuthaditjhaba comprises 13 sections, and the CBD is known as Setsing. In the 1980s, the government invested in Setsing via the QwaQwa Development Corporation to create a new capital for the region. Outlying villages had smaller shopping centres to serve their communities. Setsing contains a mix of uses such as a hospital, municipal offices, a library, shopping centres, administrative office blocks, taxi ranks and informal traders' stalls. Besides providing commercial and social services, the CBD is currently the transport hub for the area within QwaQwa and the wider region, including Lesotho.

QwaQwa experienced outward migration from 1991 to 1995 (Cooper et al. 1994) when apartheid influx controls were abolished. However, the population increased by 0.71% from 1996 to 2000, experiencing a decline of −0.69% from 2001 to 2011 (Housing Development Agency 2014). Unfortunately, due to often

unreliable apartheid statistics, the population statistics of QwaQwa between 1991 and 2010 were inconsistent (Palamuleni 2010). The population of QwaQwa stood at approximately 280 000 by 2011 (Denoon-Stevens and Mocwagae 2019:4).

MAP is a municipality with grave governance problems, an ageing infrastructure that has suffered from many serious acts of vandalism (Parliamentary Monitoring Group 2020), and an unstable administration. These governance problems will constrain the implementation of any but the most urgent projects, limit service delivery of the most essential services and hinder any long-term planning. The focus will be on immediate crises rather than future needs and problems that could or will arise in the future due to unsustainable actions in the present. The lack of action in protecting a fragile montane environment will also have consequences for the entire socio-ecological system (Walker and Salt 2006).

3.3 Methodology

An exploratory qualitative research method was employed. This was deemed the best suited to explore how Setsing can be sustainably expanded through land-use planning practices. It allowed for an in-depth exploration of the problem and how it affected its intended end-users (Creswell and Plano Clark 2006:75). Due to the COVID-19 pandemic, telephonic interviews were conducted with homeowners identified as participants through purposeful sampling. Interviews with business people were conducted in 2019. Secondary data were collected from municipal policy documents, legislation and academic publications. Six homeowners and six businesses participated in the research and could respond in both Sesotho and English. Content analysis was undertaken to identify land-use practices that will allow Setsing to expand. Participation was voluntary, and target participants could choose not to participate.

3.3.1 Study Site

Setsing was established in the 1980s to serve major commercial activities of the QwaQwa homeland (Cooper et al. 1984). However, after QwaQwa was reintegrated into South Africa in 1994, planning interventions have not been proactive in addressing the future demand and the expansion of Setsing. As shown in Fig. 3.1, Setsing is surrounded by residential dwellings of Phuthaditjhaba. Major commercial activities and services provided by Setsing include supermarkets, clothing stores, social services, informal trade, taxi interchanges, furniture stores, and financial services. Setsing is at risk of being stifled by informal traders (Slater 2002) and suffers from poor municipal maintenance.

Google Earth (2021) was used to determine the land extent of QwaQwa and Setsing. The total land extent of QwaQwa is 206 km^2 (20 600 ha), with an official total population of 284 729, comprising 54 661 (19%) in Phuthaditjhaba and 230 068 (81%) in villages (Statistics South Africa, 2012). The current land extent for Setsing is approximately 0.39 km^2 (39.04 ha). Thus, Setsing forms 0.19% of the total land extent occupied by the entire population of QwaQwa and surrounding towns as a central place within the MAP. When compared to Bloemfontein, a city of similar size in terms of a total land area of 236.2 km^2 (23 620 ha) with a CBD of 2.58 km^2 (258 ha) that takes up 1.09% of the total land area, it is clear that Setsing has far too little land (Statistics South Africa, 2016). The QwaQwa Development Corporation, now known as the Free State Development Corporation, developed most of the buildings in Setsing in the 1980s (Cooper et al. 1984).

3.4 Sustainable Development: Concepts and Effects in Africa

For sustainable development to be sufficiently delineated, constructs of sustainable development and urban governance were explored.

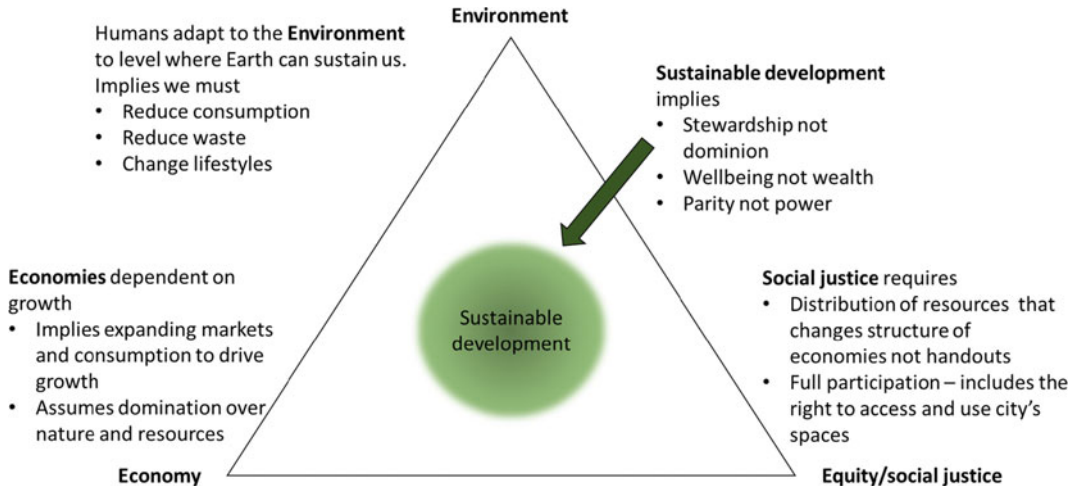

Fig. 3.1 Assumptions and sustainable development concepts. *Source* Adapted from Campbell (1996), Connelly (2007), Haughton (1999) and Jabareen (2008)

Sustainable development through its concepts and their effects on Africa is discussed in two sections. The first section discusses the constructions of sustainable development, which delineates the origins of the concept of sustainable development globally. The second section delineates how South Africa adopted sustainable development and has incorporated it into its urban governance.

3.4.1 Constructs of Sustainable Development

Sustainable development is a very well-known concept now. However, rapid population growth, fears about resource depletion and the impacts of development on the environment, coupled with widening gaps between the Global North and South, spurred an international awareness of the limits to growth and the subsequent United Nations Conference on the Human Environment in 1972 (Du Pisani 2006:91; Gough 2017). The awareness was intensified by the first images of Earth from space, which emphasised the finiteness of the planet and its resources (Du Plessis 2000:2; Foody et al. 2019).

The Brundtland Report (World Commission on Environment and Development 1987) provides the most widely-quoted definition of sustainable development. It is implicit in South Africa's Bill of Rights in Chapter 2 of the Constitution (1996, Section 24). The centrality of humans in sustainable development is clear in this definition that concerns the survival of humans now and in the future. It assumes that social equity, conserving the environment and economic development are possible (Du Pisani 2006:92). However, other views support, oppose or modify this interpretation (Connelly 2007; Du Plessis 2000; Haughton 1999; Williams and Millington 2004). Most discussions concerning the meaning of sustainable development acknowledge that it is a 'slippery' concept that can be adjusted to suit a particular agenda (Du Pisani 2006; Jabareen 2008; Meadowcroft 2007; Hajian and Kashani 2021). In more recent times, Sachs (2015:42) emphasised that interlinkages between society, environment, politics and economy should be found through SDGs to create a global path for sustainability.

Many descriptions of sustainable development contain the three competing goals of protecting the environment, ensuring equity and social justice and enabling economic growth. See Fig. 3.2 for the assumptions behind some of these goals. These tensions are described by Campbell (1996, 2016). The first tension is the resource conflict

Fig. 3.2 Setsing Locality outlined in yellow. *Source* Google Earth (2021)

between the environmental or ecological perspective and a more market-driven view. Jabareen (2008:181) termed this tension an ethical paradox between a sustainable state that can be maintained perpetually and development that implies environmental intervention.

In contrast, the concept of sustainable development suggests that humans can continue extracting resources but in a manner that does not lead to self-destruction. The ecological or deep green approach seeks to limit human activities and consumption levels in favour of the environment, while a light green or greenwash view assumes that technology will solve many of the current problems, along with recycling and reducing the demand for non-renewable resources and economic growth that is essential to create wealth (Connelly 2007; Du Plessis 2000; Haughton 1999; Khanna et al. 2019). However, several authors now argue that well-being, not growth, should be the path to sustainable development, particularly in cities, as there is increased urbanisation globally (Fioramonti et al. 2019; Lang and Marsden 2018).

The second tension is between environmental protection and social justice. It is particularly pertinent to the Global South, where leaders contend that there cannot be sustainability without development (Jabareen 2008:188) and where the people aspire to the resource-intensive lifestyle of the wealthy Global North (Du Plessis 2000). This contestation also reveals critical differences between a long-term view of the future and one focused on immediate issues (ranging from conspicuous consumption to the basic survival needs of the poor).

Campbell's property conflict describes the economic relations between economic development and the demands for social justice and greater equity (Brenner et al. 2009; Campbell 1996). These include community participation in planning and governance (Fainstein 2014). Social justice has been linked to the "right to the city", which concerns actions to reclaim the city

as a space beneficial for all in response to capitalism that led to spatial inequality (Parnell and Pieterse 2010; Duff 2017).

The tensions created by the factors of the sustainability triangle (see Fig. 3.2) require a solid relationship between society and the environment for economic benefits and social justice to be achieved by cities. These factors, if not adequately addressed, pose a significant threat to the sustainability of any city. It should be noted that the factors of the sustainability triangle should be addressed according to the context in which they are being planned.

3.4.2 Sustainable Development and Urban Governance in South Africa

Sustainable development is multidimensional, as evidenced by the many SDGs focusing on the various facets of such development. Inevitably, tensions and disputes will arise from diverse perspectives and agendas (Strezov et al. 2017). Campbell (1996, 2016) identified three conflicts that urban development should manage: (i) the development conflict (between equity and the environment); (ii) the resource conflict (between the economy and the environment); and (iii) the property conflict (between equity and the economy). He further expounded on the tensions between environmental and equity goals (Campbell, 2013). Such tension ranges from a global scale, where human needs are rapidly overwhelming the ability of the environment to continuously meet them, to the local scale, including conflicts around informality, contestations between the established citizens and the marginalised communities, who still seek their rights to the city and their impact on both economy and environment (Paller 2020).

Good governance is essential for sustainable development, and as is captured in SDG 16, this requires strong institutions. Governance includes planning and policymaking, public debate, political decision-making, and implementing those plans and policies (Meadowcroft 2007:299). Governance also implies partnerships with groups outside of the government (Van Doeveren 2011). Key players in the South African context are all three spheres of government, the private economic sector and civil society (Haywood et al. 2019). Local government is particularly important, although the relationships between national, provincial and local governments are poor (South Africa, The Presidency 2014). Also, trust in government is declining due to rampant corruption (Masuku and Jili 2019; Taylor et al. 2020).

Many municipalities struggle to perform their social and economic development mandates for several reasons, including a lack of capable officials and the inability to generate and collect revenue, leading to financial crises and irregular and wasteful expenditure (Auditor-General 2020; Masuku and Jili 2019). The consequence of the underperformance of local government is a lack of service delivery, with the poor suffering the most as they cannot afford alternative services. Crisis management precludes the Maluti-a-Phofung Local Municipality from effective long-term planning and development (Isserman 2014). It is expected to detract from the serious commitment to sustainable development.

3.5 The Sustainable Development Policy Agenda

The sustainable development policy agenda consists of global and South African policies that foster sustainable development: United Nations Sustainable Goals, New Urban Agenda, Urban Agenda 2063, National Development Plan, Integrated Urban Development Framework, and Spatial Planning and Land Use Management Act.

3.5.1 The United Nations Sustainable Development Goals

In 2015, 17 United Nations Sustainable Development Goals were adopted to enhance the world's prosperity and protect people (United Nations 2015). The UN SDGs are a 2030 vision to address sustainable development as the

globe's greatest challenge. SDGs are a more integrated build-up of the Millennium Development Goals (MDGs) that incorporate new ideas (Hák et al. 2016:253; Le Blanc 2015), facilitating the integration of multiple sectors.

Patel et al. (2017) emphasised that the success of SDG 11 depends on the accessibility and availability of robust data and the reconfiguration of governance systems accordingly. With the challenge of a lack of resources in the Maluti-a-Phofung Local Municipality, an investment in data collection and analysis to achieve sustainability in cities and QwaQwa, in particular, is essential (Thomas et al. 2020). Arfvidsson et al. (2017) state that informality has not been sufficiently addressed and mentions a need for raising awareness of strategies to resolve issues and build the capacity of local government. What has become increasingly evident with SDG 11 is that data collection systems have to be in place to improve the quality of decisions made by MAP to plan sustainably for the expansion of Setsing (Croese et al. 2021; Klopp and Petretta 2017; Almeida et al. 2018).

SDG goals provide access to justice for all and build effective, accountable and inclusive institutions at all levels. In addition to SDG 11, SDGs 1, 8, 9, 14 and 16 are particularly relevant to this study. These goals focus on ending poverty, promoting sustainable growth and employment, building resilient infrastructure, conserving the marine environment, and promoting peaceful, inclusive societies for sustainable development.

3.5.2 New Urban Agenda

The United Nations (2017) adopted the New Urban Agenda (NUA), envisioning a better and more sustainable future. The NUA is a tool to assist in creating more sustainable development in areas of high urbanisation in both developing and developed countries (Caprotti et al. 2017). The NUA has eight focal points for human settlements, but this study focused on only one. This point aims to meet current opportunities and challenges, and also, to prepare for a future inclusive of sustainable economic growth, high productivity, leveraging of urbanisation, harnessing local economies, value-added activities and being resource-efficient, and embracing the role that the informal economy plays while transitioning into the formal economy. This focal point's is relevant to the intention of this study to plan for the expansion of Setsing.

As far as the NUA is concerned, many countries face challenges in planning sustainable urban settlements (Mycoo 2017:68). Even though the NUA has good intentions, Satterthwaite (2016:3) considered it merely a condensed version of the 100-page Habitat II of 1996 because the NUA is highly dependent on the political will of its member states. Satterthwaite further stated that it offers nothing new because all the solutions we need are already available, depending on how deliberate we are about dealing with our issues. For Kaika (2017:89), the NUA is merely a paradigm shift of the SDGs that still use old methodologies that yield the results of broadening the gap between the haves and have-nots. Nonetheless the inclusion and sustainability of urban areas are important (UN Habitat 2020) as the world has become more urbanised, with over 50% of the population living in urban areas (Chirisa 2008:362). South Africa is also over 60% urbanised (World Bank 2019).

With these concerns being considered, planning for the expansion of Setsing should reduce reliance on political will, consider methods employed elsewhere and ensure that the gap between 'the haves and have-nots' does not widen further.

3.5.3 Agenda 2063

Agenda 2063 is an ambition of the African Union Commission to entrench a culture of gender equality, human rights, inclusion, democracy, safety and security, prosperity, and promote the collective interest for all. Agenda 2063 (African Union Commission 2015:7) has seven aspirations it aims to achieve by 2063. These include ideals of a prosperous, united,

Table 3.1 Aspiration 1 of Agenda 2063

Aspiration	Goals	Priority areas
A prosperous Africa, based on sustainable development and inclusive growth	Goal 1: a high standard of living, quality of life and well-being for all citizens	•Income, jobs and decent work •Modern and liveable habitats and basic quality services
	Goal 4: transformed economies	•Sustainable and inclusive economic growth •Economic diversification and resilience

Source African Union Commission (2015:7)

peaceful Africa, characterised by sustainable development, a concern for women and youth, and a strong, values-based cultural identity.

Of the seven aspirations of Agenda 2063, Aspiration 1 is relevant to the study as it focuses on sustainable development and inclusive growth. Aspiration 1 has seven goals, of which only goals 1 and 4 were relevant to the study with its priority areas as discussed in Table 3.1.

According to Mhangara et al. (2019:399), Agenda 2063 can create shared prosperity, wealth creation, transformative capacities and a sustainable environment if sustainability is placed at the centre of planning. By planning for the expansion of Setsing, there is potential for a positive economic impact on the community at large.

Even with the positive aspirations of the SDGs, NUA, and Agenda 2063, the current institutional arrangements would make it challenging to implement these aspirations effectively to realise development, change, transformation and integration (DeGhetto et al. 2016:98). Slavova and Okwechime (2016:3) analysed Agenda 2063's sustainability from a Smart Cities point of view and listed the following challenges: inadequate physical infrastructure; unemployment and informal urban economy; urban slums and informal settlements; unsustainable, poor quality, and segregated social services; and vulnerability relating to environmental, food security and climate change risks. Amupanda (2018:56) rightfully stated that, despite the continent of Africa having the largest youth population, not enough effort has been put into enabling them to participate meaningfully in development. The challenges raised here must be considered when planning to expand Setsing through UN SDGs.

3.5.4 National Development Plan

The NDP is the long-term South African government vision adopted by the government led by the African National Congress (ANC) in 2013. It aimed to eliminate poverty and reduce inequality for all citizens (National Planning Commission 2012). Its goals are only attainable through the collective effort of people to build capacity, promote leadership, grow an inclusive economy, and through partnerships with society (Alloggio and Thomas 2013; Zarenda 2013).

The NDP contains 15 chapters with the key issues it intends to address, with only five chapters relevant to this study. These include Chap. 3: Economy and employment; Chap. 4: Economic infrastructure (hygienic drinking water and sanitation systems in particular); Chap. 5: Transforming to a low-carbon economy; Chap. 6 : Inclusive rural economy (Phuthaditjhaba is regarded as an urban centre in a rural economy) and Chap. 8: Human settlements, where urban planning is of particular importance.

3.5.5 Integrated Urban Development Framework

In 2016, the South African Department of Cooperative Governance and Traditional Affairs (COGTA) introduced the IUDF as a response to urbanisation. This framework primarily focused on large urban centres rather than smaller ones such as Phuthaditjhaba. However, the study considered the IUDF a critical element in achieving the SDG goals in Phuthaditjhaba. The IUDF is a response to the SDGs, particularly Goal 11: Making cities and human settlements inclusive, safe, resilient and sustainable. Furthermore, the IUDF is an expansion of Chap. 8 of the NDP: Transforming human settlements and the national space economy that includes measurable and meaningful progress. It also includes rural areas with more balanced, integrated and vibrant urban settlements relating to the sphere of influence of Phuthaditjhaba to the villages in QwaQwa (South Africa, COGTA, 2016).

The IUDF includes four strategic goals: (1) Governance, (2) Spatial integration, (3) Growth and (4) Inclusion and access. Based on these four strategic objectives, there are nine policy levers in the IUDF:

> (1) integrated urban planning forms the basis for achieving integrated urban development, which follows a specific sequence of urban policy actions: (2) integrated transport that informs (3) targeted investments into integrated human settlements, underpinned by (4) integrated infrastructure network systems and (5) efficient land governance, which altogether can trigger (6) economic diversification and inclusion, and (7) empowered communities; all of the above will demand effective (8) governance and (9) financial reform to enable and sustain these policy actions. The levers thus seek to address in combination the structural drivers that maintain the status quo (South Africa, COGTA 2016:8).

De Beer's (2016) study of the challenges that the IUDF hopes to address asserted that the IUDF has the potential to make cities more inclusive of the urban poor and disenfranchised, where equal liberation for all citizens will be the result. De Beer proposed five areas of focus for political and theological action: new economics, consciousness from below, collaborative knowledge generation, socio-spatial transformation and different politics. Richter et al. (2020) suggested an urban integration model that stakeholders can tackle by first focusing on technology solutions and providing the necessary detail for the specific context. IUDF interventions will be most suitable if they introduce new infrastructure service provisions and use resources cost-effectively in a green economy (Fieuw et al. 2019).

3.5.6 Spatial Planning and Land Use Management Act No. 16 of 2013

The Spatial Planning and Land Use Management Act (SPLUMA) No. 16 of 2013 is a framework for planning, spatial policy and land use management that is more inclusive of rural and informal areas that were not included during apartheid (Nel 2016a). Kruger (2014) and Van Wyk (2015) have cited SPLUMA as the first key piece of legislation that aims to address past injustices in South Africa. SPLUMA is thus legislation for sustainability and creating equitable development through land use management tools (Nel 2016b and Schoeman 2017).

SPLUMA is centred around five principles: (1) spatial sustainability (including state involvement in food security, settlement sustainability, and innovative planning); (2) spatial resilience (context-specific, flexible measures ensure sustainable livelihoods and build resilience against unexpected life events) (3) spatial justice (redressing past injustices in development and ownership through upgrading, among others); (4) good administration (including planning and decision-making tools, community empowerment through public participation, and spatial performance management); and (5) efficiency (promoting efficient, good governance to optimise current resources and reduce negative economic, socio-cultural and environmental aspects).

3.6 Land Use Planning

Land Use Planning (LUP) is a component of the broad discipline of Urban and Regional Planning of the built environment, which is an approach to negotiating decisions for sustainable land use that includes initiating and monitoring implementation (Amler et al. 1999). Taylor (2010) argues that LUP is used interchangeably with spatial planning as it includes a wide range of planning documents that focus on social, environmental and economic aspects of settlements. Liu and Zhou (2021) further define spatial planning as long-term planning and the arrangement of space layout of land resources of a region or country with the aim of scientific management and effective control of territorial space while promoting a balance between protection and development. Lastly, for Metternicht (2017), LUP contributes to sustainable land management that includes economic, socio-cultural and ecological dimensions of sustainable development through the processes of land use design, land use planning and land development.

3.6.1 Zoning as a Land-Use Tool

With an understanding of what LUP and spatial planning are, the primary means of implementing LUP is zoning; a tool involving dividing larger areas into units or zones according to interrelations and characteristics (Amler et al. 1999; Karimi and Adams 2019, and National Research Council 2009). According to Metternicht (2017), zoning is a practice that drives forces of change to promote environmentally-sound land use and management, leading to reduced land degradation, resolving conflicts of land demand, ecosystem rehabilitation and enhancing territorial cohesion towards sustainability. Such zoning, therefore, plays an essential role in how land is utilised and managed in a large area to be representative of the various needs that arise. Zoning is separated into base and overlay zones.

3.6.1.1 Form Based Codes

Base zoning, also known as form-based zoning, regulates land use and form that may take place through form-based codes that determine the physical structure of a community to create adaptable and walkable environments (Chandler and Dale 2001; Hughen and Read 2017; Qurnfulah and Isah 2019). In the international context, zoning regulation is implemented through zoning ordinances (Juergensmeyer and Roberts 2013). In the South African context, bylaws are used to respond to the local context of municipalities drawing from SPLUMA (Nel 2016a).

SPLUMA further requires municipalities to produce land-use schemes (LUS) for land use management and regulation that include slums, informal settlements, and areas previously not subject to LUS, such as Phuthaditjhaba and the greater QwaQwa area (Van Wyk 2015 and Nel 2016a). LUS consist of land zoning codes with land uses and zoning maps (Denoon-Stevens 2016). The most common types of zoning codes are residential, commercial/business, institutional/school, administrative/government, mixed-use, public open space, industrial and special zonings specific to the town/city (Lemar 2015; Kazemzadeh-Zowet al. 2017; Nel 2016a, b). Zoning is regulated through specific regulations controlling density or bulk, parking size, floor area ratio and height (Chandler and Dale 2001). A zoning map depicts the allowable uses of certain land areas by the municipality, property developers, residents and business people (Denoon-Stevens 2016; Tafreshi and Tafreshi 2021; Ciurleo et al. 2016). Base zoning is greatly considered in the study as it forms a critical part of the technical implementation of land uses that can assist with expanding the Phuthaditjhaba CBD through SDGs.

3.6.1.2 Overlay Zoning

Overlay zoning is a tool used to create special zoning districts placed over existing base zones (Gravin 2001). Furthermore, overlay zones cut across multiple base zone boundaries to create an overlay for intended outcomes (Robayna 2018).

Overlay zoning is generally grouped into four districts: commercial, residential, manufacturing and apartment (Shertzer et al. 2018). Overlay zoning can be utilised to incentivise the development of a city that is beneficial for property owners and community members (Clarke and Mogassabi 2019). It is also a critical tool that the study considers to assist with expanding the Phuthaditjhaba CBD through SDGs.

3.7 Findings

The findings in the chapter are grouped into two themes, namely perceptions of surrounding homeowners and responses from businesses.

3.7.1 Perceptions of Surrounding Homeowners

The inclusion of homeowners was based on a 1 km proximity to Setsing. Six homeowners (numbered H1 to H6) participated in the study and shared their perceptions regarding the topic. The results of the findings are discussed in chronological order of the questions to which homeowners responded. These homeowners indicated their time as residents of QwaQwa ranging from 33 to 54 years, demonstrating that they have lived there long enough to have an informed opinion of Setsing. It is worth noting that of the six homeowners, two had received ownership of their homes from their parents that moved out of QwaQwa.

It was important to establish what all homeowners thought of land provision for current and future commercial activities in Setsing. All six participants agreed that this was not sufficient for current activities or future expansion. They remarked as follows:

> Setsing is too congested. The walkways are not in a good condition. Not forgetting the traffic congestion issue that is made worse by traffic lights that do not work (H1).

> The town is too small. Near Bibi Cash and Carry it's too congested. Street vendors are also packed everywhere. Pirate taxis are also an issue for me. There is no order in Setsing! The shops are too packed in town, which leads to a lot of crime. I think banks should also consider opening branches in villages (H2).

> There is a need for provision of more roads in town. From my previous participation in the Land Advisory Committee of QwaQwa, things were planned for correctly. But, as you can see, the town doesn't have enough provision to grow (H3).

The homeowners were asked to indicate if they knew what town planning (urban and regional planning) was and how it affected their property. Of the six homeowners, only two clearly understood what town planning entailed and its effects on their properties. Four homeowners indicated that they did not understand what town planning was, stating:

> I have heard of it, and my daughter does it, but I do not really know what it is about (H2).

> I think town planning has something to do with planning new towns. I am not sure how it affects my property, though (H4).

> I think town planning has to do with planning new areas (H5). I have heard of it before, but I am not sure what it is about (H6).

An explanation was offered to those that did not know what town planning is and how it affects their property. Land use management is the relevant town planning activity for assigning land use rights to a property based on the context and the needs of the time. To ascertain future sustainability, tools such as the SDF, integrated development plan and growth and development strategies are used for long-term planning for specified areas.

The final question was whether the homeowners would be willing to leverage (sell or trade on) their properties to allow Setsing to have some expansion options. There was an even split between the six homeowners as three indicated that they would be willing to leverage their properties to allow Setsing to expand:

> I would be willing to sell my property because we experience a lot of criminal elements from the homeless drug addicts that live in town and loiter in my community due [to] its close proximity (H1).

> I currently run a business from the house my parents gave me that is profitable because I live near town. This suggests to me that there is great

> opportunity for anyone that is willing to develop because the demand is there (H5).
>
> I would be willing to participate in leveraging from my property because I have a guesthouse. QwaQwa is in need for such considerations needed because our town needs to develop for us to benefit economically (H6).

The remaining three homeowners disagreed:

> No. At the age of 72, I am no longer interested in participating in those sort of things. I have done my time and need to rest now (H4).
>
> I have lived here for too long, and this is where I would like to spend the last days of my life (H3).
>
> I am not willing to participate in this but am sure that other people would be willing to. I have invested time and money into building my home (H2).

3.7.2 Responses from Businesses on the Expansion of the CBD

The business respondents were from two formal and three informal businesses operating in Setsing and one business located in a neighbouring section of Phuthaditjhaba. It was important to obtain the responses from business participants (BPs) because they currently provide goods and services to the residents of QwaQwa and neighbouring towns and already offer employment opportunities to the QwaQwa community. All six BPs indicated that they felt Phuthaditjhaba needed planning interventions for expansion. Due to the nature of their business not being the same, the BPs offered different ideas.

BP1 is a formal business that sells weight loss products from a rented office space, whose representative stated:

> There are many people in QwaQwa, who, like myself, would like to participate in business. However, the challenge of facilities and infrastructure presents us with major drawbacks for growing our business.

BP2, an elderly woman, who has been selling school uniforms on a sidewalk in Setsing since 1985, expressed that this was all she knew how to do. Having raised children and grandchildren, it was heart-warming to hear how a business that not many people would consider lucrative was able to provide enough to raise an entire family. She voiced that:

> The biggest challenge for my business is not having access to storage facilities that are exclusively for my business. I currently make use of shops around here to keep my stock for me when I go home. Which means that my business operations are linked to their operational hours.

BP3 represents a local store with seven outlets in QwaQwa and two other towns outside QwaQwa. It was important to include this formal business because of its economic contribution to QwaQwa − it is one of the biggest businesses and employs approximately 1 000 people. When asked to comment on whether there was a need for Setsing to expand, BP3 stated:

> As a business, we have been able to succeed in a condition where informal traders surround our store selling products that we also sell. Pirate taxis that cause congestion affect parking space. The municipality has not been supportive in ensuring that we receive sufficient water and consistent electricity, which is what our business relies on heavily.

BP4 is an informal business that has been trading in fruit and vegetables since the mid-1990s. She started this business due to poor alternative employment prospects. When asked to comment further, she explained:

> What you are talking about is important because I currently work with my daughter that I raised, using the money I made here. My wishes were for her to complete school and have a better job but had to realise that she could not access those opportunities after not performing well at school. There is a need for space so that people like my daughter can also trade because this is my space.

BP5 is another informal business that trades fruit and vegetables. BP5 had been in business since 1986 while a large part of Setsing was under construction. When asked to respond, she expressed:

> I have been selling my goods from this spot since 1986. I rely on people that walk past here to buy the goods I sell. However, I feel like the state of our town is not too good because there is litter everywhere. There is planning which our government has to do to fix this situation.

BP6 operates a law firm in the neighbouring section of Phuthaditjhaba and contributed to the study by pronouncing that:

> After I completed my articles to be an admitted attorney, I applied for jobs but was not getting satisfactory feedback. I was based in Welkom but eventually decided to come back to QwaQwa and use the house my parents had given me to establish a law firm. I have been in business since 2017 and have seen the potential this area has due to the proximity to town. I also have future plans to develop this property into a business park.

3.7.3 Responses from Town Planning Official and Observations of the Study Area

Responses from the town planning official and observations were grouped together because the outcomes of the observations were a direct reflection of planning in Phuthaditjhaba. The town planning official (TPO) was included in the study to determine the process followed for land use applications in Phuthaditjhaba in general and the CBD in particular. When asked about the history of land use management in Phuthaditjhaba, the TPO stated:

Phuthaditjhaba, as an urban centre in the former homeland of QwaQwa, is part of many other[s] which were planned centrally by the apartheid state using top-down planning. Not much provision was made to empower the town to have its own town planning scheme to guide development. For most years after apartheid (post-1994), we have relied on assistance by the Department of Cooperative Governance and Traditional Affairs (CoGTA).

Based on further engagement with the TPO, it turned out that despite apartheid laws having been repealed in 1993, "former" black Townships such as Phuthaditjhaba relied on the Black Communities Development Act 4 of 1984 for land applications in the area. A further contribution by the TPO included:

Even though SPLUMA commenced in July 2015, Phuthaditjhaba still does not have its own land-use scheme as required by the act. We, however, do consider SPLUMA in collaboration to CoGTA when working on applications submitted.

During apartheid, commercial property within the Phuthaditjhaba CBD was owned by the QwaQwa Development Corporation (QDC), later renamed the Free State Development Corporation (FDC). Post-apartheid, private sector developers have had a significant need for participation based on the critical mass in QwaQwa. The Maluti Crescent Mall to the northwest of the Mofumahadi Manapo Mopeli Hospital was developed on land previously used as accommodation for nurses working at the hospital. This mall was a second-phase development of the Setsing Crescent Shopping Centre that was bought and upgraded by the Vukile Property Fund after facing challenges acquiring land to the east of the hospital for approximately three years. The time-consuming experience of the Vukile Property Fund is fairly common in QwaQwa because potential developers pull out due to a lack of support from the municipality.

Clear signs of a lack of planning are evident in how there is a major contestation between formal and informal business for space throughout the Phuthaditjhaba CBD, which began after deindustrialisation in the 1990s, as also previously cited by Denoon-Stevens and Mocwagae (2019). Figure 3.3a demonstrates how informal traders are situated directly in front of similar formal businesses. Furthermore, Fig. 3.3b shows how grimy Setsing has become. Note the water leak from an adjacent building flowing into the road.

It has become common practice for affluent residents to purchase goods and services from Bethlehem, 70 km away, due to the congestion and crime in Setsing. This implies that residents now spend money outside the area that could have created more investment and employment opportunities in a municipality with a general unemployment rate of 41.8% in 2016 (Local Government Handbook 2016).

Further to the pressure of contestation of formal and informal business is a lack of well-functioning and adequate road maintenance in the Phuthaditjhaba CBD. Figure 3.4a depicts

Fig. 3.3 Pressure on the Phuthaditjhaba CBD. Credit: Kgosi Mocwagae

Fig. 3.4 Road infrastructure challenges. Credit: Kgosi Mocwagae

traffic transgressions caused by a lack of demarcation of road markings and non-functioning traffic lights. Figure 3.4b shows poor governance, displayed by uncleanliness in the town and an incomplete road surface.

3.8 Discussion

The lack of planning for the extension of Setsing may be a direct consequence of the poor governance of the municipal area, as shown in

Figs. 3.3 and 3.4. This can largely be traced back to poor planning during the apartheid era, which did not envision the need for a dynamic homeland town of Phuthaditjhaba; thus, not offering land use management tools that would assist with retail and service centre functions (Nel 2016a, b). However, many of the governance problems experienced in the area can be linked to the same problems plaguing the majority of South African municipalities.

As per the homeowners' responses surrounding the Phuthaditjhaba CBD, three out of the six participants indicated that they would be willing to either rezone or sell their properties for the purposes of a merger of the CBD. This would initially need base zoning to be established for the classification of various land uses, coupled with an overlay zone that would cover areas that would be practical to include for homeowners that would like to participate in the expansion of the CBD. This is the route many central business districts have taken. However, social, economic and environmental effects must be considered. Two participants mentioned that they were unwilling to move from a home with social and emotional value, even if it meant they could move to a home of similar financial value. Additionally, during a transitional phase from residential to commercial uses, properties may not be maintained due to speculation, with detrimental effects on the environment and possibly the economy. This option characterises the resource conflict between the economy and the environment (Campbell 1996, 2016).

Secondly, taller buildings should become more common within the Phuthaditjhaba CBD to reduce the sprawl caused mainly by informal businesses contesting for space. However, this plan will increase the construction cost and, subsequently, local businesses' rent, which may be unsustainable for small enterprises. If vertical development were to reduce street-level pedestrian traffic, it would severely disadvantage the informal traders who depend on this traffic. This would exacerbate the existing inequalities—an example of the property conflict (Campbell 1996, 2016; Masuku and Jili 2019). However, the scale of the development required in the Phuthaditjhaba CBD may not be appropriate to the scale of the local economy and thus not financially viable.

Would the development of a completely new CBD resolve the problem? This option would seriously impact the existing investment in buildings and infrastructure where the current market for goods and services would decline substantially with a move elsewhere. Teller (2021) states that small cities can also have multiple centres (polycentric). It can be considered based on the demand of retail shops and businesses. Equally or more affected would be the tenants and employees of enterprises who could find their livelihoods declining. This would be unjust for some, while a few may benefit. Furthermore, the development of a new site may have its own set of environmental problems, including generating traffic, urban sprawl and the demand for additional services, issues associated with the development conflict. It is also worth noting that the topography of QwaQwa makes it challenging and expensive to develop due to Phuthaditjhaba being in a valley (Campbell 1996; Watson 2014; Paller 2020).

The expansion of Setsing requires participatory planning that includes all sectors of the community. Watson (2014) argued for the co-production of space in a manner that facilitates the involvement of all affected parties and promotes a bottom-up development with power more evenly spread between the participants. Such a process may yield innovative options that the municipality or its planners may not consider. It could also resolve, at least to some extent, the property conflict and possibly mitigate other conflicts in development.

3.9 Conclusion

This chapter has explored the extension of Setsing through the lens of SDG 11—sustainable, resilient and equitable cities as the central land use management policy mandated by SPLUMA, and other relevant policies such as the UN SDGs, NUA, Agenda 2063, NDP and IUDF. Setsing is the primary economic centre for a population of

over 284 000 from around QwaQwa, and others from neighbouring towns. The concept of sustainability became central because urban planning enforces development that is considerate to meeting current needs without compromising the future of others. With sustainability in mind, land use planning tools such as base and overlay zonings can sufficiently cater to current needs without comprising future generations. Conflict over space was observed in the area, and there was consensus that action was needed. Participatory planning that includes all stakeholders in the co-production of plans and their implementation is recommended as the most appropriate way to deal with the extension of the CBD in a manner that is just and equitable, builds the economy and livelihoods and protects the environment. Utilising SDG 11 would play a valuable role in guiding localised policy initiatives to assist with the sustainable expansion of the Phuthaditjhaba CBD.

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4 Using Local Spatial Biodiversity Plans to Meet the Sustainable Development Goals

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Abstract

The Sustainable Development Goals (SDGs) represent global development ambitions, but achieving these goals depends on local-level application. Many local governments, especially in countries with emerging economies, lack the capacity and resources to integrate SDGs into municipal planning. The feasibility of local implementation is particularly challenging in areas with rugged topography and international borders, such as the Thabo Mofutsanyana District Municipality, South Africa, into which the city of Phuthaditjhaba falls. Here we explore the suitability of existing spatial biodiversity plans for local application in the six local municipalities within Thabo Mofutsanyana District. We considered four plans related to biodiversity and ecosystem services, including international maps of (1) Key Biodiversity Areas and (2) Strategic Water Source Areas; a national (3) Protected Area Expansion Strategy; and a provincial map of (4) Critical Biodiversity Areas. Although these plans were not designed specifically to meet the SDGs, we show that they can be repurposed to address seven of the 17 SDGs. Next, we summarised the spatial coverage of each plan across the six local municipalities and evaluated the opportunities and shortcomings of using these plans for local application. Our findings guide local officials on the most efficient way to plan for the SDGs using currently available spatial products.

Keywords

Protected areas · Planning · Ecosystem services · Land-use · Biodiversity

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4.1 Local Application of the Sustainable Development Goals

The Sustainable Development Goals (SDGs) articulate a shared vision for international development. The 17 SDGs define development using multiple indivisible criteria of economic progress, poverty alleviation and environmental protection. Achieving these multidimensional goals will require complete transformation of global socio-ecological systems (Sachs et al. 2019; Reyers and Selig 2020; Leclère et al. 2020) because current development pathways are causing widespread environmental degradation (Steffen et al. 2015; Díaz et al. 2019). Although the SDGs are detailed enough to build global consensus amongst nations, their success ultimately depends on local-scale implementation (Gao and Bryan 2017; Jiménez-Aceituno et al. 2020; Moallemi et al. 2020). A sustainable future will remain out of our grasp unless global ambitions are translated into actionable local policies (Irwin et al. 2018).

There are two general strategies for streamlining local implementation towards the SDGs. The first is to downscale global SDGs by defining science-driven sub-targets tailored to specific local contexts (Gao and Bryan 2017). This strategy redefines higher level aspirations in terms that are more relevant to local stakeholders, policymakers and practitioners, who can then devise new approaches for implementation (Jiménez-Aceituno et al. 2020; Moallemi et al. 2020). Although this strategy ensures that plans are tailored for SDG implementation, it would have to be compatible with existing policies, laws and institutions. By contrast, the second strategy is identifying existing local plans and policies and then evaluating whether these can be repurposed to meet higher-level SDGs. This latter approach has been followed for sector-specific energy (Fuso Nerini et al. 2018) and climate change (Fuso Nerini et al. 2019) policies, which have been re-interpreted through the lens of the SDGs. The advantage of repurposing existing policies and plans is that it ensures compatibility with current laws and institutions.

An effective starting point for repurposing existing plans and policies is to focus on those governing land-use. Although the SDGs are supposed to be indivisible, there are obvious trade-offs between individual goals (McGowan et al. 2019; Kroll et al. 2019), which can manifest as land-use conflicts (Gao and Bryan 2017). In such instances, the pursuit of one goal might jeopardise other goals. For example, land-use change for infrastructure development could contribute to economic growth (SDG 8), resilient infrastructure (SDG 9) and sustainable cities (SDG 11), while simultaneously polluting water sources (SDG 6) and destroying habitat (SDG 15).

Land-use conflicts may be exacerbated when landscapes have complex topography or straddle geopolitical boundaries (Payne et al. 2020; Vinca et al. 2020). Habitat heterogeneity means that landscape patches are less interchangeable, which makes identifying and managing potential trade-offs more difficult. Similarly, cross-boundary land-use management is complicated by differing legal frameworks and political priorities. Therefore, avoiding trade-offs between incompatible land-use policies are especially important in mountainous areas that cover more than one geopolitical jurisdiction.

Despite the importance of biodiversity for sustainable development (Blicharska et al. 2019; Bawa et al. 2020), attaining environmental SDGs may actually jeopardise the integrity of biodiversity (Reyers and Selig 2020; Zeng et al. 2020). This is partly because the SDG indicators focus on threats to biodiversity, rather than the actual state of biodiversity (Zeng et al. 2020). Moreover, the SDGs tend to consider socioeconomic systems as uncoupled from ecosystems, so socio-ecological interdependencies are not considered explicitly by the SDG framework (Reyers and Selig 2020). The consequence of this is that biodiversity is declining to the extent that it might be unable to support future human development aspirations (IPBES 2019; Díaz et al.

2019). Therefore, efforts to realign existing local plans and policies to meet the SDGs should prioritise safe-guarding biodiversity.

In this study, we examine whether existing biodiversity plans at a local level can be repurposed to meet the SDGs. We focus on six local municipalities in South Africa, which are adjacent to the international border with Lesotho. These six municipalities comprise a mixture of land-uses across complex mountainous terrain, making them susceptible to negative development trade-offs. For instance, prioritising land for smallholder farming might meet food security goals, but could jeopardise the supply of ecosystem services (e.g. increased erosion can worsen sedimentation in water bodies). To consider policies across varying scales of governance, we consider four existing plans for biodiversity and ecosystem services, which have been developed internationally, nationally, and provincially. In the following sections, we begin by describing the four existing biodiversity plans, paying particular attention to their opportunities and shortcomings for meeting the SDGs. We then present maps for each of these plans and summarise how they might affect the six municipalities differently. Lastly, we provide a roadmap for stakeholders, practitioners and policymakers on how existing biodiversity plans should be applied to meet the SDGs. Combined, this can guide local efforts to manage land-use for sustainable development.

4.2 Methods

Our study focused on six local municipalities in the Thabo Mofutsanyana District Municipality, central South Africa (Fig. 4.1a). South Africa has a multi-sphere government at the national, provincial and local levels. Local government is split into district municipalities, which focus on integrated planning and supplying bulk utilities; with nested local municipalities, which focus on town planning and local service delivery to residents. The six local municipalities (Fig. 4.1b) in this study are: Dihlabeng (which includes the main towns Bethlehem and Clarens), Maluti-a-Phofung (main towns Phuthaditjhaba and Harrismith), Mantsopa (main town Ladybrand), Nketoana (main town Reitz), Phumelela (main town Vrede), and Setsoto (main towns Senekal and Ficksburg). These municipalities are predominantly rural and agriculture is the main land-use. However, some towns have large and growing populations in desperate need of development. For example, according to the 2011 national census, Phuthaditjhaba has a population of approximately 55,000 people of which 30% are younger than 14 years old and only one third of adults have completed their secondary schooling. Thus, the need for sustainable development is urgent.

The biophysical environment of Thabo Mofutsanyana District Municipality can be classified as temperate grassland, with habitat heterogeneity caused by elevation and rainfall gradients that both increase from west to east (Fig. 4.1b). This climatic and topographical variation means that the biodiversity of the six local municipalities is not interchangeable and needs to be managed in a spatially explicit way. To this end, we consider four spatial biodiversity plans developed at different scales of governance and varying levels of detail. The first of these is a map of *Critical Biodiversity Areas* (CBA), developed by the provincial governmental department responsible for the environment (this is also referred to as the Free State Spatial Biodiversity Plan). The second plan is an international map of *Key Biodiversity Areas* (KBA), which was originally devised by Birdlife International and is currently being updated by the South African National Biodiversity Institute (SANBI) and BirdLife South Africa. The third is a national map of legally protected areas as well as areas earmarked for future protected area expansion. This map was developed by the national government Department of Environment, Forestry and Fisheries. The fourth map is a regional map of *Strategic Water Source Areas* (SWSA) in South Africa and neighbouring countries developed by the South African Council for Scientific and Industrial Research.

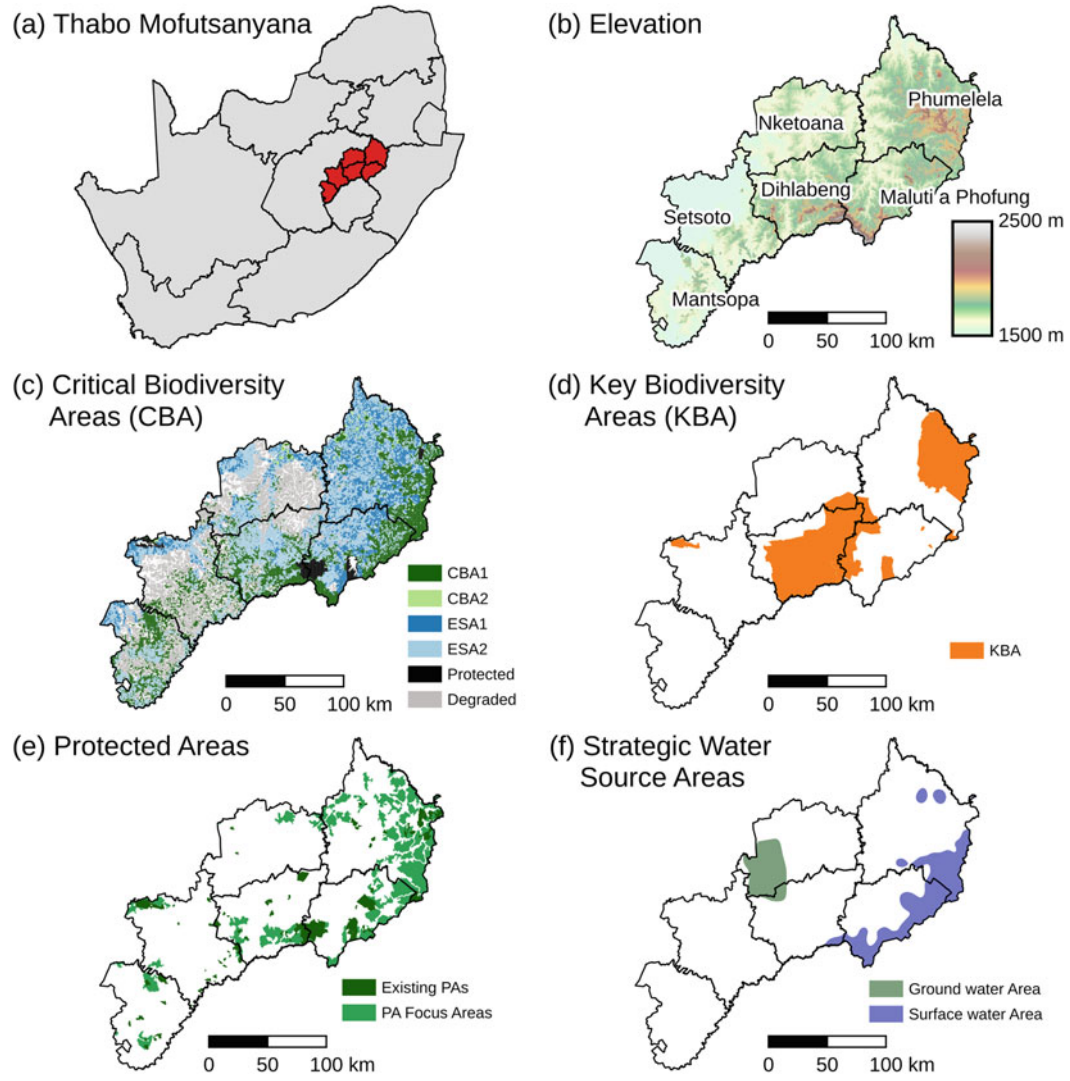

Fig. 4.1 Geographical distribution of biodiversity features in the six local municipalities of Thabo Mofutsanyana District Municipality. **a** The position of Thabo Mofutsanyana District in South Africa, and **b** the elevation and location of the six local municipalities. **c** Critical Biodiversity Areas (CBA) and Ecological Support Areas (ESA), **d** Key Biodiversity Areas (KBA), **e** Existing protected areas and protected area focus areas, and **f** Strategic Water Sources Areas (SWSA) for surface and ground water

We elaborate on the characteristics of each of these biodiversity plans in subsequent subsections.

4.2.1 Critical Biodiversity Areas

CBA are maps developed through a systematic conservation planning process (Margules and Pressey 2000; Kukkala and Moilanen 2013). Systematic conservation planning entails (i) dividing the landscape into planning units, (ii) mapping biodiversity features, (iii) identifying conservation targets for each biodiversity feature, and (iv) using a prioritisation algorithm to select the smallest and most spatially efficient set of ecologically connected planning units that meet targets for all the biodiversity features.

Planning units that are most essential for meeting biodiversity targets—referred to as irreplaceable—are classified as CBAs. By comparison, planning units that meet targets for biodiversity features, but which have potential substitutes elsewhere in the landscape (i.e. are more replaceable) are classified as Ecological Support Areas (ESA). The degree of irreplaceability can be used to further subdivide CBA and ESA into two levels each (CBA1, CBA2, ESA1, and ESA2). In South Africa, systematic conservation planning has evolved technically to the point where social and development objectives are incorporated into CBA maps (Buschke et al. 2019a, b; Botts et al. 2019). This means that the final prioritisation of planning units avoids areas that are likely to be developed in the future or which would carry a high opportunity cost if managed exclusively for biodiversity. Thus, CBA maps can be valuable tools for land-use planning by directing development away from areas of irreplaceable biodiversity.

The CBA map used in this study (Fig. 4.1c) is the official biodiversity plan of the Free State Provincial Department of Economic, Small-Business, Tourism and Environmental Affairs (Collins 2017), which represents the irreplaceability of hexagonal 100-hectare planning units. As input biodiversity features, the plan includes distributions of threatened and endemic plants, invertebrates and vertebrates; the extent of terrestrial and freshwater ecosystem types; migratory corridors; and areas of significant ecological and evolutionary processes, such as areas for climate change resilience and adaptation, and unique geological features (Collins 2017). CBA maps receive legal force from the environmental impact assessment (EIA) regulations in terms of the National Environmental Management Act 107 of 1998. In practice, this indicates that any proposed development within a CBA area will trigger an environmental authorisation process and any development without approval from the authorising government agency will be considered illegal (SANBI 2017). CBA have also been integrated into land-use schemes under the Spatial Planning and Land Use Management Act 16 of 2013, which categorises land use zoning and regulations for entire municipalities. Therefore, CBA are directly linked to existing legislation within South Africa and would align with existing institutions if repurposed to contribute to the SDGs.

4.2.2 Key Biodiversity Areas

KBA are sites important for the global persistence of biodiversity (IUCN 2016). Thus, they have much in common with CBA, but they differ in several important ways (Smith et al. 2019). While both CBA and KBA identify geographical areas of significant biodiversity, KBAs are not prioritised according to their relative ability to meet biodiversity targets nor do they consider socio-economic objectives (Smith et al. 2019). They, therefore, represent a biodiversity-centred view of the landscape, without considering other competing land-uses. This means that KBA can coincide spatially with high intensity land-uses, such as commercial agriculture (Buschke et al. 2020). Moreover, individual KBAs are considered equally significant for biodiversity, so it is not possible to rank one KBA above another.

Designating KBA boundaries vary because KBA are defined as sites that can realistically be managed as a single unit (IUCN 2016). This could be based on natural features, like water catchments; or geopolitical features, such as municipal boundaries or formal protected areas. Once the management unit is identified, it can be classified as a KBA if it contains a considerable proportion of the global distribution of (a) at least one threatened species, (b) geographically restricted biodiversity, (c) ecologically intact communities, (d) significant biological processes (e.g. breeding aggregations), or (e) irreplaceable biodiversity (IUCN 2016). This biodiversity-centred form of spatial planning means that KBAs tend to overlap closely with areas prioritised through systematic conservation planning, but imperfectly so (Plumptre et al. 2019).

The KBA map used in this study (Fig. 4.1d) is from the Key Biodiversity Area Partnership (http://www.keybiodiversityareas.org/), a partnership of 13 international conservation

organisations. The eight KBA in the study area (Alexpan, Ingula, Golden Gate, Grassland, Murphy, Rooiberge-Riemland, Sterkfontein, Willem-Pretorius) were originally classified by BirdLife International as Important Bird Areas because they contain globally threatened and globally significant congregations of bird species (Buschke et al. 2020). These Important Bird Areas were subsequently integrated into the KBA system, which is currently being updated by SANBI and BirdLife South Africa to include other taxonomic groups besides birds.

Currently, KBAs do not have specific legal standing in South Africa. However, this is likely to change in the upcoming decade because KBAs have taken a central position in negotiations of the post-2020 Global Biodiversity Framework under the Convention on Biological Diversity (Open-ended Working Group on the post-2020 Global Biodiversity Framework 2020). Target 2 of the draft version of the post-2020 framework aims to "*by 2030, protect and conserve through well connected and effective system of protected areas and other effective area-based conservation measures at least 30 per cent of the planet with the focus on areas particularly important for biodiversity.*" The implication is that KBA would represent the "*areas particularly important for biodiversity*" (e.g. Visconti et al. 2019). If this draft target is ratified by the Convention on Biological Diversity, then as a signatory to the convention, South Africa would commit to protecting KBA; thereby preventing harmful land-uses across these sites. This need not entail the establishment of formal protected area, but could include other effective conservation measures (Donald et al. 2019), such as biodiversity stewardship agreements (Wright et al. 2018). Therefore, KBA could constrain future sustainable development options through land-use restrictions, but they could also create opportunities for land-owners to diversify their incomes through private protected areas.

4.2.3 Protected Areas and Protected Area Focus Areas

Protected areas are the cornerstone of biodiversity conservation (Le Saout et al. 2013; Watson et al. 2014). These are areas of land that are managed exclusively for the purpose of conserving plants, animals and ecosystem services. Although the focus of protected areas is on conserving nature, in South Africa's National Environmental Management Protected Areas Act 57 of 2003 allows for these areas to also enhance nature-based tourism, provide sustainable access to natural resources and generally contribute to economic development. Moreover, the Act allows for varying levels of protection, including national parks managed by South African National Parks, provincial protected areas, local nature reserves managed by municipalities, as well as private protected areas.

As a signatory to the Convention on Biological Diversity, South Africa committed to protecting 17% of terrestrial land by 2020. However, it fell well short of this target (Buschke et al. 2019b) and set out to identify focus areas that should be prioritised for protected area expansion (Department of Environmental Affairs 2016). Focus areas overlap closely with CBA, but preference is given to sites nearer to existing protected areas or sites to potentially link existing protected areas in a connected network.

The protected area spatial dataset used in this study (Fig. 4.1e) is from the National Protected Areas Registry developed in accordance with Section 10 of the Protected Areas Act 57 of 2003. This registry is the official governmental source of information used to report to the Convention on Biological Diversity. We distinguished between existing protected areas, which are formally proclaimed and managed according to the Protected Areas Act 57 of 2003; and protected area focus areas, which are predominantly private farmland with reasonable

ecological intactness (Department of Environmental Affairs 2016). Protected area focus areas do not have formal legal protection, but they ought to be managed in a way that avoids high impact land-uses so as to maintain the option of future protection. Moreover, private land-owners might benefit from committing contractually to managing their land as voluntary biodiversity stewardship areas, which are also recognised by the Protected Areas Act 57 of 2003. This would make them eligible for financial incentives, such as tax rebates, for the duration of their stewardship contracts (Wright et al. 2018).

4.2.4 Strategic Water Source Areas

Ecosystem services are the benefits humans gain from nature. Although conservation planning has advanced considerably in the last three decades, incorporating ecosystem services into these plans have lagged behind (Villarreal-Rosas et al. 2020). An essential provisioning service is the reliable supply of clean freshwater. Strategic Water Source Areas (SWSA) are geographical regions that are disproportionately important for supplying clean freshwater and contributing to society and the economy (Nel et al. 2017). These SWSA can be further sub-divided into areas that are important for surface water supply and those important for ground water recharge. Surface water SWSAs are mountain catchments that generate disproportionate water runoff from precipitation compared to lower lying areas, combining the topographical and meteorological aspects of a landscape (Le Maitre et al. 2018a). In comparison, ground water SWSA represent areas of disproportionate importance for ground water recharge (based on run-off and geology-modulated infiltration rates) as well as ground water demand (based on human dependency on ground water sources) (Le Maitre et al. 2018a).

This study used an updated dataset of SWSA developed by the South African Council for Scientific and Industrial Research (Fig. 4.1f) (Nel et al. 2017; Le Maitre et al. 2018a). This included one ground water SWSA (Arlington SWSA) and portions of four different surface water SWSAs (the Maloti, Northern Drakensberg, Upper Vaal and Ekangala SWSAs). The Maloti and Northern Drakensberg SWSA extend across the national border with Lesotho and in combination support approximately a quarter of the South African population and a third of the gross value added to the national economy (Nel et al. 2017). Currently, SWSA are not directly protected by specialised legislation. However, they can be incorporated into land-use planning schemes—such as spatial development frameworks and integrated development plans—which do have legal protection (Le Maitre et al. 2018b). Furthermore, SWSAs also justify land-use management as outlined by national ecosystem guidelines, which recommend that high altitude grassland be managed as water production landscapes (SANBI 2013).

4.2.5 Analysis

The 17 SDGs are sub-divided into 169 targets (8–12 targets per SDG), which are monitored using 232 unique indicators. We evaluated the potential and consequences of repurposing existing biodiversity plans to meet the SDGS using a two-step process. First, we reviewed all the SDGs and their sub-targets and linked these conceptually to the four spatial biodiversity plans: CBA, KBA, protected areas and SWSA. Linkages were based on whether the biodiversity plans can be used towards meeting the SDG sub-targets, either because they represent key ecological features defined by sub-targets and their indicators, or because they can support or constrain activities designed to meet the SDG sub-targets. Therefore, we do not consider all the possible ways these biodiversity plans could affect the SDGs; focussing instead on the explicit links between these plans and the existing SDG monitoring framework (i.e. the 17 SDG, their 169 sub-targets, and 232 indicators). Once we linked each plan to relevant SDGs, we ranked each of the biodiversity plans based on how many SDGs they can contribute towards. The second step of this process was a geographic summary of four spatial biodiversity plans in the

six local municipalities within Thabo Mofutsanyana District. This allowed us to compare the six local municipalities in terms of the four biodiversity plans and make recommendations on how local stakeholders, practitioners and policymakers can use existing plans to guide their progress towards the SDGs.

4.3 Results and Discussion

4.3.1 Linking Biodiversity Plans to Sustainable Development Goals

There were direct links between existing spatial biodiversity plans and seven of the SDGs (Fig. 4.2). We only considered links where a biodiversity plans could be interpreted through a specific sub-target or monitoring indicator for the SDGs. This meant that indirect links were not considered in our assessment. For example, we did not include indirect links between the biodiversity plans and SDG 3 (*Good Health and Wellbeing*) even though managing wild species effectively would reduce the likelihood of zoonotic spill-over effects and limit pathogen transmission (IPBES 2020). However, the indicators for the sub-target associated with communicable diseases (Target 3.3) focus specifically on incidents or treatments of diseases, so they cannot be linked to biodiversity maps directly. Therefore, it is likely that our assessment underestimates all the ways biodiversity plans can support the SDGs indirectly.

SDG 2 aims to achieve zero hunger by 2030 and is particularly relevant to Thabo Mofutsanyana District, which has a strong agricultural sector. CBA can be repurposed to support Target 2.4 because it could ensure that food production maintains ecosystems and strengthens the capacity for adaptation to extreme weather, drought, flooding and other disasters. For example, mountains and rocky outcrops, which are identified as CBA, serve as refuges where invertebrates can persist during periods of drought (Buschke et al. 2020). Such resilience is needed to maintain the socio-ecological integrity of food production landscapes (Kremen and Merenlender 2018).

SDG 6 strives for clean water and sanitation. CBA, protected areas and SWSA can all be repurposed to support Target 6.6, which entails protecting water-related ecosystems. Moreover, SWSA also support Target 6.4 by ensuring freshwater supplies and Target 6.5 by identifying areas for cross-boundary integrated water resources management. The interbasin transfer of water from Lesotho to South Africa has considerable benefits for both countries, but these benefits are not without risk (Matete and Hassan 2006; Nel et al. 2017). For instance, while the transfer of water to South Africa has economic significance for many sectors (Matete and Hassan 2006), it still depends on healthy catchments to supply regulating ecosystems services and ensure that water stays unpolluted until it reaches end-users (Cumming et al. 2017).

SDG 8 promotes decent work and economic growth. Protected areas contribute to Target 8.9 by supporting policies to promote sustainable tourism, create jobs and promote local culture. Tourist visits to protected areas globally generate US$600 billion in in-country expenditure and US $250 billion consumer surplus annually (Balmford et al. 2015). Although tourism is encouraged by the South African Protected Areas Act 57 of 2003, the benefits of tourism are not constrained by the boundaries of these protected areas. Tourism in the Thabo Mofutsanyana District Municipality provides economic multipliers because tourism revenue tends to move between towns and local municipalities (Buschke and Seaman 2014). Thus, the overall contribution of protected areas to employment and the economy likely outweighs direct expenditures.

SDG 9 aims for sustainable industry, innovation and infrastructure. The CBA map supports Target 9.1 by guiding the sustainable design of infrastructure for economic development and human well-being. Because CBAs speak to the EIA regulations in terms of the National Environmental Management Act 107 of 1998, they directly affect the authorisation of infrastructure development projects. Thus, CBAs provide a direct mechanism for applying a spatially-

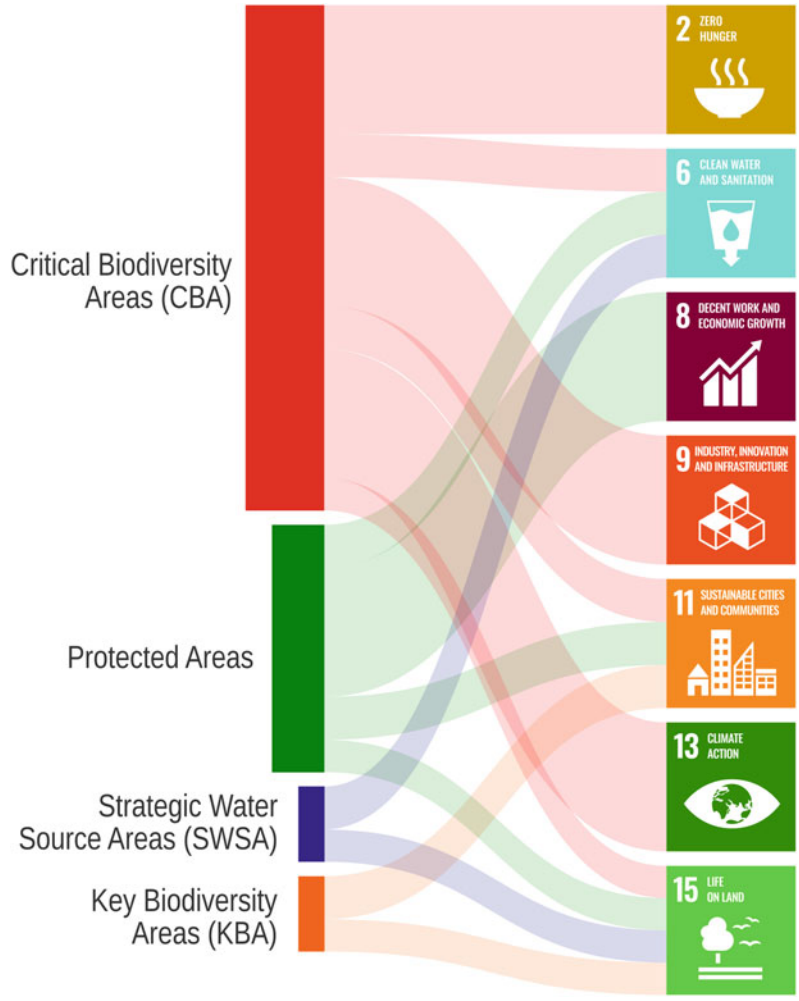

Fig. 4.2 The conceptual links between four spatial biodiversity plans and the Sustainable Development Goals (SDG). Spatial biodiversity plans are ranked according to the number of links to the SDGs, which are represented by the width of the coloured bars. The widths of the semi-transparent flows are determined by the proportional contribution of each plan to specific SDGs

explicit mitigation hierarchy during economic development activities (e.g. Arlidge et al. 2018; Bull et al. 2020). The benefits of this are twofold: first, it prevents unsustainable infrastructure development in sensitive ecosystems; and, second, it directs development towards least sensitive areas, reducing the regulatory risks to investors (Dempsey 2013).

CBAs, protected areas, and KBA can be used to meet SDG 11: sustainable cities and communities. This is because all three spatial biodiversity plans strength efforts to protect and safeguard the world's natural and cultural heritage (Target 11.4). Although the contributions of these plans to natural heritage are obvious given their original purposes, links to cultural heritage need elaboration. At the minimum, nature provides opportunities for education, recreation, harvesting and cultural expression (Mace et al. 2012). Nature also underpins relational values, which are not present in plants and animals as objects, but which are derived from the way people relate to nature (Chan et al. 2016). While relational values, like feeling a sense of place in a mountainous landscape, are often intangible, they can manifest themselves through the way people express their culture (Makombe and Nyambi 2021). A notable local example is San rock art, which is prevalent in the sandstone caves throughout Thabo Mofutsanyana District (Mol and Viles 2010; Grab et al. 2011).

SDG 13 aims to promote sustainable climate action and could be supported by CBA, which contributes to Target 13.1 by strengthening the resilience and adaptive capacity to climate related hazards and natural disasters. This is because systematic conservation planning accommodates corridors for climate-mediate migration (Rouget et al. 2006) and prioritises habitat features that provide refuge to species (Buschke et al. 2020). While there are other ways that biodiversity contributes nature-based solutions for climate change mitigation (e.g. carbon storage, drought resilience and flood water regulation), these links between the spatial biodiversity plans and the SDG sub-targets are only indirect.

It is unsurprising that all four spatial biodiversity plans link conceptually to SDG 15, which aspires to sustain life on land. This is because the plans were designed specifically to focus on terrestrial biodiversity. Therefore, they can be directly linked to the SDG targets to conserve and restore ecosystems (Target 15.1), combat desertification (Target 15.3), conserve mountain ecosystems (Target 15.4), and protect biodiversity and natural habitats (Target 15.5). They can also be linked indirectly to promoting access to genetic resources (Target 15.6), eliminating poaching (Target 15.7), preventing invasive alien species (Target 15.8), and integrating biodiversity into government planning (Target 15.9). These indirect contributions depend on these plans being used to support related initiatives, such as prioritising land for eradicating invasive species or implementing anti-poaching initiatives within protected areas.

4.3.2 Spatial Coverage of Biodiversity Features

The six local municipalities each cover over half a million hectares on average (Fig. 4.3a), with Phumelela in north-east being the largest (818,349 ha) and Mantsopa in the south-west the smallest (429,059 ha). These local municipalities are too large to be managed as homogenous units and should instead be sub-divided based on their ecological characteristics.

Although the median elevation for the six local municipalities is consistently higher than 1,600 m above sea-level, certain municipalities are more mountainous than others (Fig. 4.3b). Dihlabeng (containing the Witteberge and the Rooiberge mountain ranges) included peaks exceeding 2600 m above sea-level, and Maluti-a-Phofung (which incorporates the Rooiberge and Drakensberg ranges) has peaks exceeding 3200 m above sea-level. Phumelela (which is on the western slopes of the Drakensberg range) boasts the highest median elevation, but few high-altitude peaks (maximum = 2207 m above sea-level). By comparison, Mantsopa, Nketoana and Setsoto are generally less mountainous with more uniform topography. These flatter areas are more suitable for cultivation, which explains why these municipalities contain a higher proportion of degraded land caused by agricultural transformation (Fig. 4.3c).

Although five of the six local municipalities included more than 20% coverage of CBAs 1 & 2 (Fig. 4.3c), these areas tended to be in more mountainous portions of the landscape (Fig. 4.1c). For example, the Drakensberg in Phumelela and Maluti-a-Phofung were classified as CBAs, as were the Witteberge and Rooiberge in Dihlabeng. The CBAs in Mantsopa were also associated with mountain ranges, in this instance the Korannaberg inselberg on the northern sections of the municipality (Fig. 4.1c). The close association between mountains and CBA can be attributed to their lower likelihood of transformation (due to rocky substrates and steep slopes) and their disproportionate role in landscape-wide ecological processes (Buschke et al. 2020).

The contiguous municipalities of Dihlabeng, Maluti-a-Phofung and Phumelela had the highest proportional coverage by KBA (Fig. 4.3d). This is primarily due to the Rooiberge-Riemland KBA in Dihlabeng and Maluti-a-Phofung, and the Grasslands KBA in Phumelela. These two large KBA cover extensive areas that include sandstone outcrops, which provide nesting sites for globally vulnerable species like the southern bald ibis, *Geronticus calvus*; and high altitude wetlands, which supply habitat to critically endangered species like the wattled crane, *Bugeranus*

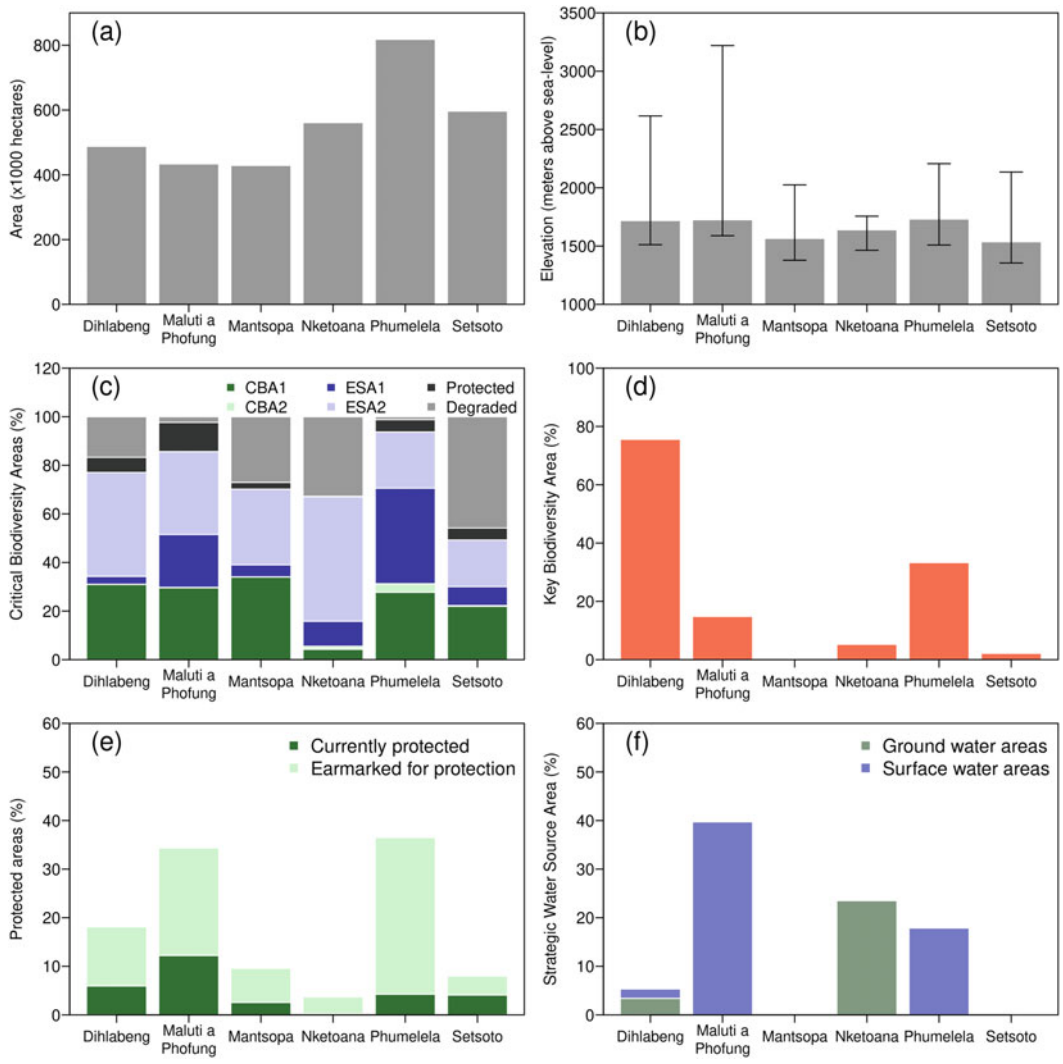

Fig. 4.3 The geographic characteristics of spatial biodiversity plans of six local municipalities within Thabo Mofutsanyana District Municipality. **a** The surface area of each local municipality in hectares. **b** The median elevation across municipalities, with minimum and maximum elevation as error bars. **c** The percentage coverage of features from the map of Critical Biodiversity Areas, which includes two levels of Critical Biodiversity Areas (CBA 1 & 2) and Ecological Support Areas (ESA 1 & 2). **d** The percentage coverage of Key Biodiversity Areas. **e** The percentage coverage of protected areas and focus areas earmarked for protected area expansion. **f** The percentage coverage of Strategic Water Sources Areas for ground and surface water

carunculatus, and the white-winged flufftail, *Sarothrura ayresi* (Taylor et al. 2015). Despite the global significance of these areas, they are generally poorly protected (Fig. 4.3e) and coverage does not even approach the 17% target for 2020 set under the Convention on Biological Diversity (Buschke et al. 2019b). Only Maluti-a-Phofung exceeded 10% coverage by protected areas, mainly due to Golden Gate Highlands National Park and Sterkfontein Dam Provincial Nature Reserve. That said, the more mountainous local municipalities (Dihlabeng, Maluti-a-Phofung and Phumela) had higher proportional coverage of protected area expansion focus areas (Fig. 4.3e).

The high elevation Maluti-a-Phofung and Phumlela municipalities were more likely to overlap with the Maloti and Northern Drakensberg SWSA. However, more than 20% of the low-lying and heavily transformed Nketoana Municipality included groundwater SWSA (Fig. 4.3f). This illustrates that even landscapes with relatively uniform topography and low biodiversity can contribute to the supply of water ecosystem services.

In summary, our spatial assessment allows us to make the following context-specific land-use recommendations. In Phumelela and Maluti-a-Phofung, which include large coverage of SWSA, land-use management should aspire to preserve biodiversity and ecosystem services by managing these areas as water production landscapes. The National Ecosystem Guidelines recommend using (i) a low intensity fire management program that considers slow plant growth times and high erosion rates, (ii) restrictive grazing of bulk, rather than selective grazers at low stocking rates, and (iii) focus on sensitive plant and animal species of concern during the EIA process (SANBI 2013). Dihlabeng, with its high coverage by KBA, should prioritise managing the landscape for biodiversity, paying particular attention to plants and animals in agricultural landscapes (e.g. Buschke 2016) and keystone ecosystems that provide resilience to climate change (e.g. Buschke et al. 2020). Nketoana should be managed as a ground water production landscape, which includes maintaining interventions to enhance water infiltration by respecting buffers around wetlands, avoiding fragmentation of primary grassland, and minimising urban sprawl (SANBI 2013). Lastly, Setsoto and Mantsopa had relatively lower representation of significant biodiversity and ecosystem services, so these areas could accommodate more intensive land-uses like cultivation agriculture. However, managers in these municipalities ought to identify parts of their landscapes that are important for ecological and evolutionary processes linking plants and animals across larger scales. For example, Korannaberg, a complex isolated sandstone plateau that straddles both these municipalities, is prioritised by the CBA map as important for climate change resilience and maintaining migratory corridors between dry highveld grasslands in the western Free State and mesic highveld grassland in the eastern Free State.

4.4 Conclusion

Meeting the SDGs by the year 2030 will require substantial societal transformation (Sachs et al. 2019; Reyers and Selig 2020). Our study illustrates that these transformations need not start from a blank slate in Thabo Mofutsanyana District. Instead, spatial planning tools already exist, which can be used to meet seven of the 17 SDGs. However, the mere existence of these plans does not guarantee sustainability in the upcoming decade. In order to extract the most benefit from these existing tools, we make three recommendations.

First, stakeholders, practitioners and policymakers must educate themselves about the existence of these spatial biodiversity plans, including the characteristics of each plan as well as their strengths and weaknesses towards meeting the SDGs. We believe that this study is a useful resource for this purpose. Second, stakeholders, practitioners and policymakers would benefit from a deeper understanding of the spatial distribution of biodiversity features throughout the landscape. For coarse plans—such as KBA and SWSA—it may be sufficient to use static maps to identify relevant biodiversity features. However, the coarseness of these plans will require additional refinement to prioritise smaller landscape elements within broad areas of significant biodiversity and ecosystem services (e.g. Buschke et al. 2020). By contrast, identifying and querying more refined biodiversity plans—like CBA and protected area focus areas—might require rudimentary expertise in geographic information systems, so implementation should be coupled with technical capacity building and information transfer. Third, the spatial biodiversity plans described here should be integrated with land-use policies, regulations and legislation. Plans such as CBA maps and protected

areas are already legally enforceable through the EIA regulations and the National Protected Areas Act, respectively, so the focus here should be on the enforcing current legislation more effectively. In comparison, KBA and SWSA are not legally binding unless they are interpreted through alternative policy frameworks, like spatial development frameworks and integrated development plans. This would require transdisciplinary land-use management that more accurately reflects the indivisible SDGs (McGowan et al. 2019; Kroll et al. 2019).

Ultimately, attaining a sustainable future in Thabo Mofutsanyana District Municipality requires that stakeholders, practitioners and policymakers visualise a dynamic and interdependent socio-ecological landscape. Such a vision ought to see the development of any one parcel of land as a thread in a much larger tapestry. Spatial biodiversity plans reflect this interconnectedness, so repurposing these management tools could lay a strong foundation towards meeting the SDGs in the upcoming decade. But, like any tool, their effective use will depend on the ambition and competence of land-use managers and decision-makers.

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Beneficial Role of Pollination and Soil Fertility for Soybean Production in Mountainous Farming Conditions

5

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Abstract

The synergetic potentials of essential ecosystem services have not been well explored under mountainous farming conditions in southern Africa. Cropping practices that maximize beneficial pollinators and reduce dependency on chemical inputs through efficient crop management in the mountainous environment are needed. The synergetic potentials of insect pollination on soybeans under varying soil fertility during two seasons in Phuthaditjhaba, the Free State, South Africa was examined. We manipulated soil fertility with fertilizer treatments and used exclusion bags to manipulate pollination intensity. High intensity of pollination services increased the seed yield by approximately 0.5 tons per hectare on optimally fertilized soil and 0.3 tons per hectare on minimally fertilized soil. This study found complementary benefits of using appropriate fertilizer rates on crop pollination. It is an efficient way to minimize losses in crop production and improve yields. However, minimal fertilizer application that is common among smallholder farmers still gave substantial yield in insect pollinator-rich environments such as Phuthaditjhaba. This finding gives an immense advantage to farmers in Phuthaditjhaba who tend to minimize the use of fertilizer due to financial issues. Harnessing the prospects from these ecosystem service benefits would help local communities to attain sustainable food production (SDGs 2 and 15).

Keywords

Fertilizer · Flowering · Honeybee · Plant growth · Seed yield

5.1 Introduction

Mountain regions harbor great biological richness and are centers of biodiversity, but are greatly affected by climate change causing shifts in temporal and spatial insect species distribution and habitat losses (Liu et al. 2019). The interaction of climate change on insect pollinators' availability and the role of synthetic fertilizers during crop flowering on fragile mountain ecosystems are still unknown. Maintaining insect biodiversity and attaining sustainable food production in mountainous areas which is currently a challenge—contributes to achieving UN Sustainable Development Goal (SDG) 2 and even

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other SDGs. Therefore, improved crop management practices are essential (Viana et al. 2022).

The smallholding farming system is one of the unique and resilient strategies embraced by the mountainous community of Phuthaditjhaba in the eastern Free State, South Africa (Myeni et al. 2019; Adelabu et al. 2020). In addition, strategies that reduce reliance on chemical inputs and harness the potential of agro-ecological services in crop production could increase food security and sustainability in the community (Garratt et al. 2018; Adelabu et al. 2020). Despite the beneficial roles of ecosystem services in the agricultural landscapes of Phuthaditjhaba (Mukwada and Manatsa 2018), sustainable cropping is still very limited due to resource constraints, such as favourable agricultural policies, the use of agricultural biotechnologies, and the availability of extension expertise and funds, in comparison with other urban farming communities in South Africa (Grebitus et al. 2020).

Crop pollination is a crucial ecosystem service, while the response of crop yield to pollination is interwoven with soil nutrients and water management (Garibaldi et al. 2018). Embracing soil management practices that boost insect visitation may maximize crop yield and influence the usage of external inputs, thus affecting farmers' income, insect visitors' health and supporting the attainment of most of the 17 SDG goals, in particular 1, 2, 3, 10, 11, 12, and 15 (Garibaldi et al. 2020; Viana et al. 2022). These interactions have the potential to alter productivity and the performance of flowering crops, and an understanding of them is essential for proper management of multiple ecosystem services (Bartomeus et al. 2014; Kovács-Hostyánszki et al. 2017). Insect visitations are vulnerable to agricultural intensification, which reduces their biodiversity and abundance, consequently causing a substantial reduction in crop productivity and quality (Garibaldi et al. 2020). Studies indicated that yield benefits from common beans and other crops were affected by efficient interactions between soil nutrients and insect pollinations (Otieno et al. 2011; Bartomeus et al. 2014; van Gils et al. 2016) and other factors affecting crop yield such as micro-climate conditions, water, pest or disease status (Viana et al. 2022).

Cropping frequently relies on mineral fertilizers to boost crop productivity because of low soil nutrient availability (Wymann et al. 2014). The residual effects of these fertilizers disturb and alter soil compositions, consequently affecting the quantity and quality of flower resources, insect pollination and reducing the biodiversity hotspots (Campbell and Halama 1993; Ramos et al. 2018). Wagner et al. (2021) reported the abundance of insect pollinators and other native insect visitors to be decreasing globally. A reduction in floral resources available to insect pollinators was hypothesized to be a major reason behind pollinator loss (Hallett et al. 2017). There is an increasing interest in understanding the effects of agro-ecological conditions and soil nutrient management during the production of flowering crops such as soybeans under mountainous ecosystems (Klein et al. 2007; Kovács-Hostyánszki et al. 2017; Garibaldi et al. 2020).

Soybeans (*Glycine max* [L.] Merr) is a crop that benefits from insect pollination, though it is also capable of autonomous self-pollination. The most frequent insect visitors for nectar and pollen of soybean are honeybees, while Diptera and Coleoptera also play a vital role in its pollination (Santos et al. 2013; Fagúndez 2016; Blettler et al. 2018). Soybean production constitutes an important component in the mountain farming system of Phuthaditjhaba and in the cropping systems of South Africa in general (Liebenberg, 2013; Adelabu et al. 2020). South Africa has been a major producer of soybean for the last four decades, because of soybean's multiple roles in the livestock feed industry, for human consumption, and its biological nitrogen fixation abilities (Grain 2016; Chigeza et al. 2019). However, average soybean yields of 0.5–1.0 tons/ha were recorded among smallholder farmers in South Africa, which is much lower than the global average yields of 2.5–3.0 tons/ha (Khojely et al. 2018). This gap was attributed to production constraints such as infrastructural problems, vulnerability to climate change, degradation of ecosystem services and poor management of soil nutrients (Mutegi and Zingore 2014).

The use of mineral fertilizer alters the physiology, behaviour and diversity of insect visitors (Ramos et al. 2018). Tamburini et al. (2017) found, in northeast Italy, a strong interaction between pollination and soil nutrient availability affecting sunflower seed production which was maximized at intermediate nutrient levels. Manson et al. (2022) found that pollinator diversity and pollinator visitation time declined with increasing chemical usage in coffee farms of varying management intensity in West Java, Indonesia. Studies by Otieno et al. (2011) and Ramos et al. (2018) showed positive effects of native pollinators on common bean (*Phaseolus vulgaris* L.) yield that were more pronounced under low nitrogen inputs. Other studies reported few significant interactions between insect pollination and fertilizer application on crop yield. Van Gils et al. (2016) found insect visitation rate on oilseed rape yield did not depend on the level of soil fertilization, suggesting that increased oilseed rape yield was enhanced by pollinator visitation, irrespective of mineral fertilizer application. These variations in findings make it difficult to ascertain the impact of the interaction on the yield of modestly insect-dependent crops such as soybeans. Also, literature that attribute and quantify the role of insect pollination and soil fertility during soybean production at national levels for specific production regions, such as mountainous environments, are scarce. The importance of insect pollination—an ecosystem service—with soil fertility management during soybean production is unclear. The objective of this study was therefore to examine the synergetic response of insect pollination and different levels of soil fertility on soybeans seed yield and productivity under mountainous conditions.

5.2 Materials and Methods

5.2.1 Plant Materials and Crop Management

Soybean seed (Fundacep 65RR cultivar) was purchased from Capstone Seed Company in Free State, South Africa. It is an early cycle hybrid with a maturity group of 5.5–5.9, with medium plant height, white flower and grey pubescence.

5.2.2 Experimental Site Description

The field experiment was conducted from 12 November to 27 April during 2017/18; 28 December to 13 May during the 2018/19 summer season at the research farm of Seotlong Agricultural and Hotel School (28°45' S; 28°85' E, 1660 m a s l.) located in Phuthaditjhaba, the Free State, South Africa (Fig. 5.1).

The region is dominated by grassland vegetation, short and tall sour grass with a highly variable climate having warm to hot months (average annual temperature of 18.4 °C) (Brand et al. 2019). The winter months can be cold with temperatures of −9.5 °C. The annual rainfall (650–850 mm) occurs for more than 85% between September and March (Maloti Drakensberg Transfrontier Programme 2015). The trial site was previously used for maize and sorghum production; it has large surrounding patches of natural vegetation (uncultivated areas) at a scale of 1.5 km^2 during both seasons. The insect pollinators in the area are native pollinators that depend on the natural grasslands for their existence (Brand et al. 2019). Therefore, no specific permission was required to conduct this study because it did not involve the use of endangered or protected species.

5.2.3 Soil Sample Methodology

The soil at the experimental site was shallow, and classified as loamy-clayey soil (United States Department of Agriculture, 2014). Prior to planting each season, composite soil samples were randomly collected from 0–200 mm topsoil, then submitted for soil textural and fertility analyses at the soil fertility analytical services section, Department of Agriculture and Environmental Affairs, KwaZulu-Natal, South Africa. The soil exchangeable K, Cu and Zn, exchangeable Ca and Mg were analysed using

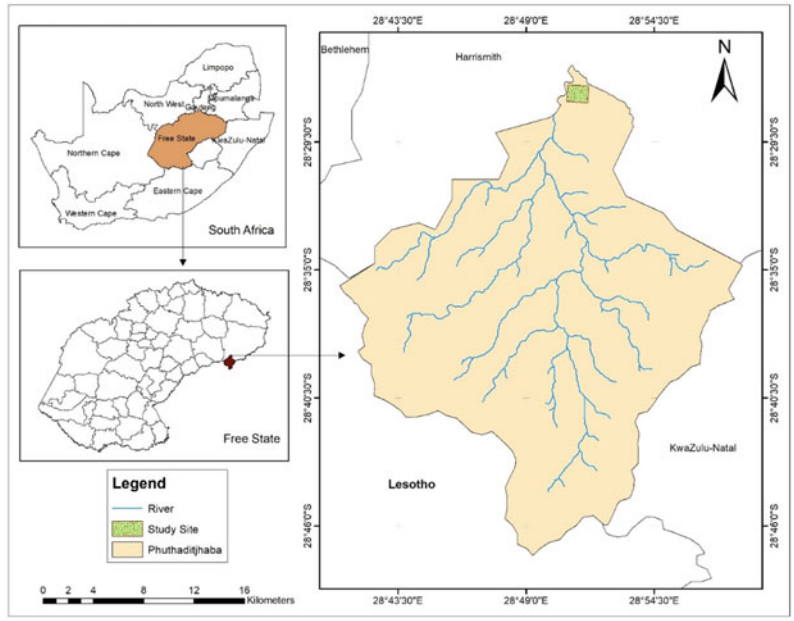

Fig. 5.1 Map of the experimental site at Seotlong Agricultural and Hotel School, the Free State, South Africa. (Map produced by Dr Adagbasa Efosa)

rapid procedures (Farina 1981), while Bray (1948) was used for the available P. The total C and N were determined by Dumas dry combustion method and Walkley–Black method for the determination of organic carbon. Based on the information from the soil chemical analysis (Table 5.1), an optimal soil fertilizer recommendation of 80 kg/ha N and 40 kg/ha P was used.

The planting date in 2017/18 corresponded to the beginning of rainfall at Phuthaditjhaba where there was $\geq$25 mm rainfall in 7 days prior to planting, which is the conventional period for planting soybeans among South African farmers. However, planting in 2018/19 was late due to a delay in rainfall and a shortage of soil water content. Weeding was done by hand hoeing.

Table 5.1 The physicochemical properties of soil (0–20 cm) before planting at Seotlong Agricultural college site in 2017/18 and 2018/19

Chemical composition	2017/2018	2018/2019
pH	5.03	4.59
Density (g ml-1)	1.12	1.14
Organic carbon (%)	0.72	0.80
N (%)	0.11	0.08
P (mg l-1)	13.00	8.00
K (mg l-1)	280.00	327.00
Ca (mg l-1)	921.00	640.00
Mg (mg l-1)	413.00	242.00
Total cations (Cmol l-1)	8.81	5.34
Zn (mg l-1)	1.10	1.80
Cu (mg l-1)	1.00	2.70

5.2.4 Experimental Design and Layout

In each planting season, the design was a split-plot replicated three times. The main plot comprised of soil fertility levels and sub-plots consisted of pollination rates. Based on soil chemical properties, soil fertility treatments consisted of N and P, where K fertilizer was not applied at all because the soil was not in the deficit of K. The soil fertility levels consisted of control (0 kg ha^{-1} N and 0 kg ha^{-1} P), minimal (40 kg ha^{-1} N and 20 kg ha^{-1} P) and optimal (80 kg ha^{-1} N and 40 kg ha^{-1} P) where urea (N) and triple superphosphate (P) granule fertilizers were used respectively. During both seasons, the trial site was 41.0 m × 12.8 m, with an individual plot size of 2.4 m × 3.6 m (8.64 m^2), and 1 m inter plot spacing between the plots given 111,111 plants ha^{-1}. This constituted four rows (planted 300 mm apart and 300 mm within rows) and the sampling units were made of inner rows where six plants were selected at each plot (Fig. 5.2).

5.2.5 Plant Physiological Growth Measurements

Plant height, leaf number, chlorophyll content index (CCI) and stomatal conductance (g_s) were measured on six randomly selected plants from the sampling units. Chlorophyll content index (CCI) was measured using a portable SPAD meter (SPAD-502-PLUS chlorophyll meter, Konica Minolta, Ramsey, New Jersey, USA) on the adaxial leaf surface. g_s was measured from the abaxial leaf surface during midday (12:00 p.m. and 14:00 p.m.) using a steady-state leaf porometer (Model SC-1, Decagon Devices, USA).

The pods were manually harvested and threshed and air-dried in the laboratory until they reached a moisture content below 12%, after which moisture content was determined on samples by oven drying. Yield components such as seed yield (kg ha^{-1}), thousand seed weight (kg), fruit weight/head (kg), head diameter (mm) and total biomass (kg ha^{-1}) were recorded. An average of six plant stands per plot was used for each parameter. The harvest index was computed as:

$$\text{Harvest index} = \frac{\text{Seed dry yield}}{\text{Total aboveground plant dry weight}} \times 100$$

5.2.6 Pollinator Exclusion

Pollination treatments were applied before flowering at the first reproductive stage of soybeans (R_1 stage) in each plot. Mesh net placement and

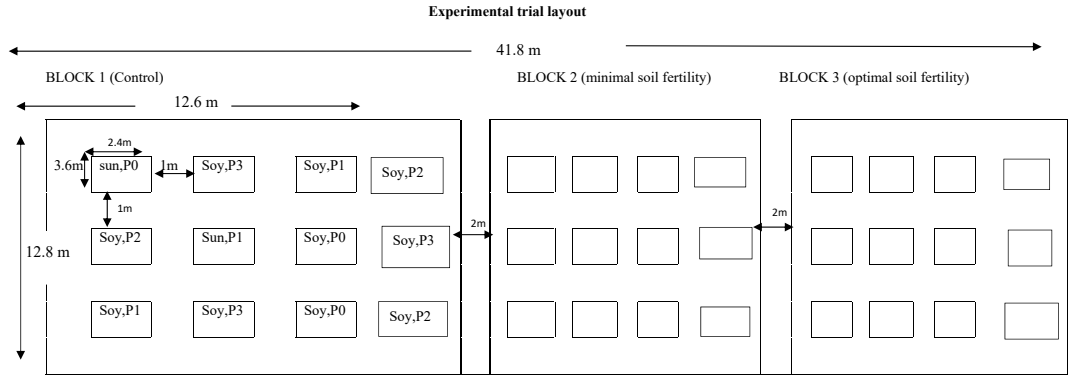

Fig. 5.2 Experimental design is 3 × 4 split plot design arranged in RCBD where sunflower,fertilizer levels [control (0 kg ha^{-1} N and 0 kg ha^{-1} P), minimal (40 kg ha^{-1} N: 20 kg ha^{-1} P) and optimal (80 kg ha^{-1} N: 40 kg ha^{-1} P)] and pollination rates (0%, 25%, 50% and 100%) were factors. Note: Soy, P0 = soybeans under 0% pollination rate, Soy, P1 = soybeans under 25% pollination, SoyP2 = soybeans under 50% pollination, SoyP3 = soybeans under 100%pollination

removal were performed according to the respective pollination treatments between 08:00 a.m. and 10:00 a.m. Plots were randomly assigned to four levels of insect pollination (0, 25, 50 and 100% pollination levels) at each soil fertility level. The different pollination levels were carried out using pollinator exclusion approach according to Tamburini et al. (2017) where the number of days those flowers were exposed to insect pollination was manipulated. Hence, during a hypothetical flowering period of 21–28 days, insects could visit flower heads 0, 7, 14 and 28 days, for 0%, 25%, 50% and 100% pollination rates respectively. Each of the mesh net was 1.8 × 1.5 m (1.2 mm diameter), fixed to the plant base to prevent insects from pollinating the plant. Newly emerged open flowers were cut from the plants and nets removed when marked flowers had finished flowering to allow undisturbed plant growth.

The 0% pollination rate was achieved by complete exclusion of the plants from insect visitation (no insect visitation) for the 28 days duration of flowering. Here, flowers were enclosed by tying large tulle mesh nets firmly around the stem of the six selected plants within the inner rows of each plot. The crop with 100% pollination rate had its equivalent area completely open to insect visitation (all insects could visit flowers) (Jacobs et al. 2009). Plants with 25% pollination rate consists one-day complete open for insect visitation followed by three days of covering with the mesh (no insect allowed). 50% pollination rate was attained by one day insect visitation where the mesh was removed for 24 h and later covered for another 24 h (no insect allowed). Crop phenology from planting to physiological maturity was followed weekly (Fehr and Caviness 1977).

5.2.7 Insect Visitation and Insect Sampling

The flowering period was from R2 (full bloom) to R4 (full pod) which took between 19 and 28 days. The guild-specific pollination behaviour was assessed following Tamburini et al. (2017), where the number of flowers visited was recorded on a subset of six randomly selected plants during one visitation event, for each pollinator guild (honeybees, beetles, butterflies and hoverflies). The average number of visitation events was calculated for each guild and used to estimate the number of flowers visited per plant. This was done daily by 5 min transect walks in each plot between 10:00 a.m. and14:00 p.m.. All insects touching the plant flowers were recorded at each soil fertility level. Observations were made at a distance of 80 cm from the flower to avoid disturbance, six plants were marked with a small piece of tape in each plot. The visitation rate of insects such as bees (Hymenoptera: Apoidea), hoverflies (Diptera: Syrphidae), ants (Hymenoptera: Formicidea), thrips (Thysanoptera:Thripidae) and butterflies (Lepidoptera: Nymphalidae) were observed and counted. Unidentified specimens were captured on the field and dichotomous keys and identification guides were used to identify insects (Bugg et al. 2008). This was carried out on days when temperatures were at or above 15°C, with no precipitation, dry vegetation, and low wind speed.

5.2.8 Yield Measurements

At the end of the season, all plants with marked racemes (six per study plot) were harvested from the plants and put individually in paper bags. Seed yield was determined after physiological maturity (R8) by cutting all plants at the ground level at each plot, followed by manual threshing. The mean of six plants was used for each parameter measured.

5.2.9 Weather Data

Daily weather data were obtained from an automatic weather station at University of the Free State QwaQwa campus (Lat 28.5, Long 28.8 and 1699 m.asl) managed by the Agricultural Research Council (ARC) and located 1 km from the experimental site. The weather parameters considered were rainfall (mm), maximum (T_x)

and minimum (T_n) temperatures (°C), maximum (RH_x) and minimum (RH_n) relative humidity (%), and evapotranspiration (mm).

5.3 Statistical Analyses

Data were analyzed using linear mixed-effect models (GLM). We analyzed the fixed effect as the pollination rates, soil fertility and their interaction on the proportion of yield components. To account for non-independence in the data, replications and years were included as random effect analyses. For the yield components and insect visitation, ordinary least squares (OLS) models were used. These models include only fixed effects and interactions. The plant physiology parameters, which consisted of plant chlorophyll content index and stomatal conductivity variables, were analyzed using Linear Mixed Effects Models (LME) and a random effect (the weeks after planting). The mixed models were fitted using the standard restricted maximum likelihood (REML) approach. Linear models were used to evaluate the effect of pollination rates, soil fertilization and their interactions on the yield components (fruit head diameter, fruit weight, thousand seed weight, total biomass, seed moisture content and seed yield). Visitation rate for insect types was firstly transformed by adding 1 to all counts and taking the natural logarithm. Where the ANOVA indicated significant differences ($P < 0.05$), we compared the treatment means using the Tukey test. All statistical analyses were performed using SPSS version 25.

5.4 Results

5.4.1 The Weather and Soil Conditions

During the 2017/18 season, rainfall in March was higher compared to other months which coincided with soybeans' vegetative growth stage. Rain decreased in April. In the 2018/19 season, plants experienced drought at the seedling stage (January) and an even distribution of rain in February and March, with prolonged rainfall into April. The air temperature and relative humidity in both seasons showed similar trends, while the minimum relative humidity in 2018/19 was a bit higher compared to 2017/18 (Fig. 5.3).

The weather conditions during the critical periods of flowering and pod formation were

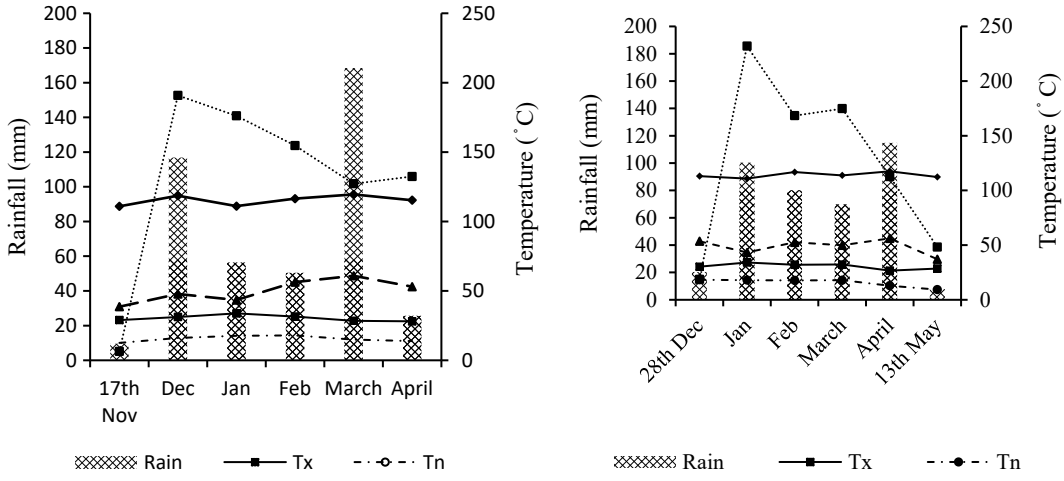

Fig. 5.3 Weather conditions during **a** 2017/18 and **b** 2018/19 planting seasons. T_x = maximum temperature, T_n = minimum temperature, ET_0 = evapotranspiration, RH_X = maximum relative humidity and RH_n = minimum relative humidity

Table 5.2 Results for linear mixed effect model of pollination rates, soil fertility levels and their interactive effect on yield components. ($df_{1,2}$) = Degrees of freedom for numerator and denominator for each variable refers to the complexity of the additive curve. P-values in italics are statistically significant ($p < 0.05$). All factors were treated as qualitative variables

Seed yield (T/ha)	df (1,2)	F values	P values	Total biomass (T/ha)	df (1,2)	F values	P values
Soil fertility (FL)	2,48	*27.306*	*<0.001*	Soil fertility (FL)	2,48	2.192	0.123
Pollination rates (PR)	3,48	5.294	*0.003*	Pollination rates (PR)	3,48	1.054	0.377
Year (Y)	1,48	21.612	*<0.001*	Year (Y)	1,48	1.551	0.219
FL × PR	6,48	2.464	*0.037*	FL × PR	6,48	0.828	0.554
FL × PR × Y	11,48	2.274	*0.025*	FL × PR × Y	11,48	1.206	0.309
Thousand seed weight (g)				*Number of pod/plants*	df	F values	P values
Soil fertility (FL)	2,48	17.844	*<0.001*	Soil fertility (FL)	2,48	23.366	*<0.001*
Pollination rates (PR)	3,48	9.529	*<0.001*	Pollination rates (PR)	3,48	3.648	*0.019*
Year (Y)	1,48	1.012	0.319	Year (Y)	1,48	10.632	*0.002*
FL × PR	6,48	0.528	0.881	FL × PR	6,48	0.958	0.464
FL × PR × Y	11,45	0.528	0.875	FL × PR × Y	11,48	1.279	0.265
Seed number/pod	df	F-values	P-values				
Soil fertility (FL)	2,45	54.954	*<0.001*				
Pollination rates (PR)	3,45	2.688	*0.057*				
Year (Y)	1,48	66.717	*<0.001*				
FL × PR	6,45	0.961	*0.462*				
FL × PR × Y	11,48	3.341	*0.002*				

almost similar in both years, while 2018/19 was drier and experienced higher temperature during seed filling compared with 2017/18 season. The soil pH at both seasons was slightly acidic but still within the suitable pH levels for soybean production in South Africa. The organic carbon, soil density, extractable K^+, and total N were comparable in both seasons. The Ca^{2+}, Mg^{2+} and total cations were higher in the soil during 2017/18 compared to the 2018/19 season (Table 5.1).

5.4.2 Yield Compositions

The crop experienced drought in the 2018/19 season which greatly affected its yield but its seed yield was still improved with pollination rate ($F_{3,48} = 5.294;\ P = 0.003$) and soil fertility ($F_{2,48} = 27.306;\ P < 0.001$). Both had synergetic effects on the yield ($F_{11,48} = 2.274;\ P = 0.025;$ Table 5.2).

Pollination increased seed yield by approximately 0.53 and 0.32 tons per hectare on optimally and minimally fertilized soil and by approximately 0.16 tons per hectare on poorly fertilized soil (Table 5.2). The pollination rates ($F_{3,,\ 48} = 1.054;\ P = 0.377$) and soil fertility ($F_{2,\ 48} = 2.192;\ P = 0.123$) as well as their interaction ($F_{11,\ 48} = 1.206;\ P = 0.309;$ Table 5.1) did not lead to increase total biomass across the years (Table 5.3).

The individual effect of soil fertility ($F_{2,48} = 17.844;\ P < 0.001$) and pollination rate

Table 5.3 The effect of soil fertility and pollination rates on the means ± SD of the yield components (PR = pollination rate)

Soil fertility	PR	Yield (Kg/ha)	Total Biomass (Kg/ha)	Pod/plant	Seed/pod	100 seed weight (g)
Control	0%	345.46^{a} (±91.03)	763.74 (±219.18)	22.49^{a}(±1.53)	1.69^{a}(±0.25)	24.54^{a}(±4.71)
	25%	361.10^{a} (±70.42)	892.00 (±177.94)	31.57^{b}(±6.69)	1.85^{b}(±0.30)	31.52^{b}(±8.53)
	50%	385.03^{ab} (±23.16)	931.02 (±129.92)	29.61^{b}(±7.24)	1.67^{a}(±0.15)	29.41^{ab}(±11.40)
	100%	334.35^{a} (±51.62)	992.33 (±178.04)	32.48^{b}(±15.02)	1.91^{b}(±0.22)	35.18^{bc}(±3.61)
Minimal	0%	418.47^{b} (±72.75)	949.84b (±225.98)	42.17^{c}(±9.31)	2.36^{c}(±0.67)	32.22^{b}(±8.19)
	25%	507.32^{c} (±186.98)	1073.04 (±135.00)	42.22^{c}(±4.10)	2.26^{c}(±0.62)	35.13^{bc}(±8.18)
	50%	504.51^{c} (±114.15)	1005.98 (±260.80)	47.00^{d}(±18.28)	2.30^{c}(±0.68)	38.58^{c}(±7.36)
	100%	594.08^{d} (±169.85)	975.86 (±228.40)	45.47 ^{cd}(±10.77)	2.46^{d}(±0.37)	43.52 ^{cd}(±6.12)
Optimal	0%	514.09^{c} (±194.44)	984.97 (±181.13)	39.13^{b}(±9.85)	2.44^{d}(±0.36)	35.73^{bc}(±8.22)
	25%	487.81^{c} (±77.71)	1714.74 (±281.00)	41.01^{c}(±12.55)	2.38^{c}(±0.57)	39.27^{c}(±2.65)
	50%	675.75^{e} (±140.72)	1229.30 (±249.79)	46.04 ^{cd}(±7.63)	2.64^{e}(±0.13)	42.80 ^{cd}(±5.91)
	100%	786.09^{f} (±153.60)	1299.78 (±230.75)	55.39^{e}(±6.72)	2.78^{f}(±0.17)	50.48^{d}(±4.29)
F values		7.753**	1.138^{NS}	5.766**	11.249**	6.057**
Df $_{1,2}$		11.48	11.48	11.48	11.48	11.48
P values		< 0.001	0.354	<0.001	<0.001	<0.001

($F_{3,48} = 9.529;\ P < 0.001$) significantly influenced seed weight, but the interactions of both factors did not influence the seed weight ($F_{11,48} = 0.528;\ P = 0.875;$ Table 5.3). The heaviest seed weights were obtained from optimal soil fertility grown under abundant insect visitation. Seed weights were 0.30- and 0.14-times higher compared with seeds from poor soil fertility with poor pollinator visitation (Table 5.3). Soil fertility ($F_{2,\ 48} = 23.366;\ P < 0.001$) and pollination rate ($F_{3,\ 48} = 3.648;\ P = 0.019$) influenced the number of pods/plant. However, no interaction effects were observed here. Higher pollination rates increased the number of pod/plants. Pod/plants harvested from minimal and optimal soil fertility conditions with exposure to abundance pollinator visitations gave similar values (Table 5.3). Pollination rate ($F_{3,\ 48} = 2.688;\ P = 0.05$) and soil fertility ($F_{2,\ 48} = 54.954;\ P < 0.001$) increased seed number/pod. Moreover, there was an interaction between the two factors ($F_{11,\ 48} = 3.341;\ P = 0.002$; Table 5.2), where increases in seed number/pod were higher with increases in soil fertility and pollination (Table 5.3).

The synergetic effect of soil fertility and pollination rate significantly increased the number of bees, (Hymenoptera Apidae,) ($F_{(9,72)}$ 4.146;

P = 0.008), hoverflies (Diptera: Syrphidae) *($F_{(9,72)}$ 2.493; P = 0.015),* ants (Hymenoptera: Formicidae) *($F_{(9,72)}$ 3.615; P = 0.001),* visitation to soybean flower across years. However, this interaction did not influence the visitation rate of the butterflies (Lepidoptera Nymhalidae) *($F_{(9,72)}$ 0.910; P = 0.097),* beetles Coleoptera (Coccinellidae), *($F_{(9,72)}$ 1.591; P = 0.134),* and thrips *($F_{(9,72)}$ 0.247; P = 0.911*; Table 5.4).

Optimal soil fertility with an abundance pollination rate experienced the highest number (7.89 bee/plot) of bees' visitations (Fig. 5.4). Plants under 25% pollination rate experienced a similar number of bees' visitation at each level of soil fertility. The number of ants visiting the plant at the minimal pollination rate was higher than at 100% pollination rate. Also, the number of hoverflies and butterflies that visited the plants increased with an increase in soil fertility, while the number of beetle/plots increased with an improvement in pollination rate (Fig. 5.4).

Similarly, bee visitation was highest (5.4 bee/plots in 2017/18 and 6.0 bee/plots in 2018/19) at optimal pollination rate. We observed high insect visitation at minimal soil fertility conditions across the years. Also, the minimal pollination rate received an increased number of hoverflies (3.5 hoverflies/plot) and butterflies (2.7 butterflies/plot) in 2017/18 compared to the optimal pollination rate in 2018/19 season. However, plants under minimal soil fertility with 100% pollination rate had a reduced number of thrips visitation at both seasons (Fig. 5.5).

There were no differences in the number of bees' visitation (4.7 bee/plot) at poor soil fertility conditions. The visitation of hoverflies was highest (3.8 hoverflies/plot) at the optimal pollination rate in 2017/18, while butterflies and ants' visitation were higher at the minimal pollination rate (1.8 butterflies/plot and 14.3 ants/plot). The number of thrips increased with increases in pollination rate. Also, the insect visitation rates were higher in 2017/18 compared with the 2018/19 season (Fig. 5.6).

5.4.3 Plant Growth and Physiological Parameters

As expected, plant physiological growth indices (plant height, leaf number, stomatal conductance and chlorophyll content index) responded positively to improved soil fertility resulting from fertilizer application (Table 5.5). Plant physiological growth indices measured highlighted the effect of soil fertility on plant growth. Thus, their explicit results were included in Figs. 5.4, 5.5 and 5.6.

5.5 Discussion

The synergetic benefits from insect pollination and soil fertility differ among soybean varieties and growing conditions (Chacoff et al. 2010; Chigeza et al. 2019). Therefore, we examined the beneficial response of the most grown soybean variety in southern Africa under mountainous growing conditions in Phuthaditjhaba. We found that synergetic interactions between insect pollination and soil fertility improved soybean seed production. A significant decline in seed yield, pod number/plant, seed number/pod and seed weight were observed when insect visitors were excluded from soybeans plants. Moreover, the impact of insect pollination was complemented by improved soil fertility. Plants under optimal soil fertility with complete access to insect pollination had improvement in their plant growth physiological parameters and gave the highest seed yield of approximately 0.53 tons per hectare. Plants on minimally fertilized soil with complete access to insect pollination showed 0.32 tons per hectare increment in seed yield. Abundant insect pollinators could only give an increase of approximately 0.16 tons per hectare on poorly fertilized soil. It was noteworthy that minimal soil fertility under abundant insect visitation also led to a substantial yield increment.

This was in concordance with Garratt et al. (2014) who reported insect visitation improving

Table 5.4 Results for linear mixed effect model of pollination rates, soil fertility levels and their interactive effect on insect visitations. Df $_{(1,2)}$ = Degrees of freedom for numerator and denominator for each variable refer to the complexity of the additive curve. P-values in italics are statistically significant ($p < 0.05$)

Honey Bee	df $_{(1,2)}$	F values	P values	*Butterflies*	df $_{(1,2)}$	F values	P values
FL	2,72	42.108	*<0.001*	FL	2,72	2.678	0.076
PR	2,72	46.188	*<0.001*	PR	2,72	6.848	*0.002*
Time	1,72	2.033	0.138	Time	1,72	0.435	0.649
Year	1,72	11.932	*<0.001*	Year	1,72	83.956	<0.001
PR × year	2,72	19.961	*<0.001*	PR × year	2,72	15.478	<0.001
FL × Time	4,72	1.400	0.243	FL × Time	4,72	2.181	0.120
PR × Time	2,72	0.856	0.358	PR × Time	2,72	0.209	0.649
FL × year	2,72	0.937	0.397	FL × Time	2,72	2.181	0.120
FL × PR	4,72	4.146	0.004	FL × PR	4,72	2.889	0.028
FL × PR × time	2,72	2.377	0.100	FL × PR × time	2,72	0.874	0.422
FL × PR × year	4,72	1.697	0.160	FL × PR × year	4,72	2.043	0.097
FL × PR × time × year	9,72	2.432	0.008	FL × PR × time × year	13,72	0.910	0.521
Beetles				*Hoverflies*			
FL	2,72	28.195	<0.001	FL	2,72	7.442	0.001
PR	2,72	15.764	<0.001	PR	2,72	54.671	<0.001
Time	1,72	4.455	0.015	Time	1,72	5.614	0.005
Year	1,72	4.307	0.033	Year	1,72	347.831	<0.001
PR × year	2,72	17.694	<0.001	PR × year	2,72	94.324	<0.001
PR × Time	2,72	0.008	0.930	PR × Time	2,72	0.518	0.474
FL × Time	4,72	0.779	0.542	FL × Time	4,72	0.428	0.788
FL × year	2,72	8.742	<0.001	FL × year	2,72	1.757	0.180
PR × FL	4,72	0.681	0.608	PR × FL	4,72	4.357	0.003
FL × PR × Time	2,72	1.325	0.272	FL × PR × Time	2,72	0.644	0.528
FL × PR × year	4,72	0.434	0.784	FL × PR × year	4,72	1.092	0.367
FL × PR × time × year	9,72	1.591	0.134	FL × PR × time × year	9,72	2.493	0.015
Thrips				*Ants*			
FL	2,72	11.300	<0.001	FL	2,72	14.235	<0.001
PR	2,72	5.957	0.004	PR	2,72	11.361	<0.001
Time	1,72	7.180	<0.001	Time	1,72	9.278	<0.001
Year	1,72	1.304	0.257	Year	1,72	1.196	0.278
PR × year	2,72	5.303	0.007	PR × year	2,72	68.058	<0.001
PR × Time	2,72	0.093	0.762	PR × Time	2,72	1.692	0.197
FL × Time	4,72	0.589	0.672	FL × Time	4,72	1.417	0.237
FL × year	2,72	1.811	0.171	FL × year	2,72	0.154	0.858
PR × FL	4,72	5.059	0.001	PR × FL	4,72	1.454	0.225
FL × PR × Time	2,72	0.750	0.476	FL × PR × Time	2,72	0.224	0.800
FL × PR × year	4,72	0.247	0.911	FL × PR × year	4,72	0.304	0.874
FL × PR × time × year	9,72	1.345	0.230	FL × PR × time × year	9,72	3.615	0.001

FL: soil fertility levels; PR: pollination rate; Time: repeated counting

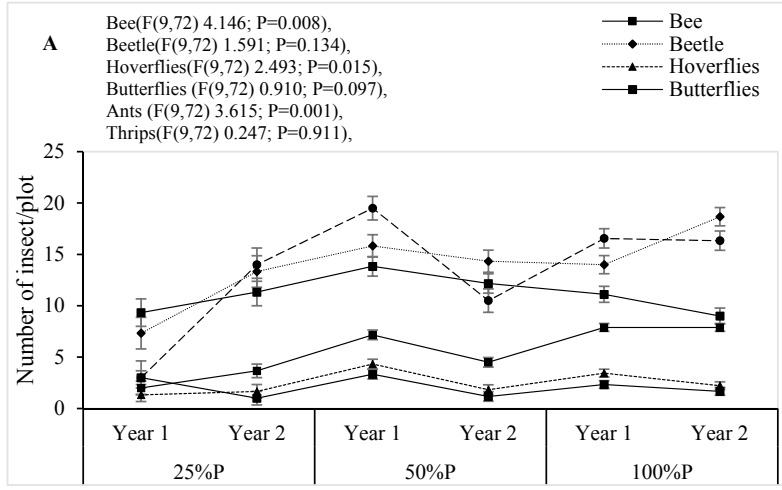

Fig. 5.4 Effect of pollination rates and soil nutrition on the insect visitation rate. A = Number of insects per plot under no soil fertility during 2017/18 and 2018/19 planting seasons

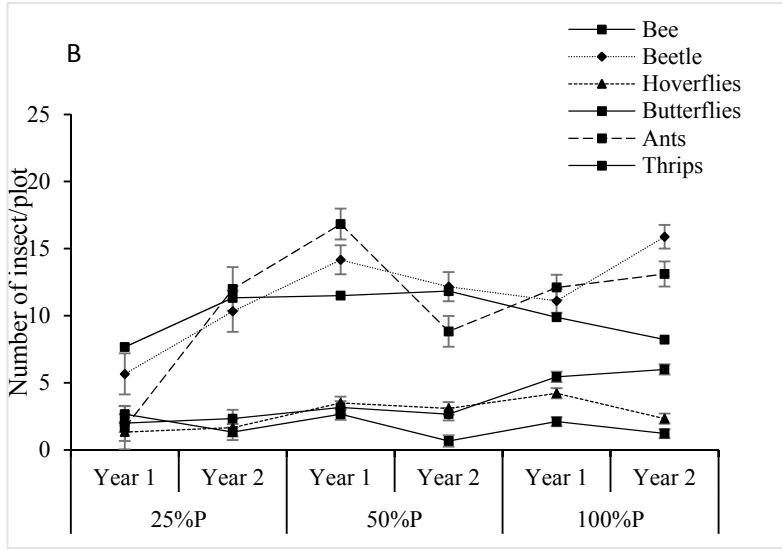

Fig. 5.5 Effect of pollination rates and soil nutrition on the insect visitation rate. A = Number of insects per plot under minimal soil fertility during 2017/18 and 2018/19 planting seasons

seed set between 60 and 69%, though the soil fertility of growing conditions were not emphasized. Similarly, Huais et al. (2020) explained that small patches of forest encourage native and wild floral insect visitors to ensure greater soybeans yield due to an increase in pollen deposition and seed set. Milfont et al. (2013) observed an increase in soybean yield up to 18% when exposed to honey bees and other native insect pollinators. Our results support these findings insofar as it highlighted the complementary action of insect visitation on soybean flower and soil fertility impacting seed yield, pod/plant and seed weight. This was likely due to the high quality of nectareous resources in the plant from optimally fertilized soil (Adelabu et al. 2021). Soybean has been reported as the most important source of pollen for insect visitors especially bees during the peak flowering periods (Blettler et al. 2018). Soil fertility increases the action of the insect visitors by boosting seed set and relating with a better pollen distribution on the stigmatic surface. This might be due to the intimate contact between the abdominal portion of the insect and

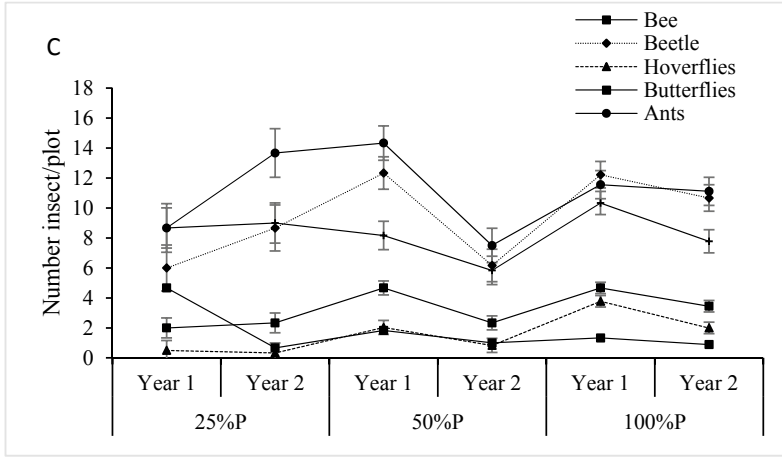

Fig. 5.6 Effect of pollination rates and soil nutrition on the insect visitation rate. A = Number of insect per plot under optimal soil fertility during 2017/18 and 2018/19 planting seasons

the receptive structure of the flower (Milfont et al. 2013). However, the abundance of insect pollination under poor soil fertility did not improve soybean seed production. Thus, restrictive soil management conditions during soybeans growth and the critical period of seed set underlie its yield (Blettler et al. 2018).

The substantial increase in yield and its components (seed yield, seed number, pod number and seed weight) obtained from minimal soil fertility with unrestricted access to insect visitation suggested that minimal soil fertility still enhanced the needed forage resources and diversity of insect visitors and moderately contribute to the increase in soybean production. This yield increase implies that under favourable entomological conditions, smallholder farmers would need to make decisions about the yield and profit implications of applying below-recommended fertilizer rates. Langyintuo (2020) observed that smallholder farmers in Sub Saharan Africa tend to use below-recommended fertilizer rates during crop production due to financial constraints. Ramos et al. (2018) reported that the benefits from insect pollinators for common bean were attained at minimal nitrogen input ($\leq$72 kg N/ha), whereas native insect pollinators had positive effects on crop yield. Otieno et al. (2011) showed that fertilizer application significantly enhanced pollinators' activity, as well as the abundance of chewing and sucking insect pests in pigeon pea.

Soybean's crop is an autogamous crop that modestly depends on flower-visitor insects (Klein et al. 2007; Chacoff et al. 2010; Milfont et al. 2013). A range of insect visitors such as bees, butterflies, flies, thrips and wasps were observed to be responsible for soybean pollination, contributing to seed set through the collection of energy-rich nectar. However, the effectiveness of each insect species was not studied. Among the dominant insect visitors of soybean flowers were bees, beetles and thrips, foraging on, inside, or very close to the flower. We found that bees, hoverflies and thrips were among the most abundant insect visitors of soybean flowers. The abundance of these visitors to the flower under complete access to insect pollination contributed to the yield increment. Thrips and bees were considered as more effective pollinators of soybeans, while thrips could also be pests that eat the pollen or leaves (Yoshimura 2011). A high abundance of ants was found on the flowers, but their specific contribution was not studied. Rostás et al. (2018) observed that ant pollination contributes little to crop pollination even with their high abundance and regular visits, because they are nectar robbers, but their ability to forage among flowers under adverse climatic conditions has been suggested to promote crop pollination.

The insect populations in the surroundings of the crop were not disturbed by pesticides because phytophagous insects were below the economic

Table 5.5 Results for linear mixed effect model of pollination rates, soil fertility levels and their interactive effect on plant physiological growth. $Df_{(1,2)}$ = Degrees of freedom for numerator and denominator for each variable. P-values in italics are statistically significant ($p < 0.05$)

Plant height (cm)	Numerator df	Denominator df	F values	P-values	Leaf number	Numerator df	Denominator df	F values	P values
FL	2	330	46.918	*<0.001*	FL	2	330	40.419	*<0.001*
WAP	4	330	1839.015	*<0.001*	WAP	3	330	668.475	*<0.001*
year	1	330	497.185	*<0.001*	year	1	330	577.973	*0.001*
FL × WAP	*8*	*330*	*2.367*	*0.017*	*FL* × WAP	*6*	330	0.995	0.440
FL × year	2	330	25.019	*<0.001*	*FL* × year	2	330	8.869	*<0.001*
FL × WAP × year	6	330	115.386	*<0.001*	*FL* × WAP × year	6	330	112.656	*<0.001*
CCI						*gs (mmol m^{-2} s-1)*			
FL	2	240	8.062	*<0.001*	FL	2	240	2.107	0.124
PR	3	240	1.028	0.381	PR	3	240	3.029	*0.030*
Year	1	240	100.755	*<0.001*	Year	1	240	147.301	*<0.001*
WAP	4	240	18.686	*<0.001*	WAP	4	240	227.614	*<0.001*
FL × WAP	8	240	1.807	0.076	FL × WAP	8	240	6.231	*<0.001*
FL × Year	2	240	1.382	0.253	FL × Year	2	240	10.839	*<0.001*
PR × WAP	12	240	0.599	0.842	PR × WAP	12	240	1.749	0.058
PR × Year	3	240	14.630	<0.001	PR × year	3	240	7.435	*<0.001*
PR × FL	6	239	1.277	0.269	PR × FL	6	240	0.576	0.749
PR × FL × WAP	44	240	0.634	0.677	PR × FL × WAP	24	240	3.143	*<0.001*
PR × FL × WAP × year	50	240	0.939	0.594	PR × FL × WAP × year	24	240	2.834	*<0.001*

FL: soil fertility levels; PR: pollination rate; WAP: weeks after planting

injury threshold, which shows that all insect visitors to the crop have positive contribution to its pollination whether predators, natural enemies, pests or pollinators. Our results indicate complementary benefits of using appropriate fertilizer rate on crop pollination. It is an efficient way to minimize loss and improve nutrient use efficiency in the crop. However, minimal fertilizer application that is common among smallholder farmers still gave substantial yield under insect pollinator-rich environments, such as in Phuthaditjhaba. The richness of insect biodiversity in Phuthaditjhaba may be similar to other montane wetland vegetation of the Maloti-Drakensberg region (Brand et al. 2010). There were large patches of natural vegetation within 500 m of the trial site, which serve as a habitat for the insect visitors. Although we did not focus on the scale of the pollinator community and diversity within the cropping area, flower-visitor assemblages in agroecosystems are increasingly threatened because of increased exposure to inappropriate use of synthetic chemicals which are responsible for yield gaps of pollinator-dependent crops in smallholder farming system (Garibaldi et al. 2016). Mountain farming is characterized by a smallholder farming system, with rich biodiversity but with low soil nutrients, all characteristics found in our Phuthaditjhaba test-site (Adelabu et al. 2020). Maximizing the potential of the native insect populations with efficient soil management practices could help to increase crop production.

5.6 Conclusions

The complementary impact of soil fertility and insect pollination is essential to developing management strategies that harness the potential of the natural environment for crop benefits, particularly in areas where fertilizers are prohibitively expensive. Our findings highlighted the importance of soil fertility and insect pollinators to soybean seed yield in a mountainous farming ecosystem located in Phuthaditjhaba. The benefits of biotic pollinators to improve yield depended on the soil fertility status of the plant. The results of this study encourage soybeans smallholder farmers to maximize the potential of native pollinators in their cultivating areas of Phuthaditjhaba to enhance productivity, thus promoting sustainable management practices and reducing dependence on purchased fertilizers. Embracing this mountainous ecosystem's interactive benefits would provide an immense advantage for smallholder farmers. Due to limited financial resources, such farmers tend to use below the recommended fertilizer rates, with implications for yield and economic viability. However, ecosystem services such as insect pollination would help local communities to attain sustainable food production, thus attaining the UN SDGs 2 and 15 which are address 'zero hunger' through sustainable and resilient food production (SDG 2.4) and 'life on land' through the conservation of mountain ecosystems (SDG targets 15.1 and 15.4).

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Phuthaditjhaba: Urban Fabric and Population Figures

Jess L. Delves and Stefano Terzi

Phuthaditjhaba can be described as a 'ruralopolis' due to its high population density, which exceeds that of many more urbanised areas. This density, combined with an agrarian economy and relatively more traditional social structure, characterizes the area as rural (Qadeer 2000). The city is a sprawling semi-urban space of detached, single story houses, which extends over more than 200 km^2. The semi-urban fabric is for the most part homogenous with boundaries between different administrative units not clearly visible. The 'center' of the city, towards the northern edge, comprises two shopping malls surrounded by a concentration formal and informal businesses (Fig. 5.7).

The area of contemporary Phuthaditjhaba had a population of 14,000 in 1970 (Krige et al. 1995), which grew rapidly following the designation of Phuthaditjhaba as the capital of the QwaQwa homeland in 1974 (Pickles and Woods 1992). The city expanded outward from the urban centre, with centrally planned urban expansion incorporating road, electricity and water infrastructure. Consequently, much of the centre and surrounding area are characterized by an organized and planned urban structure. This contrasts starkly with the informal settlement structure of the majority of the city. Particularly in steeper areas, houses are not connected to roads and are only reachable by informal footpaths. This contrast can be seen in Figs. 5.8 and 5.9. As the city has expanded over the last 50 years, the municipal administration has not managed to meet the service and infrastructure needs of many areas of the city. This is exacerbated by the semi-formal management of housing construction where chiefs allocate the land available for construction often without being aware of the existing planning from the administration. Houses are often built on top of underground infrastructure or in areas that are not served by basic services. As a consequence, many new constructions are not registered with the municipal authorities and may interfere with, or cannot be connected to, essential infrastructure planned, provided by and requiring maintenance from the municipality (for example water, electricity, sewage).

From an administrative point of view, the urban area commonly referred to as Phuthaditjhaba is in fact a conglomeration of 65 smaller administrative units called *Main Places*. Only the 'historic centre' of the city is *officially* named Phuthaditjhaba

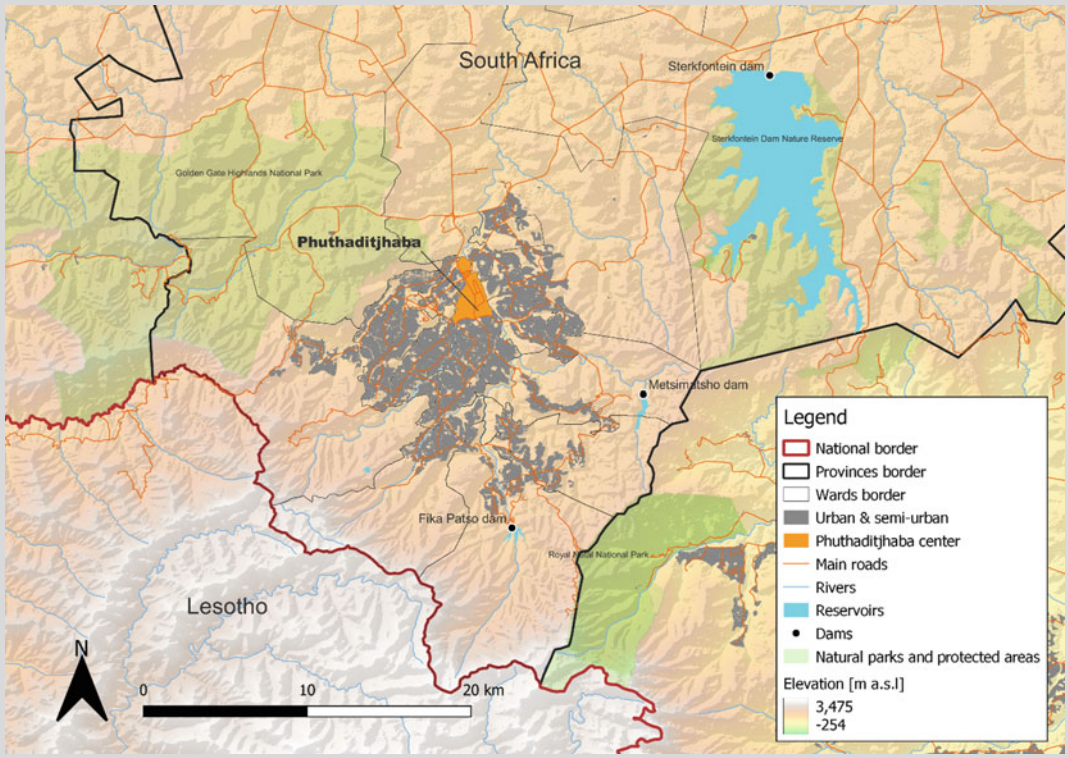

Fig. 5.7 Map showing the topography of Phuthaditjhaba and its surroundings as well as the official 'center' and the urban/semi-urban sprawl that constitutes the city. Map creator: Stefano Terzi

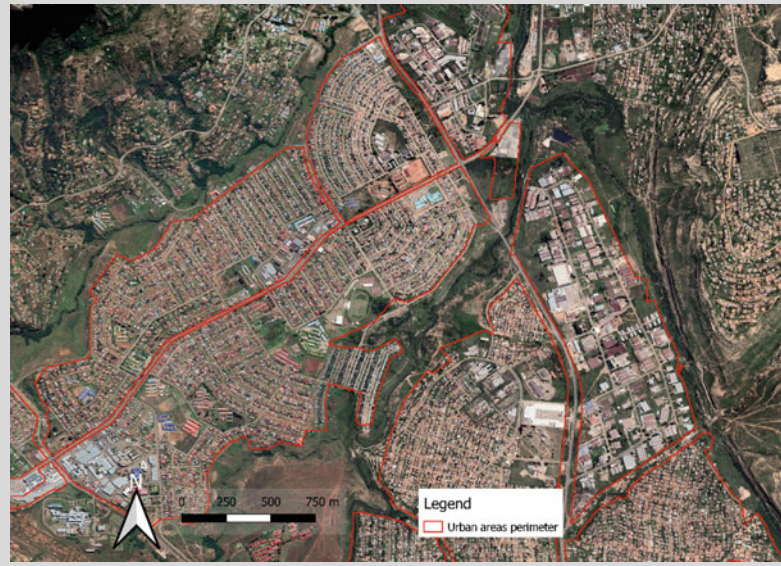

Fig. 5.8 Satellite image of the Phuthaditjhaba centre (Google earth Image© 2022 Maxar Technologies) with a clearly planned urban layout (perimeter in red line)

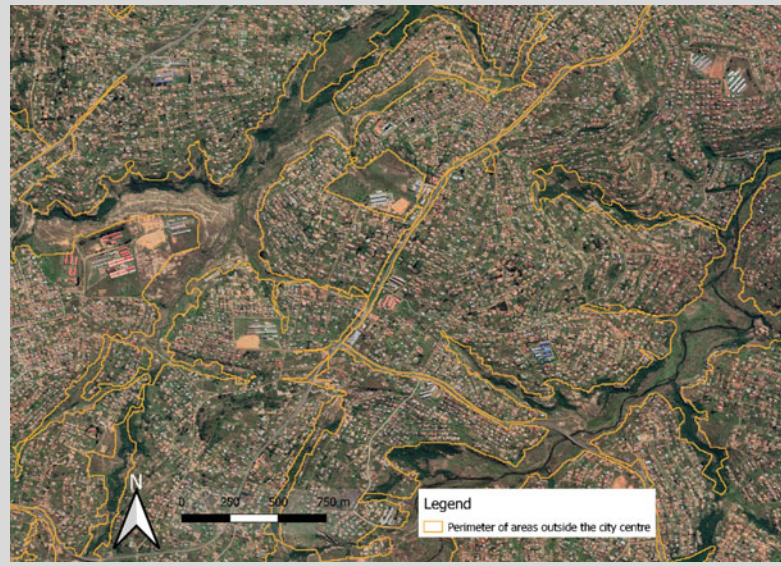

Fig. 5.9 Satellite image of the Phuthaditjhaba area outside the city centre (Google earth Image © 2022 Maxar Technologies) with less planned construction (perimeter in yellow line)

in administrative statistics, and had a population of 54,661 during the 2011 census. The other areas carry the names of the villages which comprise them. This is the first challenge faced when seeking to establish an official population figure for the city, as defining the boundaries of the urban area is very difficult, and inter-village boundaries are unclear or may even be contested.

In addition, informal constructions continue to grow and obtaining data on these is difficult. In fact, it is not clear whether such data is kept. The 2011 census put the population of the Phuthaditjhaba *Main Place*—the small administrative unit that comprises the 'city centre'—at 54,661 inhabitants. However, when considering all the administrative units that comprise the ruralopolis, the figure is 274,840 for 2011.

Phuthaditjhaba—the ruralopolis—has undoubtedly expanded spatially since the 2011 census, together with a correlated growth in population. Local researchers and administrators interviewed for this book agree that the actual population is likely far higher than the official number. Estimates range from 300,000 to 1.2 million residents. The 2007 Community Survey put the population of the municipality (including the urban areas of Harrismith and Kestell) at 385,413 (MaP 2011). However, in preparation for its 2010/2011 Integrated Development Plan (IDP), the Maluti-a-Phofung local municipality commissioned a private engineering consultancy (Miletus Consulting Engineers) to estimate the municipality's population. The resulting study digitally logged 83,000 households in the municipality, and "In line with a generally accepted density of 6 persons/dwelling, the 2007 population of Qwaqwa was estimated at 500 000" (MaP 2011: 21). The IDP then states "total population of 620 000 persons is considered accurate for the planning of water and sanitation services" (idem). This figure is far higher that the official population for the municipality as reported from the 2011 census, which was 335,784 (StatsSA 2011).

These extreme discrepancies in population numbers even from official sources is a concern for research. Establishing a reliable figure for population is absolutely

necessary for research and for government planning, in order to develop effective and targeted policies, in particular relating to the distribution and allocation of infrastructure, services and resources.

A census was conducted in February–March 2022 which will provide official data on population in Phuthaditjhaba. However, considering the rapid and informal expansion of the city, together with the potential for error in official statistics due to the difficulty in access to large areas of Phuthaditjhaba, we propose to cross-validate this data using, for example, remote sensing.

6 Surviving the Limits Imposed by a Changing Climate: The Case of Urban Drought and Water Supply Sustainability in Phuthaditjhaba

Geofrey Mukwada and Sarudzai Mutana

Abstract

In urban environments, sustainable access to water resources depends on many factors, including climatic, social and economic conditions characterizing the surrounding environment. For urban areas in mountain environments these conditions are compounded by stressors resulting from climate change, such as drought, as well as physical remoteness, economic marginalization and poverty, phenomena which impose limits on access to water. Based on Sustainable Development Goals (SDGs) 1, 6 and 13, which were part of the 2030 Agenda for Sustainable Development adopted by UN member states in 2015, in this paper we assess the impact of urban drought on water security in the mountain city of Phuthaditjhaba, South Africa. World Meteorological Organization - Time Series (4.04) climate (precipitation and maximum temperature) data for Phuthaditjhaba were analysed for trends for the period between 1960 and 2019. Trends of Standardized Precipitation Index values and Maximum Temperatures were used to determine how climate change has affected Phuthaditjhaba's sources of water supply, namely the Fika Patso and Metsimatsho dams. A sample of Landsat images from the same period was used to determine how the two water bodies have responded to the change over time. The results indicate that the two reservoirs have shrunk due to climate change induced drought, thus worsening water insecurity in the city. The results also indicate that mean annual stream discharge is projected to decrease by 39% for the 2016–2045 period. Lastly, based on government reports on water shortages in Phuthaditjhaba and other secondary sources, the results also indicate that though 90% of Phuthaditjhaba's population has access to potable water, only 55% of the residents have access to reliable water supply. We conclude that without urgent government intervention the future of the livelihoods of the poor majority of Phuthaditjhaba's residents will remain bleak due to dwindling water resources, making SDG 6, and those influenced by it, unattainable.

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Keywords

Climate change · Drought · Phuthaditjhaba · Sustainable development goals · Urban water security · QwaQwa

6.1 Introduction

Guided by Sustainable Development Goals (SDGs) 1, 6 and 13, which were part of the 2030 Agenda for Sustainable Development that was adopted by UN member states in 2015 (Nerini et al. 2019), in this chapter we assess the impact of climatic stressors on water security in the mountain city of Phuthaditjhaba. SDG 1 aims to reduce poverty, SDG 6 aims to promote access to water and sanitation, and SDG 13 aims to strengthen the resilience and adaptive capacity of communities to climate-related and natural hazards and their associated disasters. The main objective of SDG 1 is to eradicate extreme poverty for all people everywhere in the world by 2030 (United Nations 2015). People are considered to be poor if they are living on less than $1.25 a day (United Nations 2015), but this threshold is contested, with critics claiming that an average of $5 is a more realistic figure, especially in rich countries (Edward 2006; Hickel 2017; Reddy and Lahoti 2015). Among other objectives, the aim of SDG 6 is to achieve universal and equitable access to safe and affordable drinking water for all by 2030 and ensure access to adequate and equitable sanitation and hygiene for all. Similarly, one of the targets of SDG 13 is to strengthen resilience and adaptive capacity to climate-related and natural hazards and associated disasters in all countries. The three SDGs have been shown to be interrelated, since climate change affects the achievability of goals relating to material and physical well-being, including poverty eradication and water availability (Nerini et al. 2019).

Hoekstra, Buurman and Ginkel (2018) maintain that water security focuses on four elements. The first is welfare and relates to the use of water in a manner that increases *economic welfare*. The second element of water security is the enhancement of *social equity*. The third element is the attainment of long-term *sustainability* in water resource availability and the fourth element relates to the reduction of water-related *risks*. These elements are closely linked to the three aforementioned SDGs. In this chapter we examine the labyrinth of challenges that communities in Phuthaditjhaba navigate in their attempt to attain water security while confronted with poverty and threats from climate-change related hazards, and drought in particular. Attaining sustainable urban water management under such circumstances is a huge challenge. Under normal circumstances Sustainable Urban Water Management (SUWM) can reduce water insecurity. SUWM is an approach that deals with the root causes of water insecurity, for instance through the integration of spatial planning with climate change adaptation and urban water management (Hurlimann and Wilson 2018). Spatial planning involves careful allocation of land uses within an urban area. In South Africa, every local municipality is required to draw up a Spatial Development Framework, which it uses as a guide to allocate land uses to specific locations or land use zones. Spatial planning often incorporates Urban Ecological Infrastructure (UEI) into the urban design. UEI comprises three elements, namely "green", "blue" and "grey" infrastructure. Green infrastructure consists of forests, woodlands, farmlands, urban parks, and other natural or artificial green spaces (Li et al. 2017). On the other hand, blue infrastructure includes ponds, streams, lakes, wetlands, and other wet areas with flowing or fluctuating water, while grey infrastructure refers to the presence of conditions characterized by permeable surfaces that regulate the flow of water, nutrients, and air as they pass through the urban environment or control their storage or filtration during the process (Li et al. 2017). If carefully incorporated in spatial plans UEI can promote water seepage, storage, and purification as it passes through the urban environment. In SUWM, the way water resources are allocated, used and managed should be considered alongside prevailing environmental conditions, including the physical conditions of the environment such as local

landscapes and climate. A critical question that needs to be answered about water security relates to the water related risks, confronting marginalized people in urban communities.

Water related risks vary considerably and include those related to its abundance or shortage in the environment and those related to its quality. For instance, when water is in abundance within the environment it can lead to loss of life through flooding and the contamination of potable water resources. On the other hand, when water shortages occur, people rely on poor quality resources, which exposes them to health hazards such as waterborne diseases. In addressing this question, we analysed trends for the Standardized Precipitation Index (SPI) values for the period between 1960 and 2019 to determine how these trends have influenced spatiotemporal changes of water reservoirs that supply water to Phuthaditjhaba, namely the Fika Patso and Metsimatsho dams. As shown in the scope of this chapter, we confined our assessment to precipitation and maximum temperature data to determine patterns of urban drought frequency.

In Phuthaditjhaba, urban droughts are increasingly becoming an issue of concern for both the residents and water resource planners and managers. We also undertook the content analysis of government reports to determine the nature of water related risks that the residents of Phuthaditjhaba face due to urban drought. Drought is a condition that occurs when less than normal precipitation falls for an extended period of time and the lack of precipitation has reached a point of threatening water supply (Mukhawana et al. ND; Mukwada et al. 2020). Recently, a water pipeline was built between Phuthaditjhaba and the Sterkfontein Dam, which stores water from the Tugela-Vaal Water Transfer Scheme, to augment the city's water supply. Currently, The Phuthaditjhaba-Sterkfontein pipeline is supplying 6 mega litres to QwaQwa per day, but there are plans to increase the supply to 20 mega litres per day. This strategic development was undertaken following the realization that the local environment is becoming prone to drought and the traditional sources of water, namely the Fika Patso and the Metsimatsho dams no longer have the capacity to meet the city's water requirements.

In the Orange River Basin, where Phuthaditjhaba is situated, populations have become urbanized and the basin now experiences many challenges (Earle et al. 2005). The remaining part of this paper comprises four sections. In Sect. 6.2 we first describe the circumstances under which extreme events associated with climate change impact access to potable water in urban environments, drawing examples from different parts of the world. In Sect. 6.3 we present the methodology of the study, as well as the description of the study area. The last two sections (Sects. 6.4 and 6.5) comprise the discussion and the concluding section of the paper.

6.2 Background: Relationship Between Climate Change and Water Supply in Urban Environments

6.2.1 Urban Drought and Water Availability

The IPCC notes that globally climate change has already begun to alter water accessibility (IPCC 2012). Considering that more that 50% of the world's population live in urban areas, alongside the fact that cities contribute 70% of global economic output, the impact of climate change on water supply in urban areas is an issue of critical concern, especially where climate change affects local water availability (Jaramillo and Nazemi 2018; Sachs et al. 2019). Impacts of climate change "are predicted to undermine the ability of many existing urban water supply systems to meet both the future and present needs of the populations they serve" (Hurlimann and Wilson 2018: 1). Consequently, many urban areas are expected to face critical water shortages in the future. Population growth and proliferation of socio-economic activities have continuously heightened both water demands and vulnerability to droughts and floods in urban areas (Jaramillo and Nazemi 2018; Zubaidi et al. 2020). For

instance, in South East Asia, increasing urbanization, population growth, changing lifestyles, and climate change are increasingly becoming a threat to water security (Bajracharya et al. 2019; Rickert et al. 2019). Over the past decades, major cities in this region, especially in India, Nepal, Bangladesh, Pakistan and other countries have been faced with water scarcity, with millions of people receiving only intermittent water supplies or bracing long queues for drinking water (Bajracharya et al. 2019).

Similar challenges have been reported in other parts of Asia (Liu and Jensen 2018; Gao et al. 2019; Dong et al. 2020), as well as across North America (Sullivan et al. 2017; Jaramillo and Nazemi 2018; Igondou 2020), Europe (Hoekstra, Buurman and Ginkel 2018; Özerol et al. 2020), parts of Australasia (Hurlimann and Wilson 2018; Liu and Jensen 2018), Africa (Fisher-Jeffes et al. 2017; Luker and Harris 2019; Rickert et al. 2019; Zubaidi et al. 2020) and other parts of the world. In many parts of the world climate change has been the major cause of urban drought and water insecurity. For instance, in North America, climate change is critically impacting the lives of New Mexicans through decreased water supply, with serious implications for both the society and ecosystems in New Mexico, where the population depends on a reliable, clean supply of drinking water to sustain their health, and for livelihood through agriculture, energy production, recreation, and manufacturing (Igondou 2020).

Cities are highly vulnerable to climate change (Sachs et al. 2019). Indirectly, urban drought related water shortages pose health implications. For instance, in South Africa a severe drought in 2016 left many urban parts of the country with limited access to water (Fisher-Jeffs et al. 2017). Most literature indicates that climate change is expected to alter the frequency and severity of extreme weather events such as drought and floods, with possible consequences for the safety of drinking water supplies (Rickert et al. 2019). In concluding this section, we refer to the case of Lilongwe in Malawi, where water insecurity has recently been reported. In 2008, Lilongwe had a population of about 700 000, which is projected to grow at the rate of about 4% to over 3 million people by 2030 (Adams 2018). Due to this rapid population growth, water supply has been unable to keep up with demand, forcing the majority of the poorer urban dwellers to rely on water from polluted sources such as urban rivers, which are reported to be laden with pollution from nutrients and other effluents, especially during the rainy season (Hranova et al. 2006). In Lilongwe, the majority of households in informal settlements depend on water kiosks, special concrete booths that were built in the 1980s to water supply in these impoverished areas (Adams 2018). Other sources of water for the poor majority of the residents include boreholes. As expected in most informal settlements throughout Sub-Saharan Africa, the crisis of water insecurity in Lilongwe's informal settlements is expected to deepen as a result of climate change.

6.2.2 Urban Water Quality

The extreme events resulting from climate change do not only affect water availability, but the quality of the water available. Excessive precipitation can lead to flooding and promote the proliferation of pathogenic microorganisms in water sources such as cyanobacteria, resulting in gastrointestinal illnesses among people who depend on water from such sources (Fouladkhah et al. 2019). Cyanobacterial blooms and the proliferation of enteric pathogens cause diarrheal diseases in urban populations that rely on unprotected water sources. Conversely, climate change induces drought and forces urban communities to rely on poor quality water resources. Fouladkhah et al. (2019) mention that reduced river discharges, flushing rates and increased eutrophication resulting from nutrient loading in water sources enhance the proliferation of diarrheal diseases. The shortage of water that often occurs during drought forces some urban communities to rely on untreated or unprotected water sources, rendering them vulnerable to waterborne diseases. The increase in temperature arising from climate change acts as a stimulus to the proliferation of bacteria in

exposed water sources. Climate change has a direct effect on water resource availability as well.

6.2.3 Urban Drought and Water Security

Climate change induced warming is a threat to water resource availability. Increasingly extreme and unpredictable precipitation has impacts not only on surface water availability, but also on ground water recharge and water quality.

The attainment of urban water security is essential for developing resilient environments in smart cities, particularly now when cities are under the onslaught of climate change and socio-economic challenges such as rapid population growth, unemployment and worsening poverty (Zubaidi et al. 2020). In short, smart cities are sustainable cities. Climate change hazards can indirectly undermine water security in many ways. For instance, floods can increase costs of water treatment or waste-water treatment (Muller 2007) or disrupt or even damage water supply infrastructure (Hunt and Watkiss 2011), while both drought and floods can increase demand for water (Charlton and Arnell 2011).

Whereas water insecurity is expected to worsen in urban environments, there is no agreement about how to address its challenges. Some researchers suggest storm water harvesting to augment dwindling water supplies (Fisher-Jeffes et al. 2017), while others suggest solutions that are based on spatial planning (for instance, Hurlimann and Wilson 2018; van Biljon 2022, this volume). Within the context of water insecurity, spatial planning approaches put into consideration "activities of economic and service sectors (such as housing, energy, economic development, transport, water, waste, social welfare and health) that have spatial or land use consequences in their wider social and environmental context" (Wilson and Piper 2010: 10). In such approaches, spatial planning is integrated with climate change adaptation and urban water management, best illustrated in urban planning in the UK, USA and Australia (Hurlimann and Wilson 2018). While these authors acknowledge the importance of managing urban landscapes and public areas, and control of stormwater, they argue that SUWM can best be achieved through careful management of water resources across sectors in a comprehensive and integrated manner. In this context, urban planning is viewed as a process that is integrated with the protection, conservation, and management of the whole urban water cycle, since water resources and infrastructures serve multiple purposes and functions, including the provision of ecosystem services (Özerol et al. 2020). This therefore calls for "a comprehensive evaluation framework that can assess a wide range of water supply and demand management policy options in terms of economic, social, environmental, risk-based, and functional performance is crucial to ascertain their level of sustainability" (Rathnayaka et al. 2016: 1).

Integrated approaches require the adoption of a holistic management of the city, involving the whole city" planning approach, timely response to climate hazard events (such as floods and drought), all key actors from diverse professional, disciplinary and cultural backgrounds at different temporal and spatial scales. Consequently, approaches to water resource sustainability have not just aimed to provide an overarching understanding of an entire water governance system, but also to include "natural science, engineering, and social science perspectives, capable of informing change and innovation" (Sullivan et al. 2017: 3), and where applicable they use artificial intelligence technologies in decision-making (Vinuesa et al. 2020).

Apart from providing spatial amenities, urban landscapes "have ecological functions that facilitate hydrological processes such as evaporation, transpiration, infiltration and detention" (Liu and Jensen 2018: 127). However, Özerol et al. (2020: 2) cited five conditions that relatively small cities usually experience, which large cities rarely experience, which tend to undermine climate resilience. These include the following:

- "A lack of expertise in dealing with climate challenges in an integrated manner,
- Insufficient human resources to develop and implement a comprehensive climate change adaptation strategy,
- Low budget and few opportunities to make large investments for climate change adaptation and mitigation,
- Limited benefit from climate-related research programs and funding, and
- Less autonomy due to dependency on or limitations by upper governance levels."

This suggests that SUWM is a complicated process requiring synchronization of environmental, economic, social and political, as well as historical information. As noted by Jaramillo and Nazemi (2018), addressing water security in urban landscapes is a process that is inherently complex. A key aspect characterizing literature on urban water supply is a shift from past notions which were centred on augmenting supply by expanding existing infrastructure to a stance emphasizing the importance of diversification of water sources and approaches (Luker and Harris 2019). However, in this characterization it may not be possible to distinguish the role that different factors play in determining level of water security. For instance, as noted by Rasifaghihi et al. (2020) it is far from straightforward to distinguish the influence of the climatic factors from that of the socio-economic factors. Accordingly, there are five different categories of criteria for assessing urban water security, namely economic, environmental, social, risk-based and functional criteria. Economic criteria embrace the cost of capital, maintenance, and operational costs of water supply. Environmental criteria relate to impacts on "ecosystems (which) can (include) ecosystem, land ecosystem, or atmospheric ecosystem", while social criteria include social sustainability, human health and sanitation, and risk-based criteria to assess the ability of water supply sources to withstand climate change induced trends, such as long droughts and higher number of peak runoff days and short term climate perturbations, as opposed to functional criteria which deal with "technical feasibility as a criterion to assess water supply augmentation projects to ensure their long-term functionality" (Rathnayaka et al. 2016: 9–10).

In this chapter, therefore, in line with Rasifaghihi et al. (2020) suggestion we examine this complex process by assessing the environmental, economic, social, political and historical contexts of the city of Phuthaditjhaba in relation to the water insecurity conundrum the city is facing. We acknowledge that there are many factors that contribute to water scarcity in Phuthaditjhaba, though we primarily focus on climate change and its effects on urban drought, whose frequency and severity has increased alongside other extreme hydrological events that are becoming more prevalent as a result of climate change (Dong et al. 2020).

6.3 Study Area

Figure 6.1 shows the area where the study was undertaken, including the location of Phuthaditjhaba Urban and Phuthaditjhaba Rural and the reservoirs from which its water supplies are drawn. Phuthaditjhaba, referring to "a place where tribes meet" is located in the Maluti-a-Phofung Local Municipality (MaP). It is the main settlement in QwaQwa, formerly known as Witsieshoek, which was established as a homeland of the Sotho speaking people by the apartheid government in 1969. Phuthaditjhaba is the business hub of QwaQwa, the poorest part of the Free State Province (Mensah and Benedict 2010) and Setsing is its Central Business District. Approximately located at 28.5106 S, 28.8264 E, Phuthaditjhaba Urban (Fig. 6.1) is about 23.83 km^2 in areal extent and comprises around 17 529 households (StatsSA, 2011). In 1996 its population was about 40 159 (StatsSA, 1996), compared to 54 661 in 2011 (StatsSA, 2011). The average population density is approximately 2294 people per km^2, making Phuthaditjhaba (Urban) one of the most densely populated areas in the country. Without bottlenecks imposed by drought and administrative inefficiencies, 79.6% of Phuthaditjhaba (Urban) would have access to piped water in their own dwellings (StatsSA,

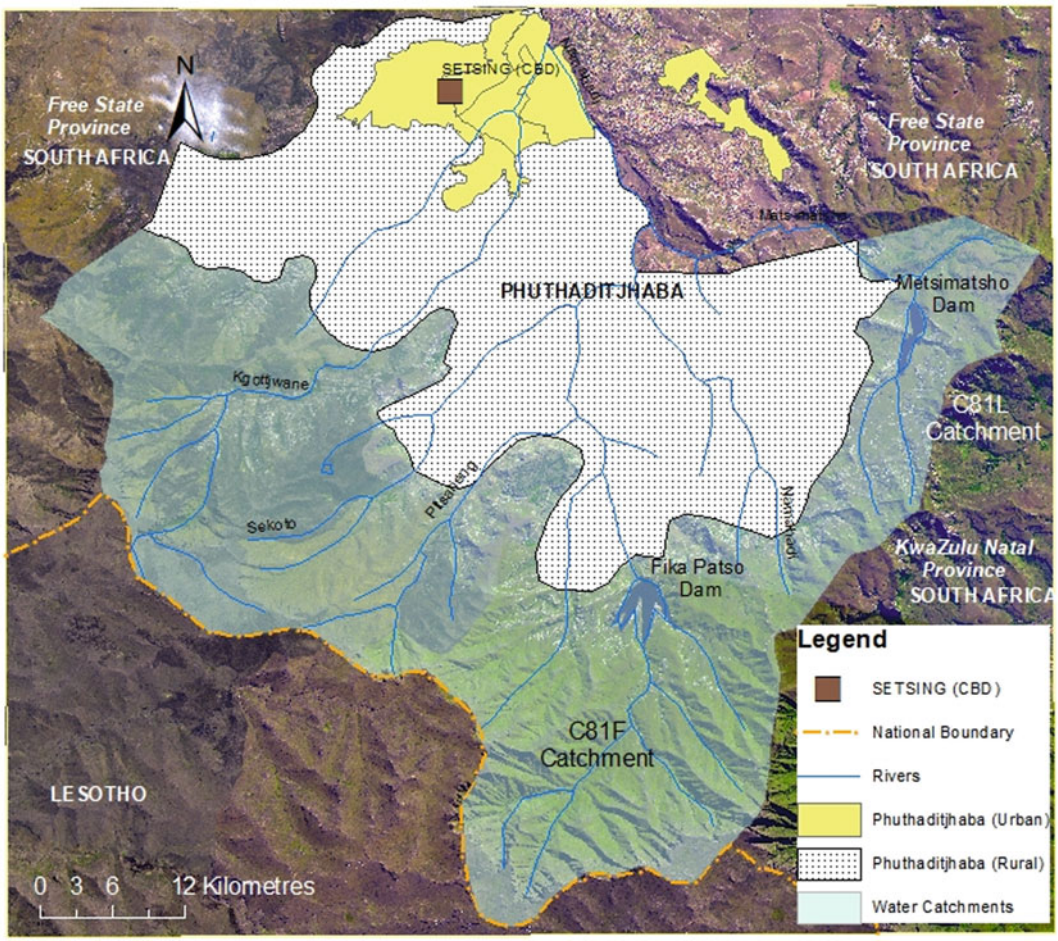

Fig. 6.1 Phuthaditjhaba and its surrounding catchments, including the Fika Patso and Metsimatsho reservoirs from which water is sourced. The main land use within the catchments is conservation, but extensive free-range grazing is prevalent

2011). With an unemployment rate of 41.8% and youth unemployment of 53% (StatsSA, 2011), poverty levels are high (Mensah and Benedict 2010). Maluti-a-Phofung Water, a government parastatal, is the main bulk water supplier in the city.

Phuthaditjhaba's main sources of water supply include the Fika Patso and Metsimatsho dams (Fig. 6.1). When they were constructed, the Fika Patso and Metsimatsho dams could contain 28 000 and 4 500 mega litres, respectively (DWAF 2007). Fika Patso Dam was built on the Elands River (also known as Namahadi River), a tributary of the Vaal River, while the Metsimatsho Dam was built on Metsimatsho River. Both dams are situated in Catchment C81F, which is part of the Witsiehoek Community Conservation Area (WCCA). The WCCA is part of the Drakensberg Transfrontier Conservation Area, which was set up with the objective of promoting watershed management. The Namahadi and Metsimatsho catchments are sub-catchments of the C81F Catchment and they are approximately 650 km^2 and 146 km^2 in size, respectively (DWAF 2007), hence they are relatively small catchments.

6.3.1 Data Sources

Using World Meteorological Organization—Time Series (4.04) climate data for Phuthaditjhaba we analysed precipitation and temperature trends for the period between 1960 and 2019. The data used was for the January–March months. The resolution of the data was 0.5° × 0.5°. Trends in SPIs were analysed for the precipitation data to determine if the climate of the area is changing, as well as if this change has any effect on water supply in the area. Streamflow data was sourced from the National Integrated Water Information Systems (NIWIS) (http://www.dwa.gov.za/niwis2/ClimateChange) to determine if river discharge in C81F is changing. SPI values were calculated using the Drought Index Calculator (DrinC), an online calculator. The trend analysis was also meant to determine if the capacity of water supply of the two major reservoirs that supply water to the city is being influenced by climate change. McKee et al. (1993) SPI classification was adopted. It consists of seven classes, including near normal (−0.99 to 0.99), moderately wet (1.0 to 1.49), severely wet (1.50 to 1.99), extremely wet (≥ 2.0), moderately dry (−1.49 to −1.0), severely dry (−1.99 to −1.50) and extremely dry (≤ -2.0) categories.

Landsat images from the USGS Earth Explorer website (https://earthexplorer.usgs.gov/) were used to assess spatiotemporal changes of the two water bodies over the study period. To achieve this goal we built Bands 5, 6 and 4 composites from the Landsat images to determine how these water bodies have been changing over time during this period. This process was undertaken in an ArcGIS 10.2 environment. Bands 5, 6 and 4 are ideal for detecting water and land changes in the environment. Additional information was acquired from online government reports and newspapers, as well as personal observations.

6.4 Results

As shown in Fig. 6.2, there is evidence that the climate of Phuthaditjhaba is changing. The trend of maximum temperature reflects a continual increase. Both linear regression analysis and the Mann-Kendal test indicate a statistically significant trend of temperature increase between 1960 and 2019.

High temperatures have been associated with drought recurrence, with the most conspicuous being the 2015/16 drought. The 2015/16 drought can be classified as an extremely severe drought according to McKee et al. (1993) classification. Altogether, there has been three severe droughts since 2014. Since 2002, there has been only four years in which above average rainfall was

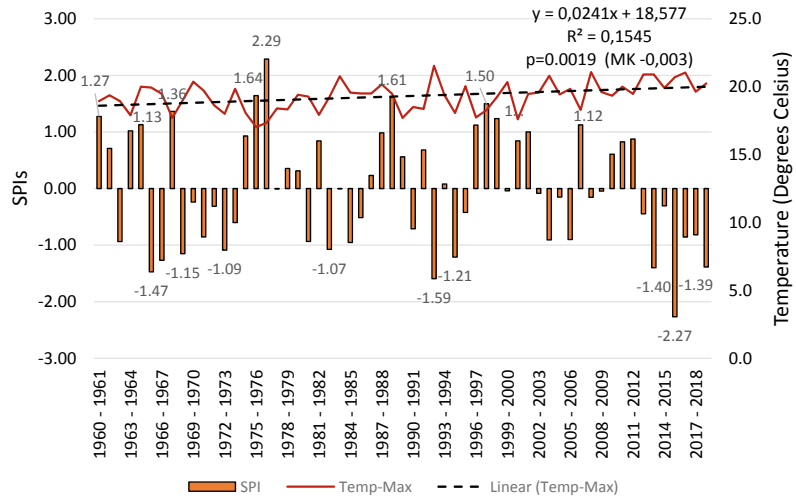

Fig. 6.2 The changing climate of Phuthaditjhaba. Note the prevalence of below average SPI values in the latter part of the time series. The precipitation data used was for the JFM months

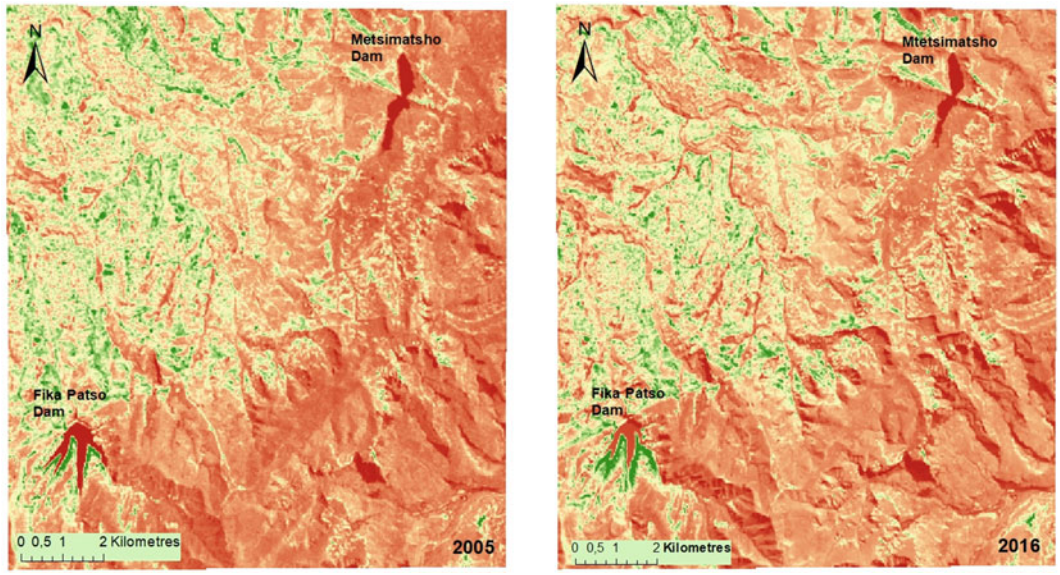

Fig. 6.3 Band 3 of 2005 Landsat image and Band 4 of 2016 Landsat image showing changes in areal extent of Metsimatsho and Fika Patso dams between 2005 and 2016. The effect of drought is clear on the image on the right (Data sourced from United States Geological Survey Earth Explorer website, https://earthexplorer.usgs.gov/)

received in the area (Fig. 6.2). The continual upsurge of maximum temperature and drought recurrence have contributed to the depletion of streamflow in the C81F catchment, and subsequently to the decline of water supply in Phuthaditjhaba. The impacts of these increases are noticeable in the decline of the capacity of the Fika Patso and Metsimatsho reservoirs to supply water to Phuthaditjhaba. This dwindling of capacity is clearly illustrated by the shrinking of the surface area of these reservoirs, as shown in Fig. 6.3.

As illustrated in Fig. 6.3, the areas of the two lakes in 2016 are less than they were in 2005. Due to this shrinking, in Phuthaditjhaba shortage of water is likely to continue into the foreseeable future and worsen water insecurity in the city. Decline in streamflow is confirmed by data from the NIWIS which shows that within the Namahadi River Catchment (C81F), mean annual stream discharge has been projected to decrease by 39%, from the average of 54.0 m^3/s for the 1975–2006 period to 32.8 m^3/s for the 2016–2045 period, as a result of climate change (http://www.dwa.gov.za/niwis2/ClimateChange). This might be explained in terms of Elevation Dependent Warming (EDW), referring to the amplification of warming with elevation (Rangwala and Miller 2012; Pepin et al. 2015). EDW is a phenomenon that has gained currency in climate change science in recent years. Warming enhances evapotranspiration and reduces streamflow discharge. However, in the discussion section of this chapter we argue that climate change is only exacerbating the outcome of human frailties arising from historical legacy, a situation that has contributed to marginalization, alongside poor planning by current local government and poverty, a cocktail of factors contributing to ecological degradation within the local environment. In the next section of this chapter we explain the current dire situation in terms of culpabilities of those responsible for water insecurity in Phuthaditjhaba and the implications of these culpabilities for the vulnerable.

6.5 Discussion

6.5.1 Culpabilities and Vulnerabilities

The 2011 census results indicate that though 90% of Phuthaditjhaba's urban population has access to potable water, only 55% of the residents have access to reliable water supply (StatsSA, 2011). Based on reports on water shortages in Phuthaditjhaba and other secondary sources, we argue that, without government support the livelihoods of the poor majority in Phuthaditjhaba will remain bleak due to dwindling water resources, making it difficult to realize SDG 6. There are similarities between the challenges posed by water insecurity in Lilongwe and Phuthaditjhaba. In both people rely on unprotected sources of water. In both, residents rely on water supply augmentation, in the form of water delivery services and community reservoir tanks. Apart from population size, the only major difference is that in Lilongwe poor residents rely on water kiosks, while in Phuthaditjhaba they rely on water vendors and supply from government funded water delivery tankers. The capacity of the city to meet the requirements of SDG 6 is under threat from the influence of climate change, especially persistent drought. However, as noted below, there are a number of historical and governance issues that also undermine water security in Phuthaditjhaba.

Historical context

Phuthaditjhaba is located in an area that was reserved for the Basotho people during the apartheid era. The Basotho are the indigenous people who inhabit the eastern part of the Free State Province of South Africa. While apartheid as a national policy has ended, its undoing is not a matter of turning back the clock, hence its legacy will continue to be felt for a long time to come, until a national solution to marginalization is found. The promulgation of the Group Areas Act of 1950 marginalized the Basotho by confining them to QwaQwa, where their livelihoods depend on steeply inclined land characterized by thin stony soils which are hardly suitable for settlement, let alone crop husbandry. QwaQwa, like all other homelands, was established during the apartheid period in order to limit the livelihoods of indigenous people and make them completely dependent on neighbouring farms, factories and mines, to whom their labour was rendered cheaply. In the case of Phuthaditjhaba, the major meaningful means of livelihood for the local populace turned out to be livestock holding, which has proved to be disastrous to the local environment. A cocktail of high stocking rates, ruggedness and steep inclination of the local terrain, sedimentation and proliferation of invasive alien plant species are a recipe for the land degradation that has negatively affected water yields from the catchments. Due to geographic confinement and limited livelihood opportunities, the local communities have had little choice but to increase their herds, which continued to grow with the bourgeoning human population. Erosion and sedimentation have been reported along the shores of both the Fika Patso and Metsimatsho dams (DWAF 2007), while widespread invasion by alien species has been widely reported in the area, including the proliferation of *Acacia mearnsii* (black wattle) along the shores of these reservoirs (Mucina and Rutherford 2006). *Acacia mearnsii*, a species of Australian origins, has a high affinity for water and a tendency of promoting water depletion at invaded sites. Though some species were imported to provide woodlots for firewood or building material, as they grow faster than indigenous trees, most alien species were introduced by the British colonists who saw their propagation as a betterment of the environment and a way of recreating conditions that were similar to those found in their home country (Aitken et al. 2009). Hence, some problems related to water insecurity in Phuthaditjhaba are inherited from the past. However, it is worth noting that climate change is extending the altitudinal ranges and expanding the geographic distribution of these species. Some environmental challenges that result from overgrazing are interlinked and tend to reinforce each other. For example, overgrazing leads to erosion and the eroded sites become susceptible to invasion by alien species, which in turn cause environmental desiccation and make it prone to fire hazards,

thus making the environment even more susceptible to erosion. The cumulative effect of both historical and current anthropogenic environmental pressures is therefore contributing to the water crisis in Phuthaditjhaba. Unfortunately, lack of alternative means of livelihood is a historical legacy that will not be addressed easily.

Poor governance, bureaucracy, and maladministration

While government is aware of the likelihood of worser future shortages in Phuthaditjhaba it has taken a long time for authorities to plan for alternative sources of water. Between 2015 and 2018, R48 million of the R1.5 billion that was allocated for the Maluti-a-Phofung Local Municipality as a whole had been spend on water supply augmentation and only 12% of the intended progress had been achieved (Department of Water and Sanitation Affairs 2016). The Department of Water and Sanitation has unveiled plans to provide R650 million through the Regional Bulk Infrastructure Grant (RBIG) for a water supply scheme that will improve water supply to the city (Department of Water and Sanitation 2018). New water infrastructural systems need to be built while older ones have to be replaced because they are ageing and insufficient to cater for the growing population. A 2020 reportage from the South African Broadcasting Corporation (SABC) indicates that the South African government acknowledges QwaQwa's reliance on ageing and unmaintained infrastructure, including pipelines that had not been maintained since the 1990s (SABC 2020). At local municipal level, poor governance and maladministration have led to bankruptcy and created a string of culpabilities that have weakened government's role in promoting water security, thus creating conditions that have weakened social security and rendered safety networks ineffective, thereby making the poor more vulnerable. Without sufficient resources the local municipality's capacity to render social support to the poor is limited. The fact that MaP municipality itself is currently under administration is testimony for poor governance. The vulnerability of the poor has been heightened by inadequate access to water at a time when the world is grappling with the COVID-19 pandemic. The COVID-19 crisis requires a continuous and stable supply of clean water to maintain high levels of hygiene and sanitation, a feat that poor households cannot afford. The poor lack the financial means to buy water from vendors. In Phuthaditjhaba, many poor households rely on unprotected water sources. Newspaper reports of violence erupting following the drowning of a child while searching for water (for instance, Eye Witness News 2020; Sowetan 2020), triggered riotous demonstrations against poor service delivery. This tragedy illustrated the extent to which the poor are vulnerable, though in a way these reports also serve as a reminder to demonstrate that water may be available in certain locations within the local environment, but it is the ingenuity to manage it that is lacking. However, shortage of potable water has recently reached a crisis in the city, especially since the 2015 drought. Government (municipal) funded water delivery services, involving the delivery of water supply tanks to communities in Phuthaditjhaba, have proved to be insufficient, forcing residents to depend on water vendors to whom they have been subjected for exploitation. While the more affluent members of the Phuthaditjhaba society can afford to rely on water purchased from water vendors or safe bottled water from supermarkets, the poor have limited access to such 'luxuries'. Local water resource planners could start considering the development of alternative water sources, including increasing the pumping of groundwater. Bureaucratic hurdles are most evident in delayed execution on water projects. For instance, the newly proposed RBIG funded infrastructural project is only being introduced, long after the water crisis has started.

6.5.2 Navigating the Current Water Crisis

As mentioned above, there is a need to develop a comprehensive evaluation framework for assessing a wider range of water supply and demand management issues and policies, in order to attain water security in Phuthaditjhaba and address SDG 6. This framework must take into account the prevailing and historical, economic, social and environmental factors into consideration (Rathnayaka et al. 2016: 1). Hence, there are goals that ought to be met simultaneously, in order to address these factors. Accordingly, while we do not advocate a prescriptive approach in achieving this SDG, we highlight some goals that must be met first in order to promote sustainability and water security in Phuthaditjhaba, including ecological, social and economic goals.

Ecological goals

In the short-term, alternative sources of water supply for Phuthaditjhaba need to be identified. Apart from pumping water from the Sterkfontein Dam, groundwater exploration should be considered in order to identify locations where safe groundwater resources are available. Where safe groundwater resources are available, boreholes and protected wells can be sunk, and the water can be pumped using hand operated technologies which can easily be maintained and managed locally.

The shale gas and oil explorations that are likely to be undertaken in the Eastern Free State Region (SLR 2020) will not contribute positively to water security in Phuthaditjhaba. Hydraulic fracking will lead to groundwater contamination and worsen water-related risks because of its negative effect on water quality. These explorations are meant to enhance energy security in South Africa. The explorations will be conducted in the greater part of the eastern Free State Region, including areas around the Sterkfontein Dam. Since it is planned that the dam will become the major source of water in Phuthaditjhaba, hydraulic fracking risks polluting an important source of water supply in the region. Hence, the currently ongoing shale gas and oil exploration project serves as testimony clearly showing that water security and energy security goals are at loggerheads, since they are totally incompatible. This could be an example of inconsistencies in government policy.

A much longer-term ecological goal should focus on the alleviation of environmental pressure in Phuthaditjhaba and its surroundings by redressing the limits imposed by confinement and marginalization, which can be achieved by promoting better access to land. Shortage of land imposes limits to the incorporation of UEI in urban planning. Space is not available for the enhancement of this type of infrastructure. Overcrowding and shortage of land also limit the diversification of livelihood strategies, including urban agriculture. The current ongoing government sponsored land reform programme could provide impetus and serve as a mechanism for addressing this goal. In short, through land reform, some land can be redistributed within the vicinity of Phuthaditjhaba in order to decongest the city. Alternative land that is suitable for grazing can be established to serve as an ecological safety valve and provide the means for transferring herders from the ecologically sensitive rugged and steeply inclined conservation and water catchment zones to flatter ecologically less sensitive lower lying areas. This goal can only be achieved through carefully planned land reform. Herds can easily be monitored and controlled in the newly established grazing zones, and overgrazing prevented through carefully planned rotational grazing schemes. Reduced environmental degradation in the catchments will curb surface runoff, erosion and sedimentation and promote infiltration, percolation and groundwater recharge, which will in turn sustain the effluence needed to maintain future water supply from the Fika Patso and Metsimatsho dams.

Social equity

As noted above, finding solutions to problems of marginalization and overcrowding could provide alternative livelihood options for the residents of Phuthaditjhaba. As explained below, the promotion of social equity and social justice is the gateway to economic opportunities and poverty

reduction. Thus, the improvement of the material conditions of the poor in line with SDG 1, by according them alternative sources of livelihood, will indirectly lead to equitable access to clean water resources.

Economic opportunities and poverty reduction

As earlier stated, Phuthaditjhaba is characterized by high levels of unemployment and poverty. One possible way of tackling these problems is to promote water security in a manner that contributes to job creation and enhances household incomes. If properly planned, both the introduction of new infrastructure and the replacement of old infrastructure can serve as a source of employment. Huge losses of water are incurred due to bursting pipes and leakages. Residents could be hired to monitor, repair, maintain and replace the decaying infrastructure or to install and maintain new infrastructure, including boreholes. Opportunities of water harvesting technologies should be explored to identify ways of collecting water during rainstorms. Locally developed technologies for stormwater harvesting can be a source of employment and livelihood improvement. Similarly, reliance on hand pumping technologies for groundwater exploitation can also be a sure way of creating employment. Residents can be trained to maintain and repair the infrastructure and earn some income for their households. Economic solutions must ensure the reduction of reliance of local communities on alien plant species. Mukwada et al. (2018) established, for instance, that poorer households in communities in Phuthaditjhaba have the tendency to propagate alien species (for example, *Acacia mearnsii*), which serves as a source of fuelwood for lighting, heating and cooking and for other domestic purposes. Hence, the creation of employment opportunities will provide alternative means of income generation to such households and reduce the need to propagate species that promote environmental degradation and water insecurity.

6.6 Conclusion

The climate of the city of Phuthaditjhaba and its surrounding environment is changing. Both the temperature and the frequency of drought are increasing and impacting water security in the city. From the foregoing, it is evident that urban water security lies at the intersection of several interrelated goals, including those that are linked to the maintenance of the ecological integrity, social equity and economic viability in the local environment. The aim of SDG 1 is to reduce poverty, a global menace, and that of SDG 6 is to promote access to water and sanitation, while SDG 13 aims to strengthen resilience and adaptive capacity to cope with climate-related hazards and natural disasters. Based on the conditions that prevail in Phuthaditjhaba, meeting the three SDG goals simultaneously requires a careful analysis of the historical context of the local environment, as well as the ecological, social and economic imperatives, alongside national goals which pit water security against energy security amongst other conflicting endeavours. Hence, blaming climate change alone, while ignoring the culpabilities of water resource managers and planners will not solve the water crisis in Phuthaditjhaba. As shown in the results section of this chapter, climate change is only worsening a situation which is already untenable, characterized by conflicting demands, poor planning and governance at the local level and challenges inherited from South Africa's historical legacy.

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7 Afromontane Community's Dependence on the Water and Climate Change Nexus of the Maloti-Drakensberg Mountain Range: The Case of Phuthaditjhaba

Ntebohiseng Sekhele and Patricks Voua Otomo

Abstract

Phuthaditjhaba is situated at the foothills of the Maloti-Drakensberg, one of southern Africa's primary water-producing regions. Nevertheless, the region suffers from a recurring lack of sufficient water for domestic and agricultural use. Since 2015, this chronic water crisis has created a state of conflict between the inhabitants of the region and the local government. Against the backdrop of the United Nations' Sustainable Development Goals, this paper provides a commentary on the contrasting realities of this town nestled within one of South Africa's most biodiverse regions, yet lacking in the very resource for which it is supposedly famous. We identify both gross mismanagement and neglect by local municipal authorities and climate change as compounding factors leading to the recurring lack of sufficient good quality water in the region. These are some of the major threats to sustainable development in Phuthaditjhaba, which may exacerbate poverty and escalate social tensions that often burst into spontaneous social unrest in the town and its surroundings.

Keywords

Afromontane living · Ecosystem services · Maluti-A-Phofung municipality · Montane Sustainability · QwaQwa · Rural mountain communities

7.1 Introduction

The town of Phuthaditjhaba (Fig. 7.1) is located at nearly 1,650 m above sea level (masl). It lies in the eastern part of the Free State Province of South Africa at the foot of the Maloti-Drakensberg Mountain Range, which rises above 3,000 masl in some areas (Zunkel 2010). The climate of Phuthaditjhaba is best described by the *Cwb* climate subgroup of the Köppen-Geiger climate classification (Köppen 1936; Geiger 1954). Also known as subtropical highland climate, the *Cwb* climate subgroup is temperate with dry winters and warm summers. Annual temperatures in the region range from 35 °C in midsummer to − 5 °C in midwinter (Department of Water Affairs 2011). Rainfall

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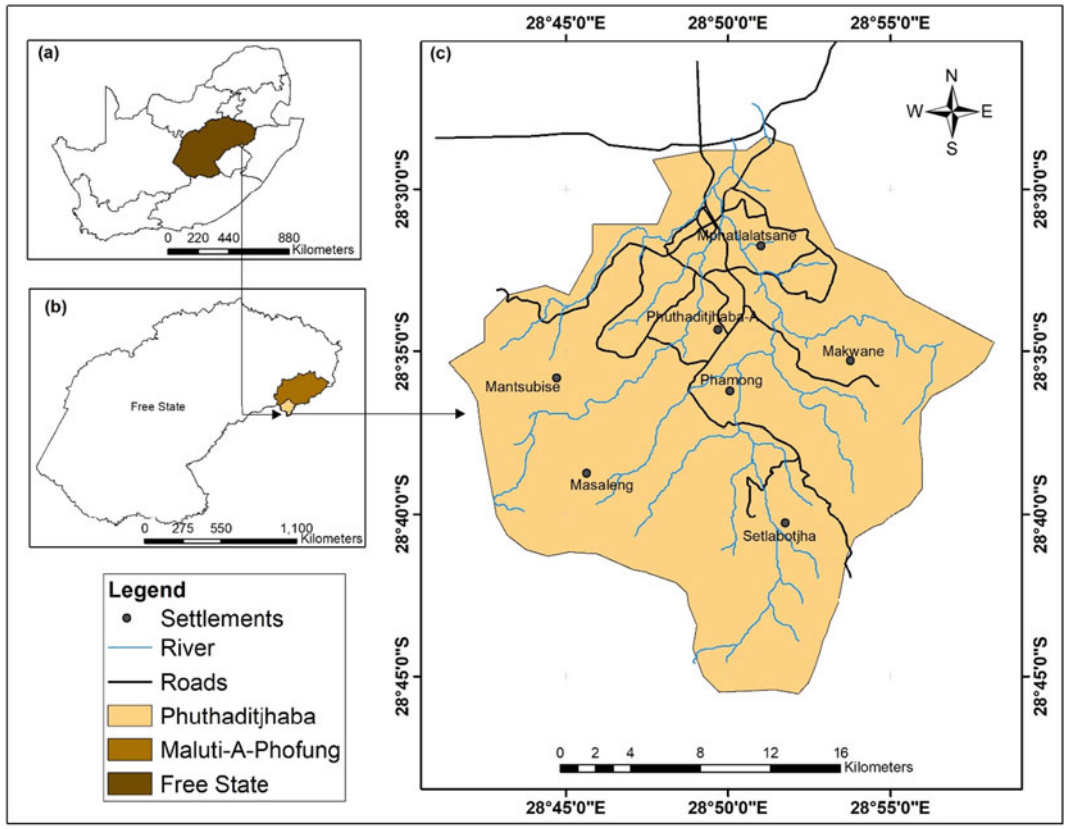

Fig. 7.1 The spatial location of the Phuthaditjhaba region, in the Free State Province of South Africa (Map by Dr. Gbenga Efosa Adagbasa)

precipitation is typically the scarcest in July, in the middle of winter, with an average of 9 mm and peaks in the summer month of January, with an average of 141 mm (Climate data 2021).

Phuthaditjhaba is traversed throughout by the Namahadi River, which has its headwaters above the town and beyond the Fika-Patso Dam in the mountainous regions of western KwaZulu Natal and the Lesotho Highlands (Fig. 7.2). The river flows northwards from the south end of the town where its tributaries include, the Sekoto, the Malemahole and the Metsi-Matsho Rivers (Fig. 7.2). By the time it reaches the north end of Phuthaditjhaba, the Namahadi River becomes the Elands River (Fig. 7.2). Indeed, Phuthaditjhaba lies in the heart of a water catchment area comprising more than half a dozen perennial rivers and streams that ultimately form the Elands River. The Elands River is itself a tributary of the Wilge River, which it joins in the farmlands nearly 30 km northwest of the town of Harrismith. This river network forms part of the Vaal River basin, whose water is used for the domestic, agricultural and industrial needs of part of the Free State and the adjoining provinces of Gauteng, Mpumalanga, and North-West (Moloi et al. 2020).

In this paper, we will provide a brief commentary on Phuthaditjhaba in light of its complex relationship with water as a commodity and an ecosystem service. Against the backdrop of the United Nations' Sustainable Development Goals (SDGs), we will discuss the existing and increasing threat of climate change on this important natural resource and provide an insight into how the problematics of water have shaped social dynamics in the region.

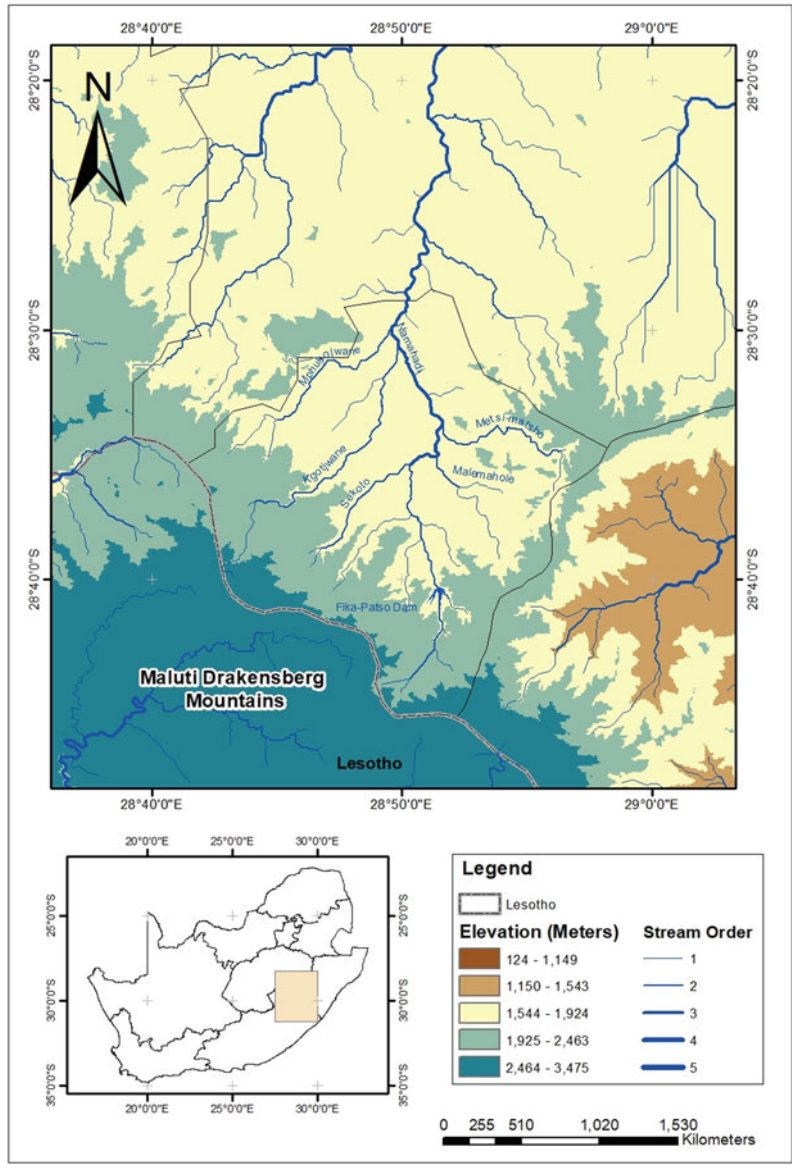

Fig. 7.2 Major rivers of the water catchment area of Phuthaditjhaba. The Namahadi River is at the centre of this river network that turns into the Elands River. This river network forms part of the Vaal River basin, which drains lands in the Free State, Gauteng, Mpumalanga, and North-West Provinces. (Map by Dr. Gbenga Efosa Adagbasa)

7.2 Methodology

The present commentary is informed by a review of the available literature. It analyses the literature on four themes; namely, the synopsis of climate of the Maloti-Drakensberg range; secondly, Phuthaditjhaba as a water deprived water catchment area despite its geographical proximity to the Maloti-Drakensberg mountains; thirdly, the relationship between ecosystem services in Phuthaditjhaba with those of the greater Maloti-Drakensberg range; and lastly, social tensions in Phuthaditjhaba influenced by water resources. These four focus areas have evolved independently despite being fundamentally interconnected and influential. The primary goal was to review these themes distinctly, in a robust and unbiased manner, so that common trends and links can be drawn. Fundamentally, the review intends to contribute to the meteorological, ecological and social discussions on the limited

research of the Maloti-Drakensberg Mountain range and its contribution to the water supply in Phuthaditjhaba.

A comprehensive exploration through triangulation of multiple search methods that includes electronic databases, hand-search and citation search was applied. Thus, relevant peer-reviewed research of qualitative and quantitative findings was obtained from universal scholarly databases that were accessible to the authors (on condition that the database was available on the university's electronic library catalogue). Thus, from the lengthy catalogue of the university's electronic library, the following scholarly databases were randomly selected—ýGoogle scholar, EBSCO Host, ResearchGate, Academic Search Ultimate, Scopus, SpringerLink and ScienceDirect. Grey literature from the South African government reports and gazettes, official departments' websites and online newspaper articles were sourced to outline and demonstrate water dynamics between the Phuthaditjhaba communities and Maloti-Drakensberg mountain range, which is deemed the primary water tower of South Africa.

In order to retrieve relevant studies, it was important to identify and define keywords to encapsulate the research topic. Therefore, the Boolean search technique was applied. The key terms combinations and Boolean operators used in the search string were as follows: (Maloti AND Drakensberg) OR range, Phuthaditjhaba AND water AND catchment AND area, Ecosystem AND services AND Phuthaditjhaba, (Climate AND Maloti AND Drakensberg) OR mountain, (social AND tensions) OR over (AND water AND Phuthaditjhaba). The search parameters had no time-limits, because of the scarce research that exists around the topic. Once the search parameters which were greatly influenced by keywords combinations from the themes of this chapter were decided to identify relevant studies, the process of selecting appropriate articles involved scrutinizing the title, perusing abstracts of all saved articles, and lastly, inspecting the introduction and discussion of results.

Ultimately, the selected literature included peer reviewed articles, reports, book chapters and grey literature. Overall, a total of 56 sources were analysed, to build a narrative of four interdependent themes in the following order: Providing a synopsis on the climate of Maloti-Drakensberg mountain which influences water supply to Phuthaditjhaba and the neighbouring areas; exploring Phuthaditjhaba as a water catchment area of water derived mostly from the Maloti-Drakensberg mountain range; ecosystem system services in Phuthaditjhaba that are impacted by the water supply from the source; and finally, social tensions that emanate from the causal relationship between climate change and water availability in the area.

7.3 The Climate of the Maloti-Drakensberg Range

"Mountains are centres of global biodiversity, endemism and threatened species" (McCain and Colwell 2011:1236). Mountain environments experience unique climate conditions over long periods. This consequently promotes mountain-adapted biodiversity and habitats with specific weather conditions. Important to note is that mountains are classified as sensitive systems (Mukwada et al. 2018), since mountainous regions are more exposed and vulnerable to changes in climate compared to, for example, boreal regions (Thuiller et al. 2005; Pepin et al. 2022). In light of the background above, a change in regional climate patterns has been recognised as a causal challenge to rural, mountainous communities who rely heavily on primary activities such as agriculture, farming and hunting (Babcicky 2013). To some degree, the degradation of ecological services and natural resources of mountainous regions has been attributed to climate change, which subsequently affects the livelihood of communities (Gentle and Maraseni 2012).

Climate change is a global challenge; however, its impacts are most severely experienced in Africa, compared to other continents of the world (Mbiriri et al. 2018). Moreover, the nations that are most vulnerable to the effects of climate change include arid and semi-arid regions. The

former category represents South Africa the best. Therefore, Africa has become hotter and drier, with unprecedented changes experienced along Southern Africa (Buhaug 2010). Verhoeven (2014: 9) cautioned that "As early as 2020, up to 250 million people in Africa were projected to suffer from increased lack of water due to climate change". Subsequently, strained water resources may lead to a collapse of the agricultural sector. Coincidental to the projection made by Verhoeven (2014), Thomas and Gillingham (2015) attest to the adverse effects of climate change on the hydrological cycle, whereby water availability is reduced, resulting in conflict outbreaks within and between societies. Lack of natural resources heightens the vulnerability of dependent societies and strains sensitive ecosystems (IPCC 2018). The occurrence of extreme weather conditions associated with the changes in the climate, such as increased heat, droughts, floods and storms, compromise society's livelihoods by impacting negatively on the availability of freshwater and arable agricultural sources. Communities become increasingly vulnerable and such conditions can lead to instability and conflict (Wapner 2013).

The Maloti-Drakensberg range is associated with decreasing temperature as altitude increases, frequent episodes of rainfall and severe wind currents (Brand et al. 2019). Nevertheless, observed temperature rates over the Maloti-Drakensberg Mountains are estimated to have increased at a rate of 1.6 to 2 °C between 1961 and 2010 (Engelbrecht et al. 2015). Mohamed and Mukwada (2019) performed a quantitative study on the Maloti-Drakensberg Region to analyse temperature change trends using the Mann–Kendall test for the period 1960 to 2016. Annual average minimum–maximum temperatures for the Maloti-Drakensberg Region were examined for variability and trends for the 57-year period. The results of the study detected change in the climate of the area, particularly of increasing temperatures. The maximum temperature increase trends were discovered to be statistically significant at $p = 0.001$, annually, monthly and sub-seasonally, whereas, minimum temperatures indicated significant variability at different temporal scales. Holistically, temperature shifts were also detected in the Maloti-Drakensberg region. For maximum temperature, significant shifts occurred in 1983, 2003 and 2015, whereas for minimum temperatures, sudden changes were recorded in 1982 and 2016 (Mohamed and Mukwada 2019).

Kruger (2006) and Taylor et al (2016) however reported a statistically insignificant difference in the rainfall variability and trend in the region over the last century. Additionally, Engelbrecht et al. (2009) points to the uncertainties around the occurrences of snowfall episodes in the Maloti-Drakensberg due to lack of sufficient climate modelling studies to investigate this form of precipitation. Nonetheless, precipitation of snow in the region would be in response to the warm Agulhas ocean current, which glides southward along the Indian Ocean coastline in the east for several months of the year. In the same token, the decrease in frontal rainfall associated conditions, reduces cut-off low pressure systems and prolongs warm temperatures thus contributing to less occurrences of snowfall (Engelbrecht et al. 2013).

The state of climate in Maloti-Drakensberg region is best addressed by SDG goal 13, whereby urgent action to combat climate change and its impacts is essential. The changing climate in the area has already proven to have dire impacts on water resources, ecosystems, and livelihoods of surrounding communities who depend on sensitive mountain environments.

7.4 Phuthaditjhaba, the Water-Deprived Water Catchment

Because of the seemingly abundant water resources within and around the town of Phuthaditjhaba (see Fig. 7.1), one might believe that access to water, for domestic, recreational, agricultural and industrial uses, is the least of the challenges for the people of the region. However, water related issues constitute one of the greatest challenges to sustainable development in Phuthaditjhaba. For instance, issues related to water quantity and quality have dominated

internal reports from the local Maluti-A-Phofung municipality and external scrutiny from the press (Greyling 2017). Minutes of the Wilge River Forum from 2006 to 2015 (reporting on wastewater treatment works in the eastern Free State- available for download at www.reservoir.co.za) reveal the occurrence of several pollution events besetting rivers in the Phuthaditjhaba and Harrismith areas. These events were said to be caused by several factors including underperforming wastewater treatment plants (WWTPs), improper sewage sludge disposal and infrastructural failures. Recent research seems to indicate that in both Phuthaditjhaba and Harrismith, these issues have persisted (Mosolloane et al. 2019; Moloi et al. 2020). Furthermore, Moloi et al. (2020) found that WWTPs alone did not account for the levels of pollutants recorded in the Elands River, thus pointing to other anthropogenic sources most notably "uncontrolled waste disposal" and "inflow of domestic sewage" at upstream sections of the river.

According to the last available figures from the Department of Statistics South Africa, in 2011, Phuthaditjhaba, which is the urban centre of Maluti-a-Phofung municipality, boasted a population of 54 661 people translating into 17 529 households of which 90.5% had at least one flush toilet connected to the sewerage system (Stats SA 2011). With an average household size of three people, according to the same source, this meant that nearly 5000 people did not have access to proper sanitation a decade ago. The same data further reveal that only 79.6% of the town houses were connected to the municipal water supply. Indicating that the rate of people without domestic access to potable water was practically double that of people without proper sanitation. Added to the fact that one and two out of ten households did not have proper sanitation and direct access to potable water, respectively, Stats SA (2011) also reported that weekly refuse removal was only offered to 68.6% of these households. Because of the time of writing, these inferences were based on the outcome of a decade old national census, it remains unknown whether these numbers have improved in the last ten years. What is certain, based on the 2020 mid-year population estimates by the Department of Statistics South Africa, is that the national population grew from 51.7 million in 2011 to 59.6 million in 2020 (Stats SA 2020). If we go by the national trend and other social indicators in the community (and highlight the fact that these numbers concern the town of Phuthaditjhaba and not the greater QwaQwa region), it would be safe to acknowledge that the current state of affairs is certainly different and could be more precarious than reported here.

Moreover, it is important to note here that having access to municipal water directly in one's household does not guarantee that water will flow through the taps. For many years now, water outages in Phuthaditjhaba have become common occurrence, with such outages often lasting for months (Macupe 2020; Mdlalane 2020; Mtengwane 2020). The reasons for this are multiple, ranging from the simple lack of water due to changing or erratic precipitation patterns, to infrastructure failure due to poor maintenance and mismanagement. In 2020 for instance, the Fika-Patso Dam (Fig. 7.2)–established in the mid-1980s as a water reservoir for the domestic and industrial needs of Phuthaditjhaba–was filled on average to 45.8% of its 29.5 million cubic meters capacity (Department of Water and Sanitation 2021). Gross mismanagement, a significant compounding factor, caused the local municipality to be put under administration in May 2018 after a municipal financial sustainability index study reported debts amounting to 2.8 billion Rand and a total lack of financial accountability (Makhafola 2019; Setena 2020).

The decade old data from the Department of Statistics South Africa help to elucidate the persistent issues pertaining to the quality of natural water resources in the greater Phuthaditjhaba area (Greyling 2017; Vorster 2018). If we are to confer value to Phuthaditjhaba as a water catchment, we are also obligated to acknowledge that access to improper water quality and quantity by the local communities represents a limiting factor to sustainable development in the region. These water-related challenges could be the nexus between several of the Sustainable

Developmental Goals (SDGs) of the United Nations. Indeed, issues related to water quantity and quality certainly have a bearing on SDGs such as:

- No poverty—Goal 1. How to lift oneself from poverty when not enough and/or good quality water is available for subsistence farming, or small-scale irrigation farming? Mukhala and Groenewald (1998), small-scale farmers of the Free State have traditionally practiced irrigation farming on communal gardens. Koatla (2012) indicates that the majority of small-scale farmers of the Phuthaditjhaba area (53%) practice livestock farming (e.g. cattle, sheep, horses, goats, etc.) and another substantial number (44%) prefer mixed farming (farming both livestock and crops). Popular crops are pumpkin, carrots, cabbage, potatoes and maize. These are sold, used for subsistence or animal feed (Koatla 2012). Such farming requires continuous access to sources of good and abundant water. Mukhala and Groenewald (1998) expressed the hope that "savings on irrigation water through efficient farming practices will release precious water supplies for human and industrial consumption." They recognized that assisting small-scale irrigation farmers to optimally utilise the water resources at their disposal is therefore of critical importance. Unfortunately, these hopes have hardly materialised because in Phuthaditjhaba, water is scarce for all forms of use.
- Good health and well-being/Clean water and Sanitation—Goals 3 and 6. How does one rise to attain good health and well-being if the basic necessity of water is a scarcity? Oyekale (2017) reports that in 2014, the majority of children younger than 5 years in South Africa lived in houses with improved access to drinking water and sanitation, although only 29.7% of households paid for safe drinking water. The author found that water pollution significantly increased diarrhoea morbidity among 1-year-old children. In the early 2000s, research had already indicated that most of the burden of unsafe water, sanitation and hygiene (WSH) in South Africa was particularly high in children under 5 years with as much as 9.3% of total deaths in this age group attributed to unsafe WSH (Lewin et al. 2007). Health practitioners and researchers have long postulated that strategies to improve water quality, in conjunction with improvements in excreta disposal and personal hygiene can be expected to deliver substantial health gains in the population (Davison et al. 2005), especially among children in developing countries who primarily bear this health burden. In Phuthaditjhaba, even the main regional hospital, the Mofumahadi Manapo Mopeli Hospital, has not been spared by the water crisis. The press has reported instances of unflushed toilets in the outpatients department and other unsanitary conditions, with members of the community acknowledging that during periods of water shortage "we get water from water trucks but that is not enough. It's impossible to flush toilets and maintain proper hygienic conditions" (Mofokeng 2016). Universal access to safe drinking water and improved sanitation are indeed paramount sustainable development goals as stated by Oyekale (2017).
- Life below water/Life on land—Goals 14 and 15. Substandard water quality and sanitation ineluctably affect the surrounding environment, especially aquatic ecosystems. Sufficient and good quality water are the inconspicuous links between life on land and life below water. There is a paucity of studies focusing on life below water in the Phuthaditjhaba area. Motholo (2014), after characterising the macro and micro-invertebrate assemblages and assessing the water quality of selected rivers in the Phuthaditjhaba catchment area, reported that the Elands river had the worst water quality. This was mostly based on the average score per taxon (ASPT), a water quality index that uses macroinvertebrate tolerance scores to determine the quality of the aquatic environment. Unsurprisingly, the Elands river located at the lowest altitudes within the catchment area, flowing through some of the densely populated sections of the

town and receiving effluent from wastewater treatment works had an ASPT of 4.8, indicating a significantly altered and ecologically poor environment (Motholo 2014). This author also noted that in general the waters below the dams (mainly the Fika-Patso and Metsi-Matsho dams) were generally of poorer quality. Consequently, organisms such as fish, frogs and crabs mainly occurred higher in the catchment area. These findings highlight the impact life on land can ultimately have on life below water, especially in a water catchment where the quality of water channelled downslope to the receiving watershed and the health of the aquatic ecosystems within the catchment depend heavily on processes occurring on land.

Therefore, in a water catchment area such as the montane terrains around and within the town of Phuthaditjhaba, failure to provide proper sanitation, regular and thorough refuse removal, and easily accessible drinking water results in increased environmental contaminants being continually released into the local waterways. As documented by early research evidence (Motholo 2014; Mosolloane et al. 2019; Moloi et al. 2020), this could have far reaching implications for the people and ecosystems within the catchment area and further downstream. Water has been at the heart of the many issues crippling Phuthaditjhaba, until these challenges are tackled, sustainable development in Phuthaditjhaba will remain elusive. In order to ensure sustainable development in Phuthaditjhaba, a catchment management strategy is necessary. This necessity is in line with the proposed research agenda of the Afromontane Research Unit (ARU) housed on the local campus of the University of the Free State. Through its an afromontane biodiversity theme, ARU plans to support and facilitate research on several sustainability topics, including biodiversity, the green economy and catchment management, among others (Mukwada et al. 2016).

7.5 Ecosystem Services in Phuthaditjhaba

The ecosystem services in the surroundings of Phuthaditjhaba are intertwined with those of the greater Maloti-Drakensberg mountain range within which it is nested. As already mentioned, the region is primarily important for its ability to provide water to near and far away lowland regions. Together with the Northern Drakensberg and the Cape Drakensberg (also known as the Cape Midlands Escarpment), the Maloti-Drakensberg is a key strategic water source area (Zunkel 2003; Taylor et al. 2016; Nel 2009). According to Taylor et al. (2016), collectively, these areas supply 50% of the water needs of the country, albeit only representing 8% of the land surface area. On a national scale, South Africa derives about 25% of its water supply from the Maloti-Drakensberg Mountain region alone (Mukwada et al. 2018).

Because of the transboundary nature of the Maloti-Drakensberg, conservation efforts in the region known as the Maloti-Drakensberg Transfrontier Conservation and Development Area (MDTFCA) have been in place since the early 2000s, managed by the Maloti-Drakensberg Transfrontier Conservation and Development Programme (Zunkel 2010). By integrating biodiversity conservation and socio-economic growth strategies, this joint initiative between Lesotho and South Africa has sought to address natural resource management and conservation issues in the Maloti-Drakensberg (Zunkel 2003). According to Zunkel (2010), the MDTFCA might be the most strategically significant transfrontier conservation area because it is located between the economic hubs of Durban, Bloemfontein and Johannesburg. In fact, through a system of impoundments and tunnels known as the Lesotho Highlands Water Scheme, the city of Johannesburg receives close to half of its water provisions from the Maloti-Drakensberg region (Zunkel 2010).

Besides water, the Maloti-Drakensberg teems with endemic flora and fauna (Stattersfield et al. 1998; Sandwith 2003; Zunkel 2003, 2010; Davis et al. 1994; Brand et al. 2019; Bentley et al. 2019). Because of these attributes, the Drakensberg Alpine Region has been recognized as one of the world's 200 most important ecoregions (WWF 2000) and one of eight South African biodiversity "hotspots" (Cowling and Hilton-Taylor 1994). Nevertheless, these ecosystems have come under threat from several factors, chief among them climate change (Bentley et al. 2019) and unsustainable land use practices (Zunkel 2010). Land use in Phuthaditjhaba and its surroundings is driven by subsistence agriculture, livestock farming, and informal land settlements. Sandwith (2003) had already pointed to these factors along with historical conflicts over the land as causes of biodiversity degradation.

Adelabu et al. (2020) argue that the anticipated effects of climate change could be mitigated by adopting agricultural practices and technologies "*that increase the resilience of mountain livelihoods.*". Taylor (2022, this volume) advocates for urban greening through the planting and maintenance of trees throughout Phuthaditjhaba, which would also necessitate training and job creation. Clark et al. (2019) acknowledge that the management of the Maloti–Drakensberg region lacks a proper vision for its sustainable development despite considerable policy and academic appraisal. Adelabu et al. (2020) argues that achieving sustainable development in the region also calls above all for the tackling of Goals 2 and 15 of the UN-SDGs, "which emphasize zero hunger and the need for sustainable, resilient food production as well as conservation of mountain ecosystems".

7.6 Social Tensions Over Water in Phuthaditjhaba

The change in climate has been accompanied by increasing civil disputes over declining natural resources over time (Solow 2013). For example, in January 2020, the community of Phuthaditjhaba and surrounding villages gathered to express their dissatisfaction over the lack of water (SABC News 2020). The roads were barricaded with burning tyres and rock boulders (Moloko 2020). This protest lasted for over two weeks, with citizens demanding running water. The region had been experiencing water problems for over 10 years; however, it was during the last four years that the situation worsened as a result of prolonged periods of little to no rainfall. The local municipality did not fulfil its duty to provide the right of access to sufficient and reliable water supply (Mtengwane 2020). Consequently, out of frustration and desperation, the community embarked on a "shutdown" and complete closure of business and prohibition of movement by people within the Phuthaditjhaba area. The intention was to have every resident participate in the service delivery protest.

Multiple factors were attributed to the lack of water in the area, including water scarcity, prolonged drought seasons and aging infrastructure. Against the backdrop of UN Sustainable Development Goals, a lack of safe drinking water is highlighted by social conflict against the local municipality of Phuthaditjhaba. It is equally important for all stakeholders who benefit from water resources to ensure the restoration and protection of water-related ecosystems such as dams and rivers, which are quite abundant in the region. At the time of writing, issues related to the provision of potable water in the region had still not been satisfactorily addressed (Koka 2022), leaving the possibility for more significant social unrest in the future.

7.7 Conclusion

Water is an integral part of the socio-economic-environmental system. Major challenges confronting Phuthaditjhaba's water supply are gross mismanagement of resources and infrastructure by local municipal authorities and climate change. These challenges prompt water-related tensions emanating from the local communities which rely on these rural–urban water supply networks. Environmental issues related to water have also dominated reports from the local

Maluti-A-Phofung municipality, similarly pointing to the absolute lack of water as a key limiting factor to sustainable development in Phuthaditjhaba. Issues related to water quantity and quality, and climate change have been proven to have an impact on SDGs that address an absence of poverty, creating good health and well-being, providing clean water and sanitation, dealing with climate action, and protecting life below water and life on land. Substandard water quality and sanitation also affect the surrounding environment. Sufficient and good water links life on land and life below water and the lack of proper climate action is already tilting this fragile balance in Phuthaditjhaba. This chapter thus advocates for more multi-disciplinary studies in Maloti-Drakensberg Mountains and surrounding rural montane communities to understand the role of water in achieving the United Nations Sustainable Development Goals in this region.

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Bottom-up Solutions to Food Insecurity: Puseletso Maphesa's Vegetable Gardens Support QwaQwa

Hilfe für Südafrika and Jess L. Delves

One way to tackle food insecurity in Phuthaditjhaba is the cultivation of small vegetable gardens, either privately or collectively. One QwaQwa resident is teaching her community to establish their own vegetable gardens and donating surplus to those in need.

While working as a nurse, Puseletso Maphesa's patients often went hungry because the hospital could not provide enough food for them. She witnessed firsthand the problems caused by undernutrition among her patients, who often had to take medicine on empty stomachs. So Puseletso Maphesa began bringing food to the hospital from her own vegetable garden for the patients. Then in 2013 she joined a social gardening project in her community where she honed her skills.

In 2017 Puseletso Maphesa set up a practical and educational project, starting with her own vegetable garden (Fig. 7.3). The key principles of Puseletso Maphesa's project are to give generously and to pass knowledge on to others. She teaches people in the community how to establish their own vegetable gardens, how to plant and care for vegetable plants and how to collect and store seeds for the next planting period. In this way, she ensures that her community can establish long-lasting gardens and thereby increase their food security. In addition, Puseletso Maphesa teaches how to prepare and store vegetables once harvested. She advises growers on how to commercialise their produce and encourages them to donate a part of their harvest to other people in need.

Fig. 7.3 Puseletso Maphesa working in her vegetable garden. Right: Puseletso Maphesa

Currently, two young men help Puseletso Maphesa both in her garden and with her educational activities in the community. The vegetables grown in her garden are donated to day care centres, to patients in hospitals and amongst the community. She has been able to expand her activities since receiving financial support from a small non-profit organization (NPO) based in Germany, *Support QwaQwa—Hilfe für Südafrika e.V.* (www.support-qwaqwa.de). With this support, she and her community have been able to expand their gardens, distribute more seeds and provide more fresh produce to people in need. In 2021, 60 families and 100 individuals benefitted from Puseletso Maphesa's gardening project.

The project nevertheless faces several challenges. In order to receive financing via the German NPO Puseletso Maphesa must complete complex paperwork. As an elderly woman who speaks neither German nor English and has no experience with European bureaucracy, this poses a significant challenge. But finding volunteers to help with paperwork or with practical activities is difficult, since young people prefer to spend their time looking for paid work. In the gardens, crops are frequently damaged by cattle, birds, insects or other pests. Extreme weather events, particularly heavy and prolonged rainfall as well as drought, can have serious impacts on crop yields. Reliable water availability is also an issue and funds are needed to purchase water tanks to store water for the community, as well as shading nets to control sunlight and protect crops. Despite these challenges, Puseletso Maphesa is determined to expand her educational activities in order to bring knowledge, food and ultimately increased independence and security to her community.

8 Planning for Effective and Sustainable Water Access and Provision in QwaQwa Through the UN Sustainable Development Goals

Kgosi Mocwagae and Thulisile Mphambukeli

Abstract

QwaQwa is a former Bantustan, which consisted of 13 sections of the Phuthaditjhaba Township and 99 surrounding villages. On 1 January 2016, the Maluti-a-Phofung Local Municipality reported that the Fika Patso Dam, which supplies the majority of water to QwaQwa, had insufficient water, subsequently shutting it down. The community of QwaQwa had reportedly been struggling to access drinking water since 2016, which forced them to collect water from provisional or improvised municipal water tankers. This chapter documents the lived experiences of 11 communities in the greater QwaQwa area, highlighting their struggle to access adequate drinking water. The chapter proposes planning interventions for effective and sustainable water access and provision in QwaQwa. It also looks at Sustainable Development Goals 6 and 11 to address policy issues toward effective and sustainable water provision in QwaQwa. The study employed an exploratory sequential mixed-methods approach. The qualitative method administered 10 semi-structured interviews with key informants (municipal officials and political leaders) and three households for 326 min in total. A total of 571 household questionnaires were administered for quantitative data collection. Discourse and thematic methods were used for the qualitative data analysis, and descriptive and inferential statistics for the quantitative data analysis. The study established that post-apartheid's ineffective planning for water access in QwaQwa, significantly and negatively affected the greater QwaQwa community, resulting in the local communities having to travel long distances to collect water. It took more time to collect water, while the water quantity decreased with an increased cost of accessing water. The misfortune of the QwaQwa water crisis presents a challenge for the attainment of UN Sustainable Development Goals 6 and 11 that require basic service provision and making cities more inclusive by the municipality.

Keywords

Effective planning · Local governance · Sustainability · Sustainable development goals · Water

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8.1 Introduction

Many cities worldwide currently experience inadequate access to clean and drinkable water, and South Africa is no exception. Despite the generally reported increase in water access and provision across South Africa, from 80.3% in 1996 to 91.2% in 2011, in QwaQwa, the increase from 16.9% in 1996 to 31.9% in 2011 was significantly lower (The Local Government Handbook 2021; Statistics South Africa 2011). Indeed, South Africa's colonial and segregation historical epochs created deeper inadequate water provision and access challenges, evident in post-apartheid South Africa (Funke et al. 2008:311). This chapter unravels the contradictions and complexities of inadequate water provision to local communities of QwaQwa and the continued distribution of water from QwaQwa across South Africa; a predicament created by the apartheid government and continuing into post-apartheid South Africa (Mphambukeli 2019). This is a continuity in change because despite having a democratic government, there has been a continuity of dismal failure to effectively plan for water access and provision to the local communities of QwaQwa. Even though QwaQwa, the smallest of the former 10 Bantustans, was and is still a water source distributor to many parts of South Africa, it failed to effectively plan for water distribution within the region, thus, requiring a closer interrogation.

This chapter is divided into seven sections. Following the introduction, the background to QwaQwa is provided, including an outline of the selected relevant UN Sustainable Development Goals (SDGs) that articulate effective water provision and access in QwaQwa. Section 8.4 presents the reviewed literature relevant to the study. Section 8.5 describes the research approach, data collection, who and how many people participated in the study, and data analyses. Section 8.6 presents the findings and discusses the importance of water and effective planning approaches for adequate provision of drinking water in QwaQwa. The chapter concludes by summarising the main points and how the issues raised have been addressed.

8.2 Background to Qwaqwa

QwaQwa, previously known as Witsieshoek, is the capital of Maluti-a-Phofung Local Municipality in the Free State province (Fig. 8.1). It has a southern physical boundary of the Drakensberg mountains, or *Maluti* in South Sotho, separating it from Lesotho and KwaZulu-Natal (KZN). QwaQwa has an average altitude of 2134 m above sea level and extends across steep slopes and foothills. The Maluti has a peak known as Mont-Aux-Sources (meaning mountain of sources in French), also referred to as *Phofung* in South Sotho, at 3282 m above sea level (Britannica 2020). The name of the municipality *Maluti-a-Phofung* was derived from the presence of the mountains, a major water source for six rivers flowing across South Africa. Phuthaditjhaba is the urban centre of QwaQwa with 13 sections and is surrounded by 99 villages.

Figure 8.2 depicts the six rivers originating from Mont-Aux-Sources in the Phuthaditjhaba region. The first is the Tugela (Thukela) River which feeds the Sterkfontein Dam (the third largest in South Africa) and flows across the KZN province into the Indian Ocean. The second is the Caledon (Mohokare) River, a tributary to the Orange River, which is the largest river in South Africa and feeds into the Gariep (largest) and Vanderkloof (second largest) dams. The remaining four rivers are the Namahadi (Elands), Metsi-Matsho, Kgotjwane and Mphukojwane. These tributaries of the Wilge River flow to the Vaal Dam (the fifth largest) (Semela 2005; South Africa, Department of Water Affairs 2017).

8.3 Sdg6 and 11: Sustainable Water Provision, Access and Management

The 17 SDGs are an attempt spearheaded by the United Nations to reflect global moral principles and long-term global strategies with a common vision for safe, just, and sustainable spaces for human inhabitancy; to be achieved by 2030 (UN 2015). This chapter focuses on SDG6 and

Fig. 8.1 QwaQwa. Britannica (2009) *Source* Slater (2002)

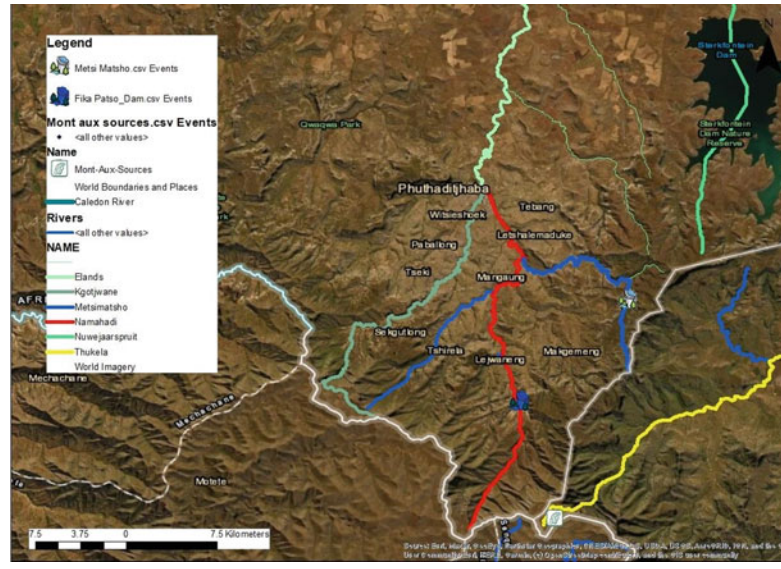

Fig. 8.2 QwaQwa. *Source* Adapted from Google Maps (2021)

SDG11 because they specifically articulate issues of sustainable water access, provision and making cities sustainable.

8.3.1 SDG6: Ensure Availability and Sustainable Management of Water and Sanitation for Everyone

SDG6 has eight objectives (Table 8.1) which are all relevant to the study because they articulate how cities can move toward ensuring the sustainability of adequate water and sanitation for everyone (UN 2015).

8.3.2 SDG11: Make Cities and Human Settlements Inclusive, Safe, Resilient, and Sustainable

SDG11 outlines 10 objectives for sustainable cities. It argues that sustainable cities cannot be attained without adequate water access and provision. Of the 10 objectives outlined by SDG11, only Objective 1 is relevant to this chapter because it focuses on providing adequate, affordable, safe housing and basic services. Thus, it focuses on the need for adequate water access and provision.

8.4 Literature Review

The literature review is organised into four themes known as commons. These include water, land and air as a common; contextualising the history of planning in South Africa; history of water governance and its impact on QwaQwa; and defining effective planning for water provision in QwaQwa.

8.4.1 Water and Land as Commons

Commons are primary resources such as land, air, and water that affect a community's livelihood that should be equitably provided for. Commons are also referred to as a common pool of resources that need to be governed (Agrawal et al. 2013:138). Commons are non-renewable resources that are depleted based on how they are consumed (Basu et al. 2017:144; Ostrom 1992:415). Therefore, commons are natural resources that are supposed to be collectively owned by the community, but were commodified

Table 8.1 Summary of SDG6 objectives

Objectives	Aims
1	To ensure that water is universally accessible and affordable for all
2	To achieve equitable and adequate sanitation and hygiene by ending open defecation and attending to the needs of vulnerable girls and women
3	To improve water quality by eliminating the dumping of hazardous waste, reducing pollution, improving wastewater treatment, ensuring sustainability, and starting recycling for safe use globally
4	To increase access to water throughout all sectors and ensure sustainable extraction and supply of freshwater to address water poverty
5	To integrate water resources management across the value chain, including transboundary cooperation
6	To restore and protect water ecosystems such as forests, mountains, rivers, lakes, aquifers, and wetlands
7	To increase international participation in capacity building in developing countries for water and sanitation programmes such as desalination, water harvesting, recycling and reuse technologies, and wastewater treatment
8	To encourage the participation of local communities in refining water sanitation management

for private interest by capitalists. Hence due to capitalism as an economic and political system based on principles of private land ownership and exploitation of resources, accumulation of wealth occurred worldwide through the commodification of land by the minority white population at the expense of the black majority groups (Harvey 2007; Shivii cited in Benjaminsen and Bryceson 2012). Land and water are inseparable commons because the land is a medium through which water is accessed through streams, rivers, fabricated channels, reservoirs, dams, and retention ponds (Dell'Angelo et al. 2017; Suhardiman et al. 2017). Land is a common globally commodified before air and water (Bakker 2007:430). In South Africa this was evident with the Native Land Act of 1913, which restricted land ownership of blacks to 13% despite them being the majority (Mphambukeli 2019).

In South Africa, the apartheid government introduced water transfer schemes in the 1950s to benefit cities such as Johannesburg and Pretoria (Hoogendoorn 2017; Barta 2018). People who resided where the water originated from were cut off completely from accessing it, while the transfer of this common economically benefitted the apartheid regime, to the disadvantage of Africans, such as the case in QwaQwa. One clear example is the Lesotho Highlands Water Project, Africa's biggest water transfer scheme that has negatively affected Lesotho (Bakker 2007:439). Indeed, the overexploitation and degradation of commons have a negative effect on the environment and human being, but until today capitalists seems little concerned by such negative effects (Hardin 1968:29). However, Ostrom (1992:416) argued that well-managed commons benefit the community equally because there is a value associated with the benefit they receive from this (Ostrom 1992:416). Therefore, a place such as QwaQwa experiencing an ever-growing population that decreases the per capita water available requires collective action (Agrawal 2014:87).

8.4.1.1 Water Access Rights

Water has been recognised as a basic human right by both the Constitution of the Republic of South Africa, 1996, and the UN. The denial of access to water is a violation of human rights. Water is necessary for life, production, and development, and the lack thereof signifies poverty. Water is also used for social needs such as irrigation, hygiene, sanitation, and environmental needs (Biltonen and Dalton 2003:1).

An inconsistent water supply creates vulnerability, more so for Africans because they access most of their water from rivers (De Wit and Stankiewicz 2006:1917). In 2019 the World Health Organization (WHO) reported that approximately 1.8 billion people have access to potable water. However, there was still a concerning number of 785 million (1 in 10) people globally who lacked potable water access. In Eastern Asia and sub-Saharan Africa, only 30% had access to safe drinking water (World Health Organization 2016:8). Furthermore, women and children are commonly responsible for collecting water for their households, often having to travel long distances, making them the most affected by inadequate water access and provision. It is noteworthy that improved water sources globally are more accessible in urban areas, compared to rural ares (Anand 2007:519; Sultana and Loftus 2019).

The UN has a prescript of factors influencing adequate water access per adult, such as quantity, distance, time, and cost. The daily **quantity** of water that should be accessible per day ranges from **50–100 ℓ** per adult. The **distance** travelled daily to access water should not exceed **1 km**. The **time** used to access water should not exceed **30 min** daily. The **cost** spent to access water should not exceed **3%** of the total monthly household income. The countries that have made the provision of water a constitutional right include South Africa, Panama, Ethiopia, Uruguay, Gambia, and Uganda (Anand 2007:518; Sultana and Loftus 2019; Patel et al. 2017).

8.4.2 Contextualising the History of Planning in South Africa

This section situates the QwaQwa context within the South African historical planning trajectory. Three periods of South African governance that had different planning objectives are presented in this section. Firstly, 1900–1947 represents the period when the Union of South Africa was governed by a joint British and Afrikaner rule after the Anglo-Boer War. Secondly, 1948–1993 represents a period of Afrikaner rule through which separate development through apartheid governance was implemented to benefit the minority white population. Lastly, 1994–2021 represents governance in South Africa in the democratic dispensation with the primary intention of redressing the injustices of British and Afrikaner regimes.

8.4.2.1 1900–1947: Colonial Planning in South Africa

The birth of planning as a profession in the late nineteenth century during the Industrial Revolution in Britain, and later through the British colonial rule in South Africa, influenced the planning landscape (Mabin and Smit 1997:195). The history of planning in South Africa and its relation to the formation of QwaQwa as a Bantustan in 1974 can be traced back to colonial planning practices (Davenport 1987). When planning was first introduced in South Africa, the aim was to remove the perceived 'insanitary areas', which led to the forceful removal of black people in cities such as Cape Town, Johannesburg and Port Elizabeth in the early 1900s (Krut 1979).

Second, the subdivision of lands (e.g., the allocation of parks, compounds and township establishments, cemeteries, and market squares) occurred through laws set out by the Republic of the Orange Free State's Townships Board across the Union of South Africa (Mabin and Smit 1997). Du Bruyn and Oelofse (2019) refer to how many townships were established based on the Orange Free State model republic that relocated black people from Waaihoek to the Batho location in 1918. Last, the Native Land Act of 1913 and the Natives Act of 1923 introduced racial zoning to planning in South Africa (Report of the Municipal Commission 1909, cited by Mabin and Smit 2010). The colonial planning period laid a foundation for inconsistent and inadequate access to basic service provision according to race and thus affected water provision in South Africa and QwaQwa in particular.

8.4.2.2 1948–1993: Spatial Planning, Forced Removals, and the Creation of Bantustans During Apartheid

From May 1948, premeditated segregation deepened in South Africa after the National Party came into power, based on an Apartheid Manifesto of compulsory urban segregation (Dubow 2014). Various legislation was further introduced to realise the aspirations of apartheid. For instance, the Group Areas Act (GAA) of 1950 facilitated the racial restructuring of cities, particularly of the separatation of black townships from white areas, driven by countless subsidiary planning committees.

In 1948, South Africa was experiencing high economic growth from mining activities which were heavily reliant of water and whose proceeds were used to fund the implementation of apartheid (Busacca 2013). From the 1960s to the 1970s, through the Promotion of Bantu Self-Government Act of 1959, the apartheid government started developing Bantustans (homelands) that formed primary urban centres for black people (Richings 1976). Planning of Bantustans was done centrally in Pretoria, with minimal consultation of Bantustan authorities (Mabin and Smit 1997:208). The Bantu Homeland Citizens Act of 1970 meant that black people were forcefully settled in 10 Bantustans separated according to eight ethnic groups (Sotho, Pedi, Xhosa, Zulu, Venda, Ndebele, Swati and Tsonga) (Venter 1989; Hino et al. 2018). The QwaQwa Bantustan, the smallest of the 10, was officially established on 1 November 1974.

In the 1980s, due to economic decline, there was pressure on the apartheid government to

revoke its laws and release political leaders, including the symbolic release of Nelson Mandela on 2 February 1990 (Glad 1997). Laws such as the Land Act of 1913 and 1936, Native Urban Areas Act of 1923, and Abolition of Racially Based Land Measure Act of 1991, were but some of the many key laws that were revoked. Despite colonial-cum-apartheid laws being revoked in the early 1990s, racially segregated planning is still evident in post-apartheid South Africa (Bickford-Smith 2008).

8.4.2.3 1994–2021: Planning for Development and Basic Service Provision in Post-Apartheid South Africa

In 1994 the democratic dispensation took effect, reintegrating the 10 Bantustans into South Africa. However, they faced major service delivery issues because the apartheid government's motive was based on racism and classism, and has proved challenging to dismantle (Mphambukeli 2019). Soon after taking office as the ruling party, the African National Congress (ANC) developed the Reconstruction and Development Programme (RDP), a White Paper to address urban fragmentation and segregation to redress the injustices created by the colonial-cum-apartheid regimes (Mabin and Smit 1997; Goldbatt 1996). Basic service delivery, particularly access to and the provision of water, were part of the RDP's critical objectives.

The second long-term vision of the ANC-led democratic government is the National Development Plan (NDP) for 2030, which aims to eliminate poverty, reduce inequality and create sustainable human settlements (South Africa, The Presidency 2012). The NDP comprises 15 chapters, but only four are discussed in this section. These include: Chap. 4 (Economic infrastructure) focuses on water resource management that addresses water supply and demand; Chap. 6 focuses on an integrated and inclusive economy, allowing for rural agricultural advancement; this chapter concerns transforming human settlements: and Chap. 10 (Promoting health) states that all require adequate water provision and access in QwaQwa (Zarenda 2013; Fourie 2018; Cumming et al. 2017).

The Spatial Planning and Land Use Management Act (South Africa, SPLUMA 2013) is a legislative framework for spatial planning and land use management in South Africa (Joscelyne 2015:ii). SPLUMA is an overarching framework for land use management, spatial policy, and planning, which includes rural areas and informal settlements (Nel 2016a:79). According to Kruger (2014) and Van Wyk (2015), SPLUMA is a single piece of legislation that addresses past injustices and allows for effective planning tools for land use that will ascertain adequate water access and provision.

8.4.3 History of Water Governance in South Africa and Its Impact on QwaQwa

The history of water governance is discussed from the precolonial era to post-apartheid South Africa concerning its negative impact on water access and provision in South Africa, particularly on QwaQwa.

8.4.3.1 South African Water Governance: Pre-1652

Africans practised customary water governance before colonialism was introduced in South Africa. Customary water rights were common knowledge, and conflict was not common within communities but only between different tribes (Tewari 2009:694). Southern Africans lived through hunting and gathering, and water and land were freely accessible through land tenure controlled by chiefs (Juuti et al. 2007; Tewari 2009:694). Water was treated as a common by customary water laws as it was freely accessible to communities. The disruption of customary water laws occurred during colonialism and was enforced through the apartheid era.

8.4.3.2 South African Water Governance: 1652–1947

The period of colonialism in South African history is signified by the arrival of Dutchman Jan van Riebeeck leading the Dutch East India Company (VOC) to establish a trade and refreshment post in the Cape (Ross 1999:23). Africans already lived in the Cape upon arrival of the VOC, utilising customary water laws for water access (Funke et al. 2007:12). New forms of water law known as *placaets* were implemented to impose strict water and land control (Findlater et al. 2007:8; Funke et al. 2008:314). Henceforth, the VOC acquired land ownership through illegitimate means.

In 1661, the first water law stipulated that individuals in the Cape Colony had to abide by stipulated irrigation hours in corn mills (Gildenhuys 1970). The second law stated that the government of the Cape Colony was responsible for the entitlement of shared water streams and conflict regarding water access among the Dutch (Thompson 2006:34). The two laws were based on Roman-Dutch law, which stated that water should be equally accessible to all through government protocols (Hall and Burger 1957:2). Despite water access being stated as equal, those with more land, political power, and economy had more rights to water, further excluding black people and creating water poverty in the process (Jacobs 1996:251).

Based on water being accessible through the land, the water laws created a dual system that initially affected the Khoisan. The Khoisan are indigenous people who were hunter-gatherers that lived in the Cape when the Dutch arrived (Verbuyst 2016). Therefore, those that owned land had rights to access water that flowed through it. The link of water access to land ownership resulted in a cumulative negative impact of colonial water laws that undermined customary water governance (Van Koppen and Schreiner 2014:59).

The British defeated the Dutch in 1806 and claimed the territory that they occupied. The British introduced four water laws that impacted water governance and planning in South Africa (Hall 1939:28). The first law allowed for exclusive water reservation for people owning land with streams and rivers (Duly 1965:361). As black people were being driven out of their territories, white landowners had the advantage of more access to water. The second law was the Land Act of 1913, which created racial ownership of land that saw only 13% being allocated to black people, which later became advantageous for creating the Bantustan system (Beinart and Delius 2014:667). The third law emphasised agriculture and irrigation through the Water Act of 1912 (Funke et al. 2007:15). The fourth law resulted from the discovery of gold in Johannesburg in 1886, which saw rapid migration to the mining town, leading to a water shortage and a need for water management. In the process, the Rand Water Board was established in 1903 to deal with water and sanitation matters of the Witwatersrand (Haarhoff and Tempelhoff 2007:96).

8.4.3.3 South African Water Governance: 1948–1993

Apartheid also brought its own water laws, promulgated according to racial lines and favoured white people (Clark and Worger 2013). Because apartheid thrived through separate development implemented through the GAA, the living conditions of many black people deteriorated, especially in Bantustans (Breckenridge 2014:225; Pirie 1984). The Department of Irrigation introduced the Water Act of 1956 to allow for agricultural and industrial water provision (Thompson 2006). The industrial water provision made it a priority for Bantustans to have access to water because they were used as labour reserves for the apartheid government (Tempelhoff 2017:190). Bantustans were also intended to reduce the migration of people to white urban areas (Cousins and Newell 2015).

In 1961, the apartheid government declared South Africa "free" from British colonialism, resulting in the apartheid government intensifying control through apartheid legislation that limited access to water in the Bantustans (Funke et al. 2008:317). This freeing of British colonialism was later discovered to be just for the sake of governance, but a continued hold over

South Africa's mineral resources was realised with the Marikana Massacre (Carmody 2017; Schultz 2020). The increased industrialisation in Bantustans led to water being provided for industrial purposes more than for domestic consumption and human needs, which is why South Africa has struggled to bridge the basic service provision and access to water and sanitation (Ruiters 2005; Evans 2019). History will also have us recall how the government only provided three boreholes, and those only for irrigation purposes, leading to people being criminalised for using them for domestic purposes (Development Bank of Southern Africa 1987). The apartheid government also began instituting greater control over rivers and developing water basin transfer schemes to provide areas with water that otherwise struggled to access it (McDonald and Ruiters 2012). This move of more control of rivers and transfer schemes negatively impacted the ecosystem because they reconfigured the hydrosocial territories socially, physically and symbolically (Funke et al. 2007; Hommes and Boelens 2017).

8.4.3.4 Post-Apartheid Water Governance: 1994–2021

After the democratic elections in 1994, all colonial and apartheid racial and discriminatory laws were repealed because through the GAA, different races were situated in separated areas experiencing different levels of water provision. The Water Services Act (WSA) of 1997 and the National Water Act (NWA) of 1998 were introduced to redress water provision and access challenges in South Africa. The WSA was put into place to establish water schemes in local municipalities across South Africa. At the same time, the NWA addressed Sect. 27(1)(b) of the Bill of Rights in the Constitution, 1996, which states that everyone has a right to access sufficient water and food.

Despite the great intentions of WSA and NWA, South Africa still faces significant challenges in a consistent supply of water, as has been the case with the Cape Town Day Zero event in more developed cities (Enqvist and Ziervogel 2019). The Cape Town Day Zero event occurred in 2015 when the city's dam reserves dropped below 13.5%. Water restrictions were imposed to reduce water consumption. However, ideological, hydrological and institutional framing remains a battle for water in South Africa, seeing the majority of the poor population struggling to access potable water (Klug 2021). Yates and Harris (2018) provide evidence from a comparative study of Accra (Ghana) and Cape Town (South Africa), demonstrating that there is a challenge in enforcing water governance that promotes human rights alongside a neoliberal environment.

8.4.4 Defining Effective Planning for Water Access and Provision in QwaQwa

The concept of effective planning is discussed in this chapter because it is the desired outcome for water provision and access in QwaQwa. Effective planning is defined as effective stakeholder engagement in the process of proactively preparing for the community's well-being (Kenawy and Shaw 2014:80). Effective planning is a futuristic process with desired outcomes which involves combining the budgeting process with planning to enhance basic service delivery (Musoga 2011:9; Maheshwari 2006; Horowitz 2017). Furthermore, effective planning shapes the future of the city, its possible political conflict or consensus and is based on representing the best interests of the community it serves and must be unpacked through its processes, benefits, and limitations (Calthorpe 2019).

8.4.4.1 Process of Effective Planning

The process of planning should accomplish seven factors: (1) community participation is needed to clarify planning interventions, strengthen urban management tools, encourage community buy-in, and promote awareness; (2) stakeholder involvement that includes all parties affected by planning; (3) coordination of policy from a national level and being reflective of local interests; (4) urban and economic planning establishes clearer processes between

development needs and the planning process; (5) sustainability should be at the centre of planning to ensure urban development and energy-efficient urban forms; (6) financial feasibility has to be determined for financial implications of planning interventions, inclusive of maintenance, cost recovery, and capital costs; and (7) the national initiative should analyse objectives that encourage participation and more effective planning (Polat 2009:95; Horowitz 2017). This effective planning process is important to follow if adequate water provision and access are to be attained in QwaQwa.

8.4.4.2 Benefits of Effective Planning

Effective planning has six benefits which are crucial for adequate water provision and access in QwaQwa: it assists in achieving desired goals; guides activities that are needed to achieve goals; improve the utilisation of resources; creates motivation and commitment of institutions and stakeholders; sets performance targets and how they can be measured when achieved; and managers can identify critical resources for effective planning (Maheshwari et al. 2011:199).

8.4.4.3 Barriers to Effective Planning

Effective planning has the following barriers: good planning requires investing time, and relevant parties might choose not to participate; dynamic environments and unstable environments need intuition; other issues need to be addressed without being planned for; and the plan can be poorly implemented leading to unintended results of effective planning (Maheshwari et al. 2011). The limitations of effective planning need to be mitigated. This will ensure adequate water provision and access in QwaQwa by fully embracing effective planning, subsequently maximising the benefits and reducing barriers.

8.5 Methodology

The study employed an exploratory sequential mixed-methods approach, which was ideal because little was known about the factors that led to the QwaQwa water crisis and how it relates to planning. The qualitative component included 10 semi-structured interviews with seven key informants (municipal officials and political leaders), three households (totalling 326 min), and observations of the research participants to narrate the effects of inadequate water access and provision on the QwaQwa community. Qualitative secondary data was collected from document analysis such as policy, legislation, literature, newspapers and archives. A purposive sampling procedure was employed to determine the key participants included in the study (Mack et al. 2005:5). The sample comprised two municipal officials, three traditional leaders, and three households. Thematic and discourse analyses were used to analyse qualitative data. The thematic analysis for interview schedules was used to emphasise and identify patterns of the meaning of the QwaQwa water crisis (Braun and Clarke 2006). Discourse analysis employed inductive content analysis of participant observation into themes relevant to the QwaQwa water crisis (Keller 2011:43).

For quantitative data, 571 close-ended household questionnaires were administered. The results were used to determine the severity of the QwaQwa water crisis on households (Creswell 2014:49). A multistage sampling technique was implemented over five stages. In order to establish the sample size from 85 524 households in QwaQwa, according to Statistics South Africa (2011), the first stage used Slovin's formula at a confidence level of 95%, resulting in 398 households (Eq. 8.1). However, this was increased by 25.6% to 500 households (Eq. 8.2) to account for population growth and to increase the reliability of the data. Nonetheless, 571 household questionnaires were administered at the end of the study.

$$\begin{aligned} n &= \frac{N}{1+Ne^2} \\ &= \frac{85\ 524}{1+\left(85\ 524 * (0.05)^2\right)} \\ &= 398.14 \text{ households} \\ &\approx 398 \text{ households} \end{aligned} \tag{8.1}$$

e = Margin of error
e = 0.05
n = Sample size
N = Total households

Equation 8.1: Slovin's formula

$$\begin{aligned} n &= sample\ size * attrition \\ &= 398 * 1.256 \\ &= 499.49 \text{ households} \\ &\approx 500 \text{ households} \end{aligned} \tag{8.2}$$

Equation 8.2: ***Reliability sampling***

The second stage used purposive sampling to determine 10% (11 out 112) of the areas to sample in QwaQwa because the land area was too broad to administer household questionnaires. The 11 areas were chosen using the following criteria (1) income level, (2) proximity to the dam and (3) type of governance. The sampled areas included the nine villages of Bolata, Tseki, Monontsha, Sekgutlong, Lejwaneng, Letshalemaduke, Makwane, Jwala Boholo, and Matsikeng and two township sections of Bluegumbosch (Phuthaditjhaba–N) and Elite (Phuthaditjhaba–J). The third stage used stratified proportionate sampling to determine the number of households per area from the entire sample, as shown in Eq. 8.3.

$$n = \frac{x}{N} \times 500 \tag{8.3}$$

n = Sample size per area
N = Total number of households from the 11 selected areas
x = Total number of households in the area

Equation 8.3: ***Proportionate stratified sampling of study areas***

The fourth stage used purposive sampling to determine the frequency of households participating in the household questionnaire, which resulted in every 41st house (Eq. 8.4). The last stage was a purposive sampling of household participants; only persons older than 18 participated in the study. The first preference was household heads.

$$n = \frac{Total\ households}{sample\ size\ of\ households} \tag{8.4}$$

For example:

$$\begin{aligned} n(\text{Bolata}) &= \frac{4359}{106} \\ &= 41^{st} \text{ house} \end{aligned}$$

n = Frequency of households sampled

Equation 8.3: ***Frequency of households sampled for questionnaires***

Descriptive and inferential statistics were used to analyse the quantitative data. Descriptive statistics included a summary of the collection of information in groups relating to the QwaQwa water crisis (Trochim 2006). A student t-test to determine the significance of inferential statistics was used to generate the variables of the QwaQwa water crisis impact on households (Upton and Cook 2008).

8.6 Findings and Discussion

This section presents the findings and discussion of the QwaQwa water crisis. Six themes emerged of which this section presents the findings and discussion. The first is the QwaQwa water crisis as reported by the media. The second findings and discussions are quantitative responses from household questionaires responding to inadequate access of water in QwaQwa before and during the crisis, contributing factors to the crisis and water-related emotions. The third to fifth findings and discussion are on inadequate access and provision of water in QwaQwa by households, traditional leaders and informal encounters. The last findings and discussion talk to the post-apartheid function of the three dams in QwaQwa in relation to the water crisis.

8.6.1 The QwaQwa Water Crisis, as Reported by the Media

The study established that although an announcement was made in January 2016 regarding water access and provision in QwaQwa, the problem had been prevalent for much longer. A year prior, the region was reported to have experienced drought and was declared one of the most drought-stricken areas (Chabalala 2015). Thus, potable water supply shortages were evident in QwaQwa, as the local communities were forced to access drinking water through improvised municipal tanks (Maluti-a-Phofung Local Municipality 2016b). Despite the report, this study discovered a continuity in change through its exploration of the QwaQwa water crisis. The following section reveals interesting lived experiences from the quantitative and qualitative analysed data at the household level in QwaQwa.

8.6.2 Inadequate Access and Provision of Water in QwaQwa: Quantitative Household Responses

The study administered 571 household questionnaires, which consisted of 1 541 household members, averaging three persons per household. Of these, 507 (88.8%) households indicated that they experienced serious water access and provision issues, while only 64 (11.2%) have not experienced inadequate water access and provision challenges.

Three interesting themes emerged from the analysed data: water access and provision before and during the reported water crisis; water-related emotions of provision and access during the QwaQwa water crisis; and the contributing factors that led to the QwaQwa water crisis.

8.6.2.1 Water Access and Provision Before and During the Reported Water Crisis: Quantitative Responses

Results for water provision and access before and during the reported crisis in QwaQwa were determined using UN prescripts (4.1.1) in terms of quantity, distance, time, and cost. Student t-tests were performed to a 95% confidence level ($p < 0.05$) to establish the statistical significance of water access and provision before and during the reported crisis in QwaQwa. Images such as that in Fig. 8.3 became common in QwaQwa during the water crisis where locals had to manually collect water from water tankers.

Table 8.2 summarises variables, prescribing access and provision before and during the reported water crisis. Households' quantity of water accessed daily decreased by 70 ℓ (37.2%). It is also worth noting that before the reported QwaQwa water crisis, access and provision were still insufficient for the average household size of three people. The distance travelled daily increased by 1.93 km (92.3%), representing increased physical strain to carry water during the reported QwaQwa water crisis. The time spent accessing water increased by 39.25 min (62.6%), resulting in more time spent accessing water during the reported QwaQwa water crisis. The cost of accessing water monthly increased by R23.19 (57.8%), but the Student's t-test indicated it was insignificant. The insignificance of the increase in monthly cost to access water was based on the average monthly household income of the study being R5 181.50 and 3% of it amounting to R155.45. Unfortunately, due to the high poverty prevalence in the study area, poor households could not afford access to water during the reported QwaQwa water crisis. Thus, they had to resort to other sources such as rivers and sewerage water leakages.

Fig. 8.3 Mother taking a break from carrying her child and water containers in a wheelbarrow in the Bolata village during the QwaQwa water crisis on 11 March 2017. *Source* Author (2017)

Table 8.2 Water access and provision before and during the reported water crisis

Variable	Prescribed access	Before	After	Difference	Student t-test
Quantity	50–100 ℓ daily	188 ℓ daily	118 ℓ daily	70 ℓ less daily	Significant change
Distance	Maximum of 1 km daily	0.16 km daily	2.09 km daily	1.93 km more daily	Significant change
Time	Not more than 30 min daily	23.45 min daily	62.7 min daily	39.25 min more daily	Significant change
Cost	Not more than 3% of monthly household income (average household monthly income = R5 181.50)	R16.96 monthly	R40.15 monthly	R23.19 more monthly	Insignificant change

Source Author (2019)

8.6.2.2 The Contributing Factors that Led to the QwaQwa Water Crisis: Quantitative Responses

The 507 household participants responded to five closed-ended choices such as (1) ecological factors, (2) dam crisis, (3) negligence, (4) corruption and (5) climate change as contributing factors to the reported QwaQwa water crisis. The five choices were determined through information from newspaper publications and participants' responses to possibilities that led to the QwaQwa water crisis during the pilot study. The participants were requested to rank the contributing factors on a Likert scale from 1 (not possible), 2 (least possible), 3 (slightly possible), 4 (possible), to 5 (very possible) for the likelihood of what caused the QwaQwa water crisis. When ranking the responses to the possible factors contributing to the QwaQwa water crisis, climate change was most frequently chosen by 337 (66.5%) household participants. The second is negligence, according to 320 household participants. Third, ranked as corruption by 310 (61%) household participants. Fourth, 290 (57%) household participants indicated the dam crisis. And, last, the ecological factors according to 279 (55%) household participants.

8.6.2.3 Water-Related Emotions of Provision and Access During the QwaQwa Water Crisis: Quantitative Responses

Water-related emotions were collected to determine the emotional impact caused by the reported QwaQwa water crisis. The 507 household participants were required to rank water-related emotions using a Likert scale with four emotions: fear, worry, anger, and bother. The variables on the Likert scale were ranked from 1 to 5, representing (1) no emotion, (2) not so many emotions, (3) moderate emotions, (4) high emotions and (5) extreme emotions. The results showed that all 507 household participants indicated that the prolonged period of inadequate water access and provision in QwaQwa escalated the water related-emotions.

8.6.3 Inadequate Access and Provision of Water in QwaQwa: Qualitative Lived Experiences

The study included three participants (HPs) at a household level. The first participant resided in QwaQwa before becoming a Bantustan (HP1). The second was when QwaQwa was a Bantustan (HP2), and the third resided in QwaQwa when the Bantustans were abolished in South Africa (HP3). Although the HPs shared common responses and some differences, all participants agreed that their drinking, eating, domestic chores, and hygiene were negatively affected by the inadequate water access and provision in QwaQwa. HP1 remembered:

> When I was a young boy growing up in QwaQwa during the early '70s, we used to access water from streams, rivers, and water tankers as we are doing now.

Another continuity of the QwaQwa water crisis 30 years after HP1's experience was highlighted by HP2, who recalled that:

> The current water crisis is a cumulative effect from the early 2000s and manifested to the situation we are currently in.

HP3 stated:

> Since 2012, my challenge of accessing water has become a normalised struggle. I am concerned about how the elderly without children, younger family members, or money to find help are expected to collect water during the water crisis.

Contrary to the media reports, these findings revealed a water crisis long before January 2016. Furthermore, the study does not aim to give the impression that natural water is not accessible within the study area. However, access to natural water by the local communities presents health and safety issues that impinge on their constitutional right to access safe and adequate drinking water.

8.6.4 Inadequate Access and Provision of Water in QwaQwa: Traditional Leaders' Responses

As a large portion of QwaQwa is under traditional leadership, their inclusion had to be considered. Therefore, three traditional leaders (TLs) were interviewed to ascertain their views and experiences of the reported QwaQwa water crisis. TLs were included in the study because they preside over households in two villages of QwaQwa. The TLs acknowledged the importance of water:

> Water is an important natural resource that QwaQwa has plenty of, but the people have no access to it (TL1).
> Water is life (TL2).
> Water is a source of life and, therefore, an important resource for communal life (TL3).

When asked to respond to the causes of inadequate water access and provision, they indicated as follows:

> Rain no longer falls for mountains to have rainwater to harvest and channel it to the Fika Patso and Metsi Matso dams, and other water catchment areas are not being exploited like Maseleng (TL2).
>
> My heart is shattered by the people having to struggle to access water with water being sourced from QwaQwa to Gauteng (TL3).

However, when asked about what they thought were possible solutions to the water crisis, the traditional leaders provided the following valuable inputs:

> During the 1970s and 80s, when we had water challenges of accessing water, the government of QwaQwa introduced an annual R10 tax called *Sethabathaba*, which was used to develop water infrastructures such as dams and drill boreholes in communities (TL1).

> If we are to address this problem, we need to come together. A Sesotho saying says, "Mollo o tjhesa hlaha", meaning matchstick lights a conflagration (TL2).

> We have to come up with ways in which our people can access water as the people from Gauteng are. This requires government intervention and collective action from the community (TL3).

8.6.5 Inadequate Access and Provision of Water in QwaQwa: Informal Encounters of QwaQwa Local Residents' Lived Experiences

Three informal encounters (IEs) took place during the study. Participants informally replied to issues related to inadequate water access and provision in QwaQwa. These informal encounters presented interesting perspectives regarding the QwaQwa crisis. As the informal respondents recalled:

> We have been struggling to access water in my community since 2015, and the challenges have been many. The first challenge that I recall is that time when an elderly woman went to collect water with a wheelbarrow and had to push it up a steep slope resulting in her breaking a leg after she slipped and fell. (IE1).

> I had to pay for water to be delivered to my house for R500 per delivery because I have a 5 000 ℓ water tank. However, I am aware that people that don't have the water tank that I have, make use of water containers and need pay R250 per load for delivery of which some of the water gets spilled on the way (IE2).

> We are only accessing water for the first time from a tap in over six months. As you can see the water comes out of the tap with brown colouring, but it is better than no water at all (IE3).

Fig. 8.4 Community of Phuthaditjhaba collecting water from the water tanker (top) and water tankers collecting water from the water access point at the Sterkfontein Dam (bottom). *Source* Author (2019)

Figure 8.4 shows further detail of community members of various ages collecting water from a water tanker. This has also become a common sight during the reported QwaQwa water crisis.

8.6.6 The Post-Apartheid Functioning of the Three Dams

The study established that most of the water collected by the three dams in QwaQwa provided water to other regions of South Africa as a continuation of their apartheid function from when they were established. First, the Sterkfontein Dam, the largest of the three dams, 25 km outside QwaQwa, was established in the 1960s. The Sterkfontein Dam was established as part of the Vaal River system called the Thukela (Tugela)–Vaal Transfer Scheme. This scheme transports water 350 km from the Wilge River to the Vaal River. Phuthaditjhaba-N began accessing water from the Sterkfontein Dam in the 2000s due to the water demand created by the low-income developments. The Sterkfontein Dam retained

the highest average dam level of 88% during the national drought in 2016 (Free State Department of Water and Sanitation 2016). As a result, water was released from the Sterkfontein Dam to help keep the Vaal Dam's water level at least at 25%, signifying the continuity of the apartheid ideology in the relationship between the two dams (Henderson 2016; Van Wyngaardt 2016).

Second, the Metsi-Matsho Dam, which became operational in 1976, was the first large water basin in QwaQwa for domestic and industrial use (Stegmann et al. 1981:16). The Metsi-Matsho Dam is the smallest of the three and supplies 15% of the water in QwaQwa (Twala and Barnard 2006). However, many local communities of QwaQwa were excluded from accessing water from the Metsi-Matsho Dam.

Third, the Fika Patso dam, the second-largest dam, became operational in 1986 to supply the entire QwaQwa and was also intended for domestic and industrial use (Moffett 2008:213). When the dam became operational, Kritzinger (1987) indicated that the Namahadi River had inconsistent annual water flow, which was already a cause for concern. Plans were put in place for more water supply in five areas in QwaQwa. However, in the early 1990s, when Bantustans were reintegrated into South Africa, the water challenge had not yet been resolved. This is a clear indication that the QwaQwa water crisis had began much earlier than 2015, as was reported by the media.

8.7 Recommendations of Effective Planning Approaches for Adequate Water Access and Provision in Qwaqwa

This section presents a summary of six major causes and actionable recommendations for effective planning towards addressing inadequate water access and provision in QwaQwa. It also puts forward actionable recommendations towards effective planning for adequate access and provision to water in QwaQwa, guidance by the SDGs 6 and 11.

First, QwaQwa has remained destitute in the democratic post colonial-cum-apartheid even in the democratic South Africa. Black people continue to be the most affected by water poverty, despite being the majority. For instance, the placaets introduced by the Dutch created long-term negative effects when access to water became linked to land ownership while also undermining customary water laws. The British also took water as a common and ensured it became more accessible to white people through the Irrigation and Conservation Act of 1912 and the Land Act of 1913. The Water Act of 1956 also increased the dispossession of water from QwaQwa by establishing the Tugela–Vaal Transfer Scheme, of which the Sterkfontein Dam forms the heart. The introduction of the WSA and NWA as legislation for municipalities has not been able to empower the disadvantaged community of QwaQwa, particularly black people, because they are perceived as indigent.

Second, due to a lack of effective planning since the establishment of QwaQwa as a former Bantustan in 1974, a combination of factors resulted in inadequate water access and provision. The Sterkfontein Dam, the third-largest dam in the country, could supply the entire QwaQwa without the need for constructing a new dam. All spheres of government have work on a common goal that will effectively plan for the capitalisation of the water from the Sterkfontein Dam to address water access and provision in QwaQwa.

Third, resilient infrastructure development must be addressed for effective planning and sustainable water provision. As additional steps to improve water accessibility and provision, the current infrastructure needs to be maintained and/or upgraded to reduce the adverse effects of water provision. A lack of maintenance of the apartheid infrastructure proved to be part of the major causes of the QwaQwa water crisis because water leakages were discovered during the field observation.

Fourth, corruption as far as the provision of water is a concern that should be addressed, which was raised by participants of the

household questionnaires. In February 2018, the Free State Department of Cooperative Governance and Traditional Affairs placed the Maluti-a-Phofung Local Municipality under provincial administration per the Constitution for financial misuse of the municipal budget (The Local Government Handbook 2021; TimesLive 2018). Accountability for good governance should be at the centre of the functions of local government that will ensure that inconsistencies to this is prosecutable.

Fifth, the study revealed that local communities had not employed safe means to address the inadequate water access and provision in QwaQwa at a household and community level. Therefore, education on water use and purification are also important in terms of how to use water sparingly as a scarce resource and how to make potable untreated water. Water use education is also a positive step toward good governance to ensure it is accessible within the prescribed distance, time, cost, and quantity.

Sixth, the COVID-19 pandemic has demonstrated that conforming the traditional ways of doing things produces limitations to people because innovation is required. In as much as the list of alternative sources of accessing water such as boreholes, rainwater harvesting, recycling, and waterless systems are existing solutions, more has to be done to offer them as a more affordable scale to marginalised communities. Formalised areas of Phuthaditjhaba have a revenue collection structure that contributes to basic service delivery, whereas the villages are reliant on indigent grants that are minimal for this purpose. Therefore villages under traditional governance should consider flat-rate contributions as revenue collection to implement alternative water access and provision sources.

To address inadequate water access and provision issues in QwaQwa, the SDGs and the Constitution provide a clear basis for legislative and policy directives. A failure of water access and provision should be treated as violation of basic human rights.

8.8 Conclusion

This chapter presented a context in which the QwaQwa water crisis unfolded. It highlighted that, despite QwaQwa being a water-rich region that supplies water to many parts of South Africa, the local people experience a violation of their human rights as outlined in SDG6. Furthermore, media reports were misleading as they published a recent water crisis that was a cause of drought in South Africa in 2015. The study established that the crisis began when QwaQwa was established as a Bantustan on 1 November 1974. South Africa is still grappling with redressing the injustices of apartheid, leading to the water crisis for the community of QwaQwa.

South Africa has received much praise for policy development but, unfortunately, has been found wanting in terms of implementing the WSA and NWA efficiently. Suppose municipalities continue to mention SDGs in their strategic documents without implementing them. In that case, effective planning of sustainable water access and provision will not be attained. The chapter demonstrated that the effects of inadequate water access and provision at household level go beyond what is expected of human beings regarding denial of adequate water, increased distance to access water, and more time spent on getting access to water. The misfortunes presented by the QwaQwa water crisis present a challenge for the attainment of SDG11 that requires basic service provision to be implemented by municipalities to achieve sustainable cities. This study of a water crisis is just a small portion of challenges that people face in former Bantustans such as QwaQwa that grapple with inadequate basic service provision for the 22 million South Africans that live in such areas.

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Conducting Research in Phuthaditjhaba: Challenges and Opportunities

Grey Magaiza, Melissa Hansen, Patricks Otomo and Jess L. Delves

High quality research is necessary to inform efficient and effective policy in Phuthaditjhaba. As the chapters of this book demonstrate, there is much research taking place in and around the city from multiple disciplinary perspectives. Opportunities and support for research are numerous and increasing, but science still faces multiple challenges in Phuthaditjhaba. Below are listed key challenges and opportunities as identified by authors of this publication.

Challenges

- Local political instability stemming from infighting in ruling parties, as well as allegations and convictions of corruption among politicians and city administrators.
- Poor service delivery leads to frequent outages of electricity (through load shedding) and lack of running water. This affects researchers' and students' abilities to work from home and conduct field research. It also makes the city less attractive to prospective visiting researchers and students.
- Poor network quality and internet connectivity affects desk research, as well as online teaching and learning.
- Ongoing public discontent with decision makers often manifests in spontaneous 'service delivery protests' leading to the closure of roads, affecting ability to conduct research or reach University campus. The campus is often the site of protests, leading to its closure.
- Ruggedness of terrain and poor road maintenance can make it difficult to reach research sites.
- Access to and quality of official data is sometimes poor. Secondary data may be difficult to obtain from institutions (private and public) and data received is sometimes incomplete or unreliable.
- Complex sociocultural and administrative processes to conduct research and access communities and research sites, in that researchers must both obtain formal ethics clearance from the university and follow informal, traditional, customary protocols when conducting research in or with traditional communities.
- Low participation and engagement in research from decision-makers can negatively affect research quality.
- The multiple barriers faced by African scholars in general in contributing to the global scientific enterprise, such as western bias (see e.g. Mulisa 2021).

Despite these identified challenges, there are multiple opportunities and enabling aspects for a flourishing research community in Phuthaditjhaba.

Opportunities

- Strong secondary and higher education environment in Phuthaditjhaba, together with a culture that values education and a strongly positive public opinion of the University and other educational institutions.
- Presence of a dedicated university campus in the city (University of the Free State QwaQwa Campus) and its dedication to the betterment of the city through research and teaching.
- Students and staff benefit from reliable water and electricity provision at the campus, thus mitigating the impacts of poor service delivery by the municipality on research, teaching and learning.
- Cohort of undergraduate and postgraduate students that are adaptive, engaged and capable.
- huthaditjhaba and QwaQwa are still relatively understudied areas, particularly from the social science disciplines, thus there is the opportunity to add a great deal to the literature. This is true for the urban area and surrounding rural and mountain areas alike.
- The university campus is set in an area of outstanding natural beauty and in close proximity to national parks, making it an attractive area for exchange students and visiting scientists.
- The recently established QwaQwa Water Research Network streamlines research on water in Phuthaditjhaba and the surrounding areas by bringing together researchers to facilitate and conduct multi- and interdisciplinary research.
- The Afromontane Research Unit (ARU) of the UFS is rapidly gaining traction in international research spheres through project partnerships with international partners across the globe.
- Access to funding, mobility and logistical support via the ARU and the QwaQwa Campus Research Management and Funding Committee for both students and researchers.

9 Virtual Disclosures and Self-emancipations: The Female Body and Self-identity on Online Platforms in Phuthaditjhaba

Loice S. Nzombe, Rodwell Makombe, and Oliver Nyambi

Abstract

Online social sites have become popular platforms for reimagining the self and (re)constructing identities. In a consumer-orientated neoliberal global order where bodies have become products to be branded, packaged and marketed, social networks have become ideal platforms for the representation and identification of bodies. Although some studies have examined the discursive construction of identities online, few have focused on the representation of the female body on social media and none has done so in the context of semi-urban spaces with a history of systemic underdevelopment such as the former Bantustan capital, Phuthaditjhaba. Thus, there is a clear dearth of knowledge about how we can read the impact of new technologies on the ever-shifting notions and perceptions of identity construction in such places. In line with the United Nations' Sustainable Development Goal (SDG) goal five, which envisages gender equality and the empowerment of all women and girls by 2030, this chapter investigates how women in Phuthaditjhaba have appropriated social networks to instrumentalise the female body as a site and mechanic of female emancipation. We used netnography as instrument to collect data from 30 women users of Facebook and visual/textual analysis as an analytical framework to interrogate how the participants constructed identity and represented the female body on the selected social networking sites in the context of emerging and historical dimensions and dynamics of Phuthaditjhaba. Results of the study show that social media networks provide women in remote areas with an opportunity to discursively challenge limiting cultural traditions and formulate empowering and experiential new identities.

Keywords

Netnography · Phuthaditjhaba · Self-representation · Empowerment · Identity

9.1 Introduction

Online social sites have become popular platforms that marginalized groups in remote, rural and mountainous communities such as Phuthaditjhaba (South Africa) can appropriate to challenge limiting cultural practices and formulate

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alternative self-liberating identities. Social network users create new identities through self-branding to attract the attention of the intended audience (Stokes and Price 2017) and transform cultural beliefs and perceptions. Schweingruber and Berns (2005) argue that people construct self-identities by managing impressions of the self that others make of them. Online platforms such as Facebook have potential to function as sites where discourses of equality and the emancipation of women can be performed and actualized. Many cultures, of which many in Africa, do not allow women to use public platforms to celebrate their bodies and construct identities that deviate from what is seen as culturally acceptable. However, online platforms have emancipatory potential because they provide spaces for marginalised groups to break the glass ceiling of socio-cultural restrictions.

The objective of this study is to explore how women in Phuthaditjhaba, a remote mountainous area in the Free State Province of South Africa, use Facebook as a platform to discourse emancipatory identities that often go against the grain of established cultural practices and traditions. We focus on social media identities in Phuthaditjhaba because it is a remote area with limited opportunities and spaces for women to fashion desired identities without clashing with cultural norms and restrictions. Urban areas such as Johannesburg, for example, are likely to offer multiple opportunities for self-identity construction because they have less cultural restrictions and more platforms and opportunities. Our objective is not to judge female bodies or engage in a debate on popular conceptualisations of what constitutes beauty but to investigate how women in Phuthaditjhaba appropriate social media to assert discursive agency by projecting the female body in new and creative ways that challenge cultural norms.

According to Jakaza (2022), early researchers on online self-presentation focused on identity construction in anonymous online environments. However, in recent times social media users create online identities with their audience in mind (Sima and Pagsley 2010). In fact, social media has become an important platform where ordinary people can formulate desired identities often in ways that prioritise individual aspirations and sensibilities. Since online identities in the form of statuses and profile pictures can be shared with a wide audience, they can be used as tools to build self-confidence and social presence among marginalized groups. Hall (1993: 350) defines identity as "the names given to the different ways people are positioned by and position themselves within the narratives of the past". Oftentimes, historical narratives position some groups more favourably than others, resulting in distorted histories especially for marginalized groups. In view of this, social networks provide marginalized groups with an opportunity to discursively participate in the construction of self and interject culturally sanctioned erasures, silences and omissions. Hall further submits that "identity is moulded with countless points of identification, the uneven points of closure that are made within the discourses of history and culture; hence, there is always a politics of identity and politics of position" (Hall 1993: 392). The politics of identity that Hall theorises intertwines with the politics of positions because those that wield discursive power also position themselves and others in certain ways.

Feminist scholars of the 'Fourth wave' such as Cochrane (2013), Chamberlain (2017) and Rivers (2017) to mention but a few, argue that women should have freedom to define themselves outside the limitations of cultural precepts. These feminists have embraced a radical discourse that celebrates the female body in ways that give women confidence to challenge oppressive traditions especially on social media platforms. 'Fourth wave' feminism is a movement that started around 2012 and relies on social media to transmit its messages. It advocates and supports justice for women against sexual harassment, violence, and sexual stereotyping. It also assists women to develop positive identities that aid sustainable development of communities. Sollee (2015) characterizes 'Fourth wave' feminism as a movement that centres marginal identities such as "the queer, the sex positive, the trans-inclusive, the anti-misandrist, the digitally driven, and the body positive". All these social formations of feminist advocacy seek to open up spaces for

women to celebrate their different identities without feeling restricted by cultural norms.

The notion of "body positivity", which is central to Fourth wave feminist discourse, is liberating because it takes a stance against body-shaming, thus allowing women and men of different body shapes and sizes to enjoy and love their bodies. The performance of "fourth wave feminist" identities online has in recent years, helped women and other marginalized groups to gain confidence and develop self-esteem, attributes which are critical in building equal and equitable societies. 'Fourth wave' feminist scholars and activists insist that women should be bold enough to express themselves without fear of being sanctioned by culture and tradition. In fact, many women who use social networks as platforms for identity construction have embraced a quasi-fourth wave' feminist orientation in terms of how they challenge oppressive traditions and create experiential identities.

The objective of the body positive movement is to boost self-confidence among women and reject standards of beauty imposed by media and society. This movement has tremendously improved women's sense of self-worth especially on online platforms. In fact, some fourth wave feminists argue that dressing affects the way a woman feels about herself in society. Yet most societies continue to prescribe culturally appropriate dressing for women without realising how appearance affects confidence and self-belief especially in the public sphere. The situation is worse for plus-size women often disparaged as ugly and unhealthy in public discourse. African women with big bodies struggle to find confidence in a world that subscribes to Western standards of beauty. Members of 'Fourth wave' feminism, such as Tess Holiday challenge established notions of beauty that seek to shame plus-size women and force them to adhere to a standard of beauty that celebrates slim women (Knight 2020; Witt, 2020).

In some historic scientific discourse, the female body has been represented as an image of abjection, castration and maternity. Kristeva (1981) describes the female body as a 'leaking corpus', the maternal body that defies clear boundaries, threatening the solid borders of the symbolic and imaginary. Freud (1927) argues that the nude female body, with its lack of penis, evokes in male spectators a fear of castration, a fear that can be alleviated by a fetish. Throughout history, patriarchal societies have oppressed women and exercised power over female bodies and sexualities. However, the advent of social media and other internet–based technologies have empowered women by creating spaces where they can confidently celebrate their bodies and create desired identities.

In Phuthaditjhaba, cultural and moral values of the Sotho generally govern and sanction behaviour of women perceived as culturally deviant. Patriarchal codes that project female bodies as objects of sexual appetite (Meko and Nel 2021) enforce an oppressive status quo. Patriarchy has created a situation where women must view themselves as appendages of men whose selfhood depend on approval (to be liked and viewed online) from and through the eyes of men. The question is whether online platforms such as social media sites can improve the social status of women especially in rural communities where oppressive cultural traditions are still rife. Seckler et al. (2015 cited in Dobson, 2015) argue that young women seek to attain self-actualisation by posting images of desired-selves online. Social media is not only a space where women and girls can potentially attain discursive power but also a site where women formulate and perform alternative identities. In light of this, this study found that women in Phuthaditjhaba see online spaces as potentially liberating platforms where they can build identities and relationships outside the restrictive parameters of culture and tradition.

9.2 Sustainable Development Goals (SDGs), Gender Equality and the Empowerment of Women

Scholars such as Adeola (2020), Struckmann (2018) Onditi and Odera (2017) argue that in spite of global efforts to promote gender equality

and empower women as articulated in the United Nations' Agenda 2030, gender inequalities persist in most countries. In fact, a wide gender gap persists in Africa's social, political and economic life (Adeola 2020) in spite of global efforts to promote gender equality. Moyo and Dhliwayo (2019: 258) note that "harmful cultural practices" in some parts of African continue to "dehumanize and perpetuate the subordinate position of women in the household and in wider society". In light of the above, it is evident that women need platforms where they can not only share their experiences but also challenge traditions and practices that promote inequality.

Although international organisations such as the United Nations have come up with initiatives to promote gender parity, scholars such Koehler (2016: 53) criticise these efforts for being "economistic" or biased towards stimulating economic growth while ignoring endemic socio-cultural attitudes and beliefs that continue to keep women on the margins of society. The general assumption embedded in global commitments to eradicate gender inequality is that economic growth will, one way or the other, lead to gender equality and the empowerment of women. Koehler (2016: 55) argues that "women continue to face systematic disadvantage, both in the sense of deliberate exclusion from access to assets, for example, and in the sense of persistent attitudes and beliefs that women are weak, or inferior, to men". Studies such as Agarwal's (2018) examination of how SDG 5 speaks to the role of women in the agriculture industry perpetuate the economistic approach to issues of gender equality and women empowerment. In this study, we argue that women need to develop a sense of self-worth before (and as) they participate in public life. In fact, Peace Corps (2020) defines women empowerment as "a woman's sense of self-worth, her decision-making power, her access to opportunities and resources, her power and control over her own life inside and outside the home, and her ability to effect change". Empowerment is not only economic but also social and cultural. It involves enabling marginalised groups to challenge received knowledge. The empowerment of women entails "the capacity [of women] to make purposive choices, the ability to consider [themselves] able and entitled to make decisions, and the ability to have a critical consciousness of [their] rights and gendered power relations" (Yount, Peterman, and Cheong 2018).

In view of the above, Struckmann (2018: 13) also criticizes the SDGs for "favour[ing] economic growth at the expense of addressing the structural drivers of women's subordination and oppression". Stuart and Woodroffe (2016) submit that empowerment should enable women to challenge and transform patriarchal structures of power that are responsible for exclusion and disempowerment in the first place. Reflecting on South Africa's commendable efforts to meet the metrics of the MDGs of 2000, Struckmann (2018: 16) notes that "achievement of the MDGs is ineffectual in addressing the main obstacles that hamper the realisation of substantive gender equality and justice in the country, such as traditional culture, harmful cultural practices and other manifestations of masculinity and patriarchy".

Consequently, efforts to promote gender equality and empowerment of women ought to focus on identifying "areas and structures that perpetuate gender inequalities" (Onditi and Odera 2017: 151) and redressing power relations and imbalances (Doğan and Kirikkaleli 2021). In fact, Onditi and Odera (2017: 148) concur that "the promotion of women agency" "has the potential of alleviating some of the traditional socio cultural disadvantages that deny women their basic rights". The issue of agency, defined as "the ability to use endowments to take advantage of opportunities to achieve desired outcomes" (Onditi and Odera 2017: 154) is critical in promoting gender equality and the empowerment of women. The notion of agency involves "having voice in society" and "the ability to fully engage in public life" (Onditi and Odera 2017: 154). In a post-feminist reading of the United Nations' Agenda 2030, Struckmann (2018:120) argues that SDGS ought to focus on "local issues of voice and agency" which are often submerged under the broad rhetoric of global development.

Chandler (2013) also argues that the empowerment of women and girls should not be limited to equal access to resources and power, but should also include the ability (or agency) to make decisions outside the pressures of culture and tradition. Therefore, the eradication of what Struckmann (2018: 20) calls "structural impediments to gender equality" is important if women and girls are to compete for economic opportunities with their male counterparts.

Moyo and Dhliwayo's (2019) study of gender equality and women empowerment in Sub-Saharan Africa appropriates Crenshaw's (2004) intersectionality to unpack the multiple systems and processes that create gender inequality in society. Women do not only suffer oppression because of structural economic inequalities but also because of cultural structures that favour men. In this study, we examine how women in remote communities such as Phuthaditjhaba can appropriate social media to curate new identities and challenge oppressive cultural practices. Women in Phuthaditjhaba use Facebook not only to highlight systems and processes that create gender inequality but also to construct alternative identities that deviate from cultural prescriptions. Moyo and Dhliwayo's (2019: 261) study emphasises the importance of confronting "unequal gender relations which are constructed by culture, politics, ideologies and religion". In light of this, we argue that the discourse of gender equality and women empowerment ought to focus on creating platforms for women to self-define and confront harmful practices that hamper their participation in the public sphere.

In most African communities, it is taboo to reveal or make comments about the female body in public spaces (Sobande 2020). Traditionally, a woman's body should remain hidden until she is married. In this context, some African communities view the public display and celebration of the female body as shameful, embarrassing and disgraceful to the community. In Sesotho culture, like in most African cultures, cultural norms often prescribe appropriate dressing and behaviour for women and girls. A decent woman should not dress in a way that excessively reveals her body and potentially provokes men. Such cultural prescriptions often restrain women and make it difficult for them to gain confidence to participate in the public sphere. In light of this, social media platforms become important forums for the curation of transgressive and alternative identities that defy oppressive cultural norms.

Perhaps because of their affordability and accessibility, social media platforms have become modern battlegrounds where oppressed groups wrestle discursive power from their oppressors. Thus, young women who participated in this study used Facebook not only to contest repressive cultural norms but also to construct empowering and self-emancipating identities.

9.3 Phuthaditjhaba: A Brief Historical Background

Phuthaditjhaba is a remote rural–urban area located at the foot of the Drakensberg Mountains in the Free State Province of South Africa. A former homeland of the Southern Sotho speaking people, Phuthaditjhaba has experienced many socio-economic challenges since the end of apartheid. In fact, most of the socio-economic challenges that Phuthaditjhaba has been grappling with over the years emanate from the homeland system that divided South Africa into autonomous communities, called homelands, run by majority ethnic groups residing in certain areas. Although the idea was to allow different ethnic groups to self-govern and lead their own development, the homelands were often poorly funded, hence the numerous socio-economic challenges. Like most former homelands in South Africa, Phuthaditjhaba has a high unemployment rate and most of its inhabitants, especially women, children and the elderly depend on government grants for their livelihood (Napier et al. 2001, Makombe and Nyambi 2021). Most of the young women who participated in the study were students studying at colleges and a university in the community. Others were unemployed matric graduates staying with their parents and/or relatives.

Although people in rural areas including Phuthaditjhaba usually subscribe to traditional cultural practices, the advent of the internet and social media has created platforms where individuals construct new identities that deviate from culturally prescribed ones. Social media has had a huge impact on Phuthaditjhaba's cultural economy because it brings people together and offers them a platform to debate and question oppressive cultural practices. Young women in Phuthaditjhaba have particularly embraced social media as a tool for self-liberation especially in the context of traditions that continue to allow social freedom for men while imposing numerous restrictions on women.

9.4 Methodology

The study used random sampling to identify young women living in Phuthaditjhaba who could participate in the study. We distributed posters in strategic places around Phuthaditjhaba such as shopping malls (Mandela Park and Setsing) and restaurants such as Steers, KFC and McDonald's. The posters requested young women Facebook users between 18 and 35 years to participate in the study. We requested those that were interested to contact the principal investigator via WhatsApp. Although 37 women expressed interest in participating in the study, only 30 met the selection criteria, which we will later explain in detail. We used netnography as method to identify and examine how young women from Phuthaditjhaba use Facebook as a platform to construct experiential identities that offer possibilities for self-emancipation. Netnography is a methodology derived from ethnography of research online communities. In an ethnographic study, the researcher observes and interacts with participants in real life situations. An ethnographic study engages the researcher with the problem in a way that enables him/her to formulate a better solution (Reeves et al. 2008; Makombe 2022). Similarly, in a netnographic study, the researcher observes the behavior of participants online without necessarily interacting with them physically. In this study, we used netnography to engage with images and texts that participants shared on Facebook.

Since the study involved human participants and social media, we had to acquire ethical clearance from the University of the Free State's Research Ethics Committee. Ethical clearance was important for the study because social networks have proven to be an 'ethically' problematic field for researchers. Online research deals with images and texts posted by real human beings whom the researcher may never meet. This requires the researcher to observe the principles of confidentiality and anonymity, which are necessary in any research that deals with humans. Participants signed a consent form they permitted the researchers to access their Facebook accounts and use the images they posted for the purposes of the study.

We adopted purposive sampling to select data (images and texts) from the participants' profiles on Facebook. The texts included status captions, comments and/or responses made by followers on participants' profile images. Purposive sampling was appropriate because it allowed us to identify relevant data that aligned with the research questions.

We focused on young women between 18 and 35 years because previous studies have shown that this age group is active on social media platforms. We excluded young women who resided in Phuthaditjhaba but did not have Facebook accounts or did not use Facebook frequently. We excluded men because the objective was to explore how the representation of female bodies on social media can offer opportunities for the creation of emancipatory identities. Textual and image analysis were appropriated as theoretical prisms to read selected texts and images that participants posted on Facebook. All the images and texts that participants posted were analysed in accordance with the objectives of the study.

9.5 Presentation and Discussion of Findings

The objective of the study was to investigate how young women in Phuthaditjhaba appropriated social media to construct self-emancipatory and experiential identities that challenged oppressive cultural practices and traditions. The study was framed by the United Nations' Agenda 2030, which aims to achieve gender equality and empower all women and young girls. Available literature suggests that the United Nations' SGDs take an economistic approach that does not take cognizance of the cultural realities of women living in remote communities such as Phuthaditjhaba. After a critical analysis of 30 Facebook profiles of young women living in Phuthaditjhaba, we identified ten self-empowering and self-emancipating identities that the women curated. The identities revolved around the discursive and visual representation of the female body in the public space against a cultural environment that sought to confine women to the domestic sphere. The 30 young women whose profiles we analysed sought to subvert this narrative by appropriating Facebook as a platform to create a new narrative about the female body and how it can be used to promote discourses of self-empowerment and self-emancipation. The implication is that confidence in one's body and/or physical appearance intricately intertwines with self-empowerment. The Facebook profiles of the 30 participants we studied subverted Sesotho culture by celebrating the female body and using it as an instrument of self-emancipation.

After examining the Facebook Profiles, we identified ten identity categories that emerged from the data and named them as follows: Trend Setter, Yellow Bone, Slimy/Portable, Curvaceous, Confident and Full-bodied, Naturals, Sexy charm, Sexy and Bold, Queen Charisma and Perfection Belle. The identity categories encapsulated the different ways in which women in Phuthaditjhaba used social media to construct self-emancipatory identities that contested culturally correct ways of being woman. The table below shows the different identity categories that emerged from the data and the number of women that belonged to each category. We identified the categories based on salient self-emancipatory attributes that particular profiles exhibited. Some categories, such as Sexy charm and Sexy overlapped with each other, however, they had certain attributes such as boldness (Sexy Bold) and charm (Sexy charm) which they did not share.

9.6 The Trendsetter Identity: Empowerment Through Keeping Abreast with Modern Trends

The Trendsetter category consists of young women who seek to influence other social media users to embrace certain identities. Trendsetters usually follow the latest fashion trends so that they can maintain a cutting-edge online identity. For Trendsetters, dressing is an important part of one's identity. Hence, they dress in ways that attract the attention of followers and viewers in general. Their dressing is designed creatively to put pressure on the audience and influence behaviour change in ways that confront oppressive cultural practices. Tight-fitting dresses, stilettos and handbags become appealing packages that Trend Setters use not only to "look good" but also to brand the female body as a medium of self-empowerment. Trendsetters' choice of dress shows exactly what body parts they want the world to see such as hips, cleavage and flat belly. Trendsetters reveal body parts often perceived as "sexy" in public social media discourse. Thus being sexy becomes a way of gaining cultural capital that enables Trend Setters to influence followers online.

Trendsetters seek to create a peculiar fashion-based identity, distinct from identities of other women online. Nithyaprakash (2015) argues that "everyday fashion is an interactive process through which individuals consciously project their bodily self in a distinctive manner in the form of clothing style." In the contemporary world, young women are bound by "a media

culture in which 'empowerment' is frequently articulated through the way their bodies look, what they can do with them, and how they beautify and decorate them for diverse junctures and circumstances, so that their appearance often takes priority over what they can do" (Holcomb 2012). According to Florova (2014) dressing the female body determines image and way of life and it has an impact on how people think as well as their attitudes towards others and the world. Trendsetters know that dressing has a huge impact on perception by others (Florova 2014) especially among young women. Lewallen and Behm-Morawitz (2016) submit that many people now use online platforms for self-branding purposes. Trendsetters seek to influence other women to embrace self-emancipatory identities through dressing boldly and confidently, against the grain of restrictive cultural dress codes.

Khamis et al. (2017) state that self-branding involves individuals developing a unique public image or identity to gain commercial and/or cultural capital. Trendsetters create unique images that draw on and modify established celebrity identities. They brand themselves as expensive women who wear "sexually" "appealing" designer clothes. Although most women in this category are not rich, they refuse to be defined by their socio-economic background. Such identities become vehicles for self-emancipation especially in remote communities such as Phuthaditjhaba where women remain on the margins of development. In most cases, Trendsetters keep their online images "fresh" by following latest trends in unique online identity creation. Women in the Trendsetter category manipulate popular discourse on beauty and "looking good" to boost their confidence in the social media space.

9.7 Confident and Full-Bodied Identity: Empowerment Through Body Positivity

This category consists of full-bodied women who have a positive attitude towards their bodies. Fourth wave feminist scholars such as Cochrane (2013), Chamberlain (2017) note that full-bodied women are often subjected to body shaming especially on social media platforms. However, in this study, full-bodied women manipulate the social media space to create alternative narratives about plus-size female bodies. Confident and full-bodied women contest societal expectations about how women should look (slender and slim) by celebrating big and plus-size bodies. In most societies, full-figured women often face challenges related to body shaming and stereotyping. Similarly, most studies on full-bodied women emphasize issues such as body dissatisfaction, body shaming and health to suggest that full-bodies carry negative connotations. Scholars such as Thabethe (2008), Fardouly et al. (2015), and Shettar (2015) write that body dissatisfaction among young women can have serious consequences such as self-hate and suicide. Mills et al.'s (2018) study of full-bodied women indicate that some full-bodied women hold insecurities about their weight and general body image. As a result, the images/photographs that they like about themselves are those linked to the way they want society to see them. Papa (2010) also states that women face many challenges and frustrations on dressing when they first enter the world of work because popular discourse often labels full-bodied women unhealthy and ugly.

However, the young women we studied did not pay attention to 'body shamers', instead they celebrated their bodies and represented themselves as "alternative beauties". Images that women in this category posted did not discriminate based on class or social standing. Regardless of class, all images reflected positive body aura. According to Limatius (2018) full-bodied women use body descriptors, such as 'voluptuous', 'fat' and 'curvy' to create a unique online identity. The terms 'voluptuous' and 'fat' are traditionally perceived as derogatory while 'curvy' is considered flattering and positive. Body image is important because it feeds into social and cultural comparisons that might affect a person's sense of physical attractiveness and larger self-worth. This is because the body image, particularly the female body image, is a corporate entity that draws substance not only from one's views of the self but also from the views of others.

9.8 The Slimmy Portable Identity: Manipulating Popular Discourses About Beauty

Research shows that most women go through a punishing dietary ordeal to gain and maintain a slim body. Young women are usually under pressure to align their identities with popular standards of beauty (Anaya-Sánchez et al. 2020; Willem and Tortajada 2021). Images in the Slimmy Portable category consist of young women who associate beauty with slim bodies. Like Trendsetters, Slimmy Portables manipulate popular discourses to construct empowering and self-emancipatory identities. This category presents itself as the opposite of the Full bodied and Confident category in that while the Full-bodied category contests stereotypical narratives about big-size bodies, the Slimmy Portable category manipulates Western representations of beauty, for purposes of self-emancipation. The Slimmy Portables do not body-shame other women; instead, they appropriate commercial images of beauty and healthy living to carve out a discursive space for themselves.

9.9 The Yellow Bone Identity: The Quest for Relevancy

In his seminal book, *Black Skin, White Masks*, Franz Fanon (1952) argues that whiteness is often perceived as a symbol of beauty (angels are white) while blackness is seen as a symbol of ugliness (the devil is black). McClintock (2013) explains that women of colour suffer from internalised oppression because society makes them believe that white skin is powerful and superior. This colonial mentality has caused many black women to hate their skin color and perceive whiteness as the standard measure of beauty. In our study of Facebook profiles of young women in Phuthaditjhaba, we found that light-skinned women posted revealing images to affirm public social presence. Like Slimmy Portables, Yellow Bones (i.e. light-skinned black people) also manipulated the "yellow bone" narrative in South African popular discourse to construct assertive and self-emancipatory identities. South African popular discourse often portrays Yellow Bones as beautiful, attractive women who deserve to be treated with utmost care. In fact, Yellow Bones present themselves to the world with confidence because they believe they are beautiful. Although Bizela (2016) posits that the desire to become 'yellow bone' and, therefore, white, through skin whitening practices, is a popular phenomenon among black people, the young women whose profiles we analysed did not associate themselves with whiteness. In fact, they used the Yellow Bone identity as a tool to navigate the public sphere and influence other young women to be bold and assertive.

9.10 Curvaceous Identity: Emancipation by Playing with the Male Gaze

The Curvaceous category consists of women with curvy body structures. The curvaceous body images that we analysed were generally in three parts to provide an all-round view of the body. Women in this category took advantage of their physical structures (curvy hips and buttocks) to construct self-empowering identities. Most women in this category preferred to wear tight fitting dresses, jeans and short skirts that exposed flesh and accentuated certain body parts. The postures and self-presentations of curvaceous women did not only challenge cultural norms that do not allow women to display their bodies in public spaces but also curved self-emancipatory identities through self-love. The images they posted demanded attention from viewers and forced social presence. Although women in the Curvaceous category also desired the good life like Trendsetters, they preferred casual dressing that could easily emphasise their curvaceous bodies. Stolovy (2021) observes that "the fashion industry is concerned with spectacle, display and creativity; it celebrates the edgy, the fashionable, the erotic and the transgressive". Similarly, Curvaceous women celebrated the

edgy, the erotic and the transgressive by posting images that traced the curvaceous contours of their bodies.

9.11 The Naturals Identity: Empowerment Through Self-affirmation

The Naturals category consists of women who considered themselves naturally beautiful. They did not use make-up to enhance beauty and often, they posted images in natural hair. In our analysis of the images they posted on Facebook, we observed that most Naturals preferred to show off their faces instead of the whole body. For social media users, showing the face is a self-branding technique that draws on the popular assumption that "the face reflects the self: that a person's inner character or personality will shine through the outer appearance" (Featherstone 2010: 12). Naturals believe that the face has potential to leave lasting impressions on viewers and followers. Given that the natural look is associated with originality, genuineness and honesty, the Naturals appropriated the natural outlook to assert agency and subjectivity online.

9.12 The Sexy Category as an Identity: "When You Look Good You Feel Good"

Generally, "sexy" images of women on social media platforms, as in cinema, tend to play with the male gaze and male fantasies about the female figure as Mulvey (1975) argues. Participants in the Sexy Categories (Sexy Charm and Sexy Bold) posted images that showed a bit of skin to celebrate their femininity. According to Floyd et al. (2022), women who post semi-revealing images on social media seek to gain a sense of "grandeur" grounded in the seductive power of the female body. Most participants in this Category used lingerie to construct bold "in the face" identities that drew inspiration from what is popularly considered "sexy". It is important to note that in popular social media discourse, the word "sexy" is not necessarily associated with sex. Rather it is associated with an eye-catching appearance that has potential to influence followers. Women in this category believe that when one looks good, one feels good. To be "sexy", therefore, is to be attractive and fashionable and not to be an object of the maze gaze.

Sexy women wore silk or lace clothing to signify their yearning to escape the rigors of labour and social-cultural responsibilities. The images they posted on Facebook suggested "amused detachment, casual playfulness, flirtatiousness without demand, and lightness of touch …a delightfully unconscious relationship [with the] body" (Schroeder and Borgerson 1998). By posting semi-naked images online, sexy women make a bold statement of self-confidence. In the context of this study, sexy women used beauty and clothes to "stimulate desire in pursuit of power or advantage" (Calogero et al. 2007: 280) which, in turn, unsettled the patriarchal social order. Most women in this category used their bodies to defy cultural norms and traditions on how the female body should be dressed. According to Stolovy (2021), people use dress to express desired identities and often times women use dress to challenge established identities. New dress styles correspond with new identities that resonate with trending global fashions and give women, including those living in remote locations such as Phuthaditjhaba, a sense of contemporaneity, modernity and global connectedness.

9.13 The Charismatic Identity: Empowerment through Appropriating Discursive Power

Women in the Charismatic category did not derive subjectivity from their physical appearance or attractiveness like those in the Sexy category. Charismatic women had the ability to influence other women. They postured as decent, self-reliant and successful. Instead of using the body as a tool of self-emancipation, charismatic women took advantage of their likeability to assert social presence in the public sphere and

inspire confidence among their followers. Although charismatic women had a good taste for fashion, they did not make it a mission to surf for latest fashions as Trend setters did. Some women in this category wore sporty outfits that made them look healthy, well-shaped and physically fit. The objective of Charismatic women is to embody an online outlook and character that is worthy emulating.

9.14 The Perfection Belle as an Identity: Breaking the Ceiling of Possibilities

The Perfection Belle category represents social media users who seek to portray the best look to their followers. They do so by dressing in expensive-looking clothes, assuming dignified postures and revealing a bit of skin in "appropriate" places. Perfection Belles aspire to embody all the identities that we have discussed above in equal measure. The "perfection" of Perfection Belles is attained through maintaining the right balance between hairdo, make-up, dress code, body shape and body posture. The Perfection Belle is probably the most expensive online identity to maintain because it occupies a liminal space between cultural conformity and non-conformity. In our analysis, we identified two categories of Perfection Belles, namely the voiced and the unvoiced. The voiced Perfect Belles are those who talk about their perfection online while unvoiced Perfection Belles let the images they post speak for themselves.

9.15 Summary of Findings

The advent of the internet and social media has created platforms for marginalized groups around the world to construct identities outside the confines of dominant cultures. As the findings of the study show, online platforms have potential to empower women and promote gender equality by providing them with spaces where they can construct desired identities outside the parameters of cultural norms. While most of the literature on Sustainable Development Goals, particularly goal five, focuses on empowering women by transforming their socio-economic status, we argue that gender equality and the empowerment of women should also include creating spaces for women to self-define and establish a sense of control over their identities. Online platforms such as Facebook and Instagram have potential to empower women because they offer them safe platforms to articulate desired identities in public spaces. The results of the study show that women can use social media for self-emancipatory purposes, to create, build and manage desired selves, which in most cases, have been suppressed by oppressive cultural practices. Although Phuthaditjhaba is a remote town, women in this area have successfully appropriated Facebook to build a discernible online footprint that has potential to empower women and promote gender equality. The different identity categories that we discussed above do not only seek to celebrate the female body as a site of subjectivity and agency but also to open a discussion on how women can use social media for self-empowerment and emancipation. We argue that the focus on material empowerment in the discourse of sustainable development overlooks an important formative pillar in the journey towards gender equality and self-emancipation. Economic and political empowerment, which is emphasised in the Sustainable Development goals, is only possible if women are located in an enabling cultural context that allows them to self-define without fear of being labelled "loose" and "indecent". All the identity categories discussed above seek to find a space for women to particulate in the public sphere, which has, for many years, been dominated by men.

9.16 Recommendations for Future Research

This study focused on how women in an underdeveloped and remote community, Phuthaditjhaba, can appropriate social media to construct self-emancipatory identities. Future studies can explore how women in these

communities can use social media for economic self-emancipation. Given that social media allows users 'follow' others, especially celebrities and influential figures, future studies can investigate how women in poor communities can use online connections to share business ideas and create economic networks. Future studies can also explore how women can use social media to create groups that share ideas on how to dismantle oppressive traditions and cultural practices and include women into macro-economic activities.

9.17 Conclusion

Remote communities such as Phuthaditjhaba usually experience economic exclusion because of their inaccessible geographical location and history of marginality. The United Nations' Agenda 2030 comprises 17 Sustainable Development Goals that all member countries should realise by the year 2030. UN SDG 5 aims to achieve gender equality and empower all women and girls. In view of this, this study has argued that the attainment of gender parity and empowerment of women requires platforms that prepare women to participate in the public sphere. Women in remote communities need access to platforms that enable them to challenge oppressive practices and build confidence to compete for access to economic opportunities with their male counterparts. Oftentimes, women in marginalised communities such as Phuthaditjhaba do not have access to support structures that can enable them to move towards socio-cultural and economic emancipation. Social media enable marginalised groups to access the public domain and voice their sensibilities. The 30 young women who participated in the study used Facebook in transgressive ways that challenged oppressive cultural norms and promoted alternative self-empowering identities. In Sesotho culture, like in most African cultures, the ability of women to make decisions (agency) is often thwarted by restrictive cultural norms. Images that young women in Phuthaditjhaba posted on Facebook portrayed the female body as a site of personal agency and subjectivity. To accept one's body and celebrate it publicly is to gain confidence and confront traditions and practices that limit possibilities for women. The postures that women assumed and the way they dressed online communicated messages of power/status, confidence and class to potential viewers and followers. Facebook is a potentially liberating platform that enables women (and other marginalised groups) to curate new and alternative identities often suppressed in the offline environment. We therefore argue that people living in rural communities such as Phuthaditjhaba can realise the United Nations' Sustainable Development Goals by using online technologies in ways that challenge oppressive cultural practices and enable them to build self-confidence necessary for economic emancipation.

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SDGs as Indicators of Holistic Small Town Tourism Development. A Case for Phuthaditjhaba South Africa

10

Mutana Sarudzai and Mukwada Geofrey

Abstract

Mountainous small towns are often geographically isolated, lack access to main decision making centres and are in many cases plagued by incessant weather related natural disasters. While these realities reduce the options for economic activities available in these towns, the lifestyles, cultures of their residents, as well as their communities' close relations with nature, make them attractive and unique tourism destinations. Many local leaders advocate for the opening of these towns to tourism for the expected economic benefits. However, tourism should be developed in a holistic manner in order to bring benefits to the economy, the host communities and the environment these destinations. In this chapter, Sustainable Development Goals 1, 2, 5, 8, 11, 12 and 13 are used to demonstrate that the achievement of holistic tourism development in the small town of Phuthaditjhaba relies heavily on the manner of development of tourism that respects the interconnectedness of these SDGs. The authors used critical discourse analysis of available literature, to conclude that tourism development in Phuthaditjhaba currently lacks balance between economic, environmental and socio-cultural benefits to the community, and suggested practical steps for the use of SDGs in planning and implementing tourism development in the lead-up to the year 2030.

Keywords

Mountain small towns · Sustainable development goals · Tourism development · Phuthadtjhaba

10.1 Introduction

The United Nations Sustainable Development Goals (SDGs) published in 2015 have been a subject of protracted discourse in the tourism industry. This is because the tourism industry relies heavily on the various elements covered under the SDGs (Dube 2020). Tourism features weakly in the indicators suggested by United Nations under SDG 8, 12 and 14. However, researchers have agreed that tourism can be a remedy for achieving all the 17 SDGs suggesting

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the need for tourism activities to be holistic (Remoaldo 2014; Barros, Biddulph and Scheyvens 2018; Scheyvens and Hughes, 2019). 'Holistic' tourism development in this chapter is defined as synergy cooperation among stakeholders in the development of tourism activities that bring benefits to all (Koodsela et al. 2019; Saneinia et al. 2020). The key stakeholder groupings in a tourism destination include the community, government, private sector, non-governmental organisations and tourists. Koodsela et al. (2019) argue that the participation of all stakeholders (including poor and marginalised groupings is critical in achieving holistic tourism development. Carson et al. (2004) reiterates the need for a holistic approach to tourism development and argue that tourism is an industry faced with a challenge of balancing between economic, social and environmental issues. This need for a collaborative approach by all stakeholders if tourism is to be used as a tool for achieving SDGs is further supported by (Hall 2019; Scheyvens and Hughes 2019; Dube 2020). However, the balanced collaboration in planning and implementing tourism development activities is not always evident especially in mountain tourism towns where economic development takes centre stage (Biddulph and Scheyvens 2018; Mutana and Mukwada 2020a, b). Small mountainous towns like Phuthaditjhaba, in South Africa, have limited economic activity due to realities related to their geographical location as well as the historical power arrangements that left communities in these areas with limited access to important forums where decisions are made (Mutana and Mukwada 2018). Tourism is regarded as one of the most important sectors which can contribute to the economic development of these areas (Taru et al. 2014; Mutana and Mukwada 2018; Mutana and Mukwada 2020a, b). However, there is compelling evidence that tourism in Phuthaditjhaba and surrounding areas has been developed in a way that is less inclusive and ignorant of the socio-economic needs as well as the environmental needs of the communities and the environments of this area. The objective of this chapter is to argue for the use of SDGs as indicators of holistic tourism, where tourism development activities that achieve the most diverse indicators for SDGs are prioritised for implementation. The authors use SDG 1, 2, 5, 8, 11, 12 and 13 to demonstrate the interconnectedness of these SDGs when applied to tourism development and hence argue that tourism activities should aim to achieve the highest diversity of indicators of these SDGs.

The thrust of SDG 1 is to reduce poverty in all its forms by 2030 through inclusive consideration of groups of people that are easily left out of developmental discussions. These people include the youths and women. SDG 2 emphasises zero hunger. SDG 5 looks at gender equality, SDG 8 decent work/economic growth, SDG 11 sustainable cities & communities, SDG 12 responsible consumption and production, SDG 13 climate action. The ensuing parts of this chapter shows the links among key SDGs, the current state of affairs in the tourism sector in Phuthaditjhaba and how indicators from SDGs can be used to enhance a balance in the development of tourism products in Phuthaditjhaba.

10.2 Background: Understanding the Nexus Between SDGs and Holistic Tourism

In recent years, authors have acknowledged the interconnectedness of SDGs in relation to tourism development (Hall 2019; Scheyvens and Hughes 2019; Dube 2020). This comes as a result of the realisation that tourism is not just an economic phenomenon but should preferably be understood as a composite human and economic phenomenon (Hall 2019). This notion is not new since Murphy (1985) argued for a more comprehensive and integrated approach to tourism planning at local levels including the community.

10.2.1 Poverty and the Notion of Decent Work in the Tourism Industry

Poverty, hunger and gender inequality can directly influence the decency of work in the

tourism and hospitality industry. Poverty is understood differently from different worldviews. However, the World bank define extreme poverty as a state of lack where a person survives on under $1.90 per day (World Bank 2020). Tourism has been mooted as a possible avenue for ending poverty because it is more labour intensive and has less barriers to entry for small enterprises (Dube 2020; Siakwah et al. 2020). However, issues of gender equality and decent work are still glaring in the industry (Bianchi and de Man 2021). There is a general neglect of fair or safe or decent labour issues in the tourism industry (Baum et al. 2016) especially because of high levels of tourism capitalism, whereby the majority of tourism organisations are controlled by private owners, for profit and also governed by laws of supply and demand (Fletcher 2011; Bianchi and de Man 2020). Fletcher (2011) argues that those investing in tourism (including the growing 'alternative' tourism subsector) are driven more by their interests in making more profits compared to their need to reduce poverty. These assertions point to the difficulty of reducing poverty through tourism employment which in some cases has entrenched gender inequality and indecent work (ILO 2017). Globally, tourism contributes one in every eleven jobs and the industry also contributes to increased skills and professional development (Mofokeng et al. 2018). Bianchi and de Man (2021) argue that the fact that tourism contributes to improvements on national economies, living standards and poverty reduction, often lack deeper interrogation of the social and political dynamics of labour in the tourism industry. When tourism happens among poor communities, the imperative to earn a wage and the very fact that tourism can provide a job to people with limited alternatives indicate possible disempowerment of the labouring classes and often coexists with exploitative labour regimes within destinations. This leaves local tourism planners with a task to take a closer and passionate look at the nature of tourism employment to unveil whether the relationships between the tourism capital and the labour, is sustainable.

10.2.2 Responsible Consumption During Economic Development Through Tourism

In communities where economic activities are limited, tourism development has often been described as an economic panacea (Visser 2016; Mutana and Mukwada 2020a). The discourse on economic benefits of tourism concentrated on the contribution of tourism towards the Gross Domestic Product (GDP) of the destinations which is a principle benchmark of economic growth of a destination (Dube 2020). GDP shapes the understanding of value from an economic activity. However, tourism is a complex phenomenon influenced by multiple interrelated economic, political, cultural and social facts which cause both positive and negative effects in the environment and local communities (Wood et al. 2019). Wood et al. (2019) further argue that tourism can carry invisible burdens for local communities if they concentrate on economic benefits without considering other aspects especially leakage and environmental impacts. Further, in some cases, where a larger fraction of tourism investors come from outside the destination, the economic benefits of tourism are affected by leakages (Siakwah et al. 2020). Leakage is a process of money leaving the local economy and ending up in economies where the investors originate from (Chirenje et al. 2013). This exposes the link between SDG 8 (economic development) and SDG 12 (responsible consumption). The subject of responsible tourism consumption is topical and still under discussion among tourism geographers. In some mountain communities (for example Nepal), tourism has been associated with numerous negative ecological impacts (Nepal and Chipeniuk 2005; Mwalukomo 2008; Nepal 2011). In many cases, governments have ignored the glaring possibilities of negative effects in favour of economic benefits (Visser 2016). It is imperative therefore to weigh the economic benefits of tourism against the social, cultural and environmental impacts associated with tourism and ensure a balance among the factors.

10.3 Methodology

The authors used critical discourse analysis to analyse available literature on the development of tourism in the mountain town of Phuthaditjhaba. There has been an increase in the use of critical discourse analysis in sustainable tourism studies in recent years (Wilson and Hollinshead 2015; Hannam and Knox 2005; Jager et al. 2009; Ardoin et al. 2015). A discourse is defined as a group of statements that represent a language for talking about or a system of representing a language for talking about, or a way of representing knowledge about a specific aspect (Jager et al. 2009). According to Qian et al. (2018) a discourse analysis recognises that language shapes people's worldviews. The authors decided to use critical discourse analysis in this chapter because they had a passion to critically approach and expose the interconnectedness of SDGs in small town development. Jager et al. 2009 argue for the use of critical discourse analysis in writings where authors seek to make explicit the power relationships which are frequently hidden and believe that this approach help authors to derive results of practical relevance. Further Hannam and Knox (2006:3) that "all texts are produced intertextually in relation to other texts, which are in turn embedded within institutional power relations within which the degree of authority is inherent". Further, the development of small towns located in poor mountainous destinations have always been a subject of conflicting viewpoints, where the recommended approaches to developing such towns have shown the power struggles and worldviews of the authors (Mutana and Mukwada 2020a, b). However, in this chapter, the authors are passionate to bring out a more nuanced reading of textual data by adding a critical edge to the way Sustainable Development Goals should be achieved through tourism development activities in small mountain towns.

10.3.1 Sources of Data and Document Selection

Authors obtained information on tourism development in Phuthaditjhaba, SDGs and tourism, from peer reviewed academic articles and grey literature from databases like Google Scholar, Taylor and Francis Online, EBSCO, Web of Science, Scopus, JSTOR, Emerald Insight, Springer and Sage Publications. The search and analysis was limited to literature to which the authors had full access (as provided by the university's physical and electronic library) and was relevant to the subject under study. This also included publications by key international organisations concerned with Sustainable Development Goals, tourism in small towns and mountain tourism. These are United Nations (UN), United Nations Environmental program (UNEP), World Commission on Environment and Development (WCED), Intergovernmental Panel on Climate Change (IPCC), International Centre for Integrated Mountain Development (ICIMOD), and United Nations World Tourism Organisation (UNWTO). The search began by keying in key words for example '*sustainable development goals*' *or* '*mountain tourism*', '*tourism development in small towns*' *or holistic tourism*' to isolate the applicable texts from the databases. Each phrase was used to generate different texts. The authors then scanned through the abstracts of the generated papers to check the relevance of the text to determine whether to include them or to leave them out. The use of various keywords ensured the generation of a variety of papers. Once the initial articles were found, authors applied the Pearl Growing Technique (PGT) to identify articles used as references in the articles in order to widen the number of texts to include in the analysis. The PGT was described as the use of characteristics of an authoritative text "pearl", to obtain more suitable and authoritative material (Mutana and Mukwada

Table 10.1 Criteria for inclusion and exclusion of literature

Inclusion	Exclusion
Peer reviewed journal articles from 1 January 1987 to 28 February 2021	Peer reviewed articles published before 1987
Peer reviewed journal articles available to the authors in full text	Not available in full text
Peer reviewed journal articles written in English	Non-English
Articles accessible through Google scholar, Taylor and Francis Online, EBSCO, JSTOR, Emerald Insight, Springer and Sage Publications or available on UNWTO, UNEP, GSTC websites	Not accessible through these databases
Books available in the Library or through e-format	Not available
Articles specifically focussing Sustainable Development Goals Articles on tourism in Phuthaditjhaba	Not focussing on these key areas Not focusing on Phuthaditjhaba

Adopted from Mutana and Mukwada (2018)

2017). Table 10.1 summarises the criteria used for deciding which texts to include in or exclude from the discourse analysis.

Authors used mainly texts published after 1987 (following the publication of the first report on sustainable tourism by the World Commission for Environment and Development (WCED). However, literature on tourism development on Phuthaditjhaba after 2015 (after the pronouncement of the Sustainable Development Goals) made up the bulk of the texts included for analysis. A total of 44 peer reviewed articles; 4 reports and 3 grey literature texts were included in the analysis.

Document Review

The procedure used for critical discourse analysis followed a three-fold manual analysis approach suggested by Fairclough (1993) (analysis of the text, discursive practice and socio-cultural practice). Firstly, (1) texts were analysed by applying content analysis, which exposed the focus of the text. This stage was important for determining the relevance of the text. Authors first graded the texts according to the objective of the study they fitted. Next, analysis arguments are advanced (for example, how can a town achieve holistic tourism? How holistic is tourism in Phuthaditjhaba?) (2) How related is this text with other literature? Is there consistency in the understanding of application of SDGs in mountain town tourism development? At this stage, texts were analysed for themes and patterns. Similar patterns in thought were highlighted in similar colours to show similarity. (3) What issues about SDGs and small mountain town development are left out? This is the stage where the authors sought to illuminate the 'ruptures' and the 'silences' in literature thereby exposing the gaps. Finally, the authors analysed the socio-cultural setting and asked the following questions concerning the texts; (1) what is the geographical setting? (2) What are the assumptions?

10.4 Research Results

This section presents results of the analysis carried out among texts/literature on tourism in Phuthaditjhaba. There is a general agreement among scholars that tourism in Phuthaditjhaba has potential to reduce poverty. However, the town should improve the positive impact of tourism in the economy of Phuthaditjhaba as well as the community and environment (Visser 2016; Taru and Chingombe 2017; Mutana and Mukwada 2020a, b. There is also general consistency in the observation that there is a lack of data for evaluating possible impacts of tourism projects and activities on the economy, community and environment of Phuthaditjhaba (Mutana and Mukwada 2017; Visser 2019; Taru et al. 2019; Zondo 2016). Paradoxically, authors also agree

that Phuthaditjhaba and its surrounding community and environs are fragile, sensitive and are susceptible to long lasting negative impacts if tourism activities are developed and implemented haphazardly (Chingombe and Taru 2016; Visser 2019). The ensuing discussion demonstrates how indicators from SDGs can be used to enhance holistic tourism in line with SDGs 1, 2, 4, 8, 11, 12 and 13, emphasising the interconnectedness of these SDGS. Three key issues emerge from literature namely (1) Poverty reduction through tourism and decent work; (2) Tourism industry climate action for a sustainable city and (3) Tourism and economic development and responsible consumption.

10.4.1 Tourism in Phuthaditjhaba

Phuthaditjhaba, also known as Qwaqwa is among the former homelands which were created for the South African population in 1951 under the Bantu Authority Act. There were ten homelands namely: Transkei, Bophuthatswana, Ciskei, Venda, Gazankulu, Kawene, KwaNdebele, KwaZulu, Lebowa and Qwaqwa. Homelands occupied 122.2 million hectares of land, which translated to 13.96% of the total South African land (Nishimwe-Niyimbanira 2020). Piennar and von Fintel (2013) estimates that Qwaqwa homeland occupies about 476 km^2 of land, of which 50% is habitable and the rest consists of inhabitable mountains. This reality presents limited possibilities for economic activity especially agriculture. Phuthaditjhaba which is the urban settlement of Qwaqwa is nestled in the foothills of the Drakensberg mountains on the border with Lesotho. There is limited tourism activity within the small town itself except a stadium, a few bed and breakfast lodges and a cinema. However, the town is located in close proximity to the Golden Gate Highlands National Park, Basotho Cultural Village, Lekhalong la Witsie (Witsie's cave) which is a Provincial Heritage site, Sterkforntein Dam and numerous spot fishing dams. Several hiking trails are used by tourism companies to take travellers into the mountains and to explore the numerous caves found in the mountains. However, (Mutana and Mukwada 2020b), argue that there is limited participation by local communities in these activities. Increased participation of communities in tourism development could lead to a reduction of poverty and achievement of SDGs in Phuthaditjhaba. There is a considerable potential for the local residents of Phuthaditjhaba and the surrounding villages in getting involved in rural ecotourism (Taru et al. 2014), community based tourism and cultural tourism (Mutana and Mukwada 2020b).

10.4.2 Tourism and Poverty Reduction Through Decent Work in Phuthaditjhaba

Currently poverty levels in Phuthaditjhaba have been persistent (Mutana and Mukwada 2018, 2020a; Nishimwe-Niyimbanira 2020). There is high unemployment, high population growth and high levels of poverty (Taru et al. 2014; Zondo 2016; Nishimwe-Niyimbanira 2018). Nishimwe-Niyimbanira (2020) argues that the poverty in Phuthaditjhaba has its roots in the apartheid era where the poor indigenous people faced extreme poverty. The South African government has developed a comprehensive anti-poverty policy in a bid to improve the quality of life among its people. Regardless of these efforts, research in the Phuthaditjhaba area shows that the current tourism activities (before the COVID-19 pandemic) have not significantly benefitted the poor locals (Nishimwe-Niyimbanira 2020; Mutana and Mukwada 2020a). Employment in tourism include locals holding menial roles like waiter/ess, gardeners, cleaners (Mutana and Mukwada 2020b).

Poverty reduction through tourism is possible if deliberate programs are implemented which help the poor local communities to take advantage of the potential tourism resources by or through turning them into tourism products (Mutana and Mukwada 2020b). Taru and Chingombe (2018) advocated for a deliberate move towards rural geo-tourism considering the available geographical and heritage resources

available in the area. On the other hand, Mutana and Mukwada (2020a) recommended the adoption of deliberate measures that increase the benefits of tourism towards the poor by creating community field frameworks for the involvement of all community members in tourism planning and implementation. However, one should consider Nishimwe-Niyimbira's assertion that poverty in Phuthaditjhaba is multi-dimensional and hence calls for a multi-pronged approach to solving it. This is the point where the connection between SDG 1, SDG 2 and SDG 8 should be considered. The development of a society stays incomplete if the situations of those tormented by poverty are not improved. Generally, workers in the tourism industry in Phuthaditjhaba earn between R2500 per month (for managers) and R 1500 (for waiter/esses) (Mutana and Mukwada 2020a). While these wages are above the poverty datum line, they are seasonal roles and workers go for at least six months every year without work (Mutana and Mukwada 2018). This is because tourism traffic in the area is dependent on the mountains where higher tourist arrivals are experienced in summer season compared to the winter season. Some tourism organisations retrench their employees during the low seasons and rehire them in the peak seasons. There are limited alternative work for employees during low season periods resulting in employees enduring the periods of unemployment while they wait for the peak periods. This keeps them in a cycle of poverty. A holistic employment creation through tourism should improve decency of work by providing wages that are available every month of the year and are high enough to improve the quality of life of workers throughout the year. Tourism activities that can run throughout the year may be created to extend the tourism season, for example by creating cultural tourism products that are not dependent on seasonal changes. Cultural tourism activities can also increase the decency of work among rural community members. Performing cultural performances requires limited educational skills, hence would include even the uneducated community members. Further, it will preserve the culture as community members take pride in their culture. However, measures to educate tourists about the need to respect local culture should be put in place to enhance decency. Alternatively, there is need for creation of alternative industries to absorb labour during the tourism low seasons. Decent work may also come in the form of the tourism industry partnering with women and youths to develop community-based tourism venture or innovative agricultural projects for agritourism and to produce food needed by the industry. This will ensure food security (SDG2), reduce poverty (SDG 1) while also providing decent and consistent work for these community members (SDG8).

10.4.3 Tourism and Climate Change

Tourism and climate change are intimately linked (Earth changers 2019). The climate provides the background within which tourism products are designed and enjoyed. The climate also determines the weather that determines the comfort which tourists enjoy during their holidays. However, as the tourism industry grows, the cost of managing and developing sustainable infrastructure will weigh heavily on destinations (Wood et al. 2019). Some of these costs may be associated with disappearance of non-renewable resources, ecosystem degradation and escalating greenhouse gas emissions (GhG). Climate change is increasingly viewed as a current and future cause of hunger and poverty. The tourism industry has the potential to reduce the carbon footprint of activities and events through practicing sustainable tourism. In Phuthaditjhaba, the impacts of climate change have been felt through the increase of urban droughts (Mohemed and Mukwada et al. 2020). Available research shows that there is a considerable gap between the recommended environmental sustainability and the tourism industry of Phuthaditjhaba (Mutana and Mukwada et al. 2017; Mohammed and Mukwada et al. 2019). Like many mountain communities in the world, the community of Phuthaditjhaba possesses rich knowledge systems that can be adopted to reduce their vulnerability to climate change. Mountain regions are

more vulnerable to climate change (Kohler 2015), yet in Phuthaditjhaba, there is an absence of a solid and structured institution or system for recording and integrating indigenous knowledge on climate change (Mohammed and Mukwada 2019). The tourism industry has not yet shown any appreciation of the need to operate in a climate smart way. There is currently a dearth in literature on tourism, climate action and sustainable cities in Phuthaditjhaba (SDG12; 13). Phuthaditjhaba has the potential of making tourism one of the key industries. Therefore, tourism projects and activities need to be evaluated in terms of their possible impact on climate and the sustainability of the city.

10.4.4 Economic Development Though Tourism and a Quest for Responsible Consumption

The use of tourism for economic development (SDG8) poses a paradox when considered in juxtaposition with the quest for responsible consumption (SDG 12). In Phuthaditjhaba, tourism development is one of the few economic options (Mutana and Mukwada 2017, Taru and Chingombe 2018). However, the tourism business owners and the community have not yet fully appreciated the need for responsible tourism consumption. A possible explanation is the urgent need to deal with poverty and unemployment issues facing the town. Findings from a study carried out by Mutana and Mukwada (2018) show that there are poor waste disposal systems, high energy and water consumption. This is an area of concern considering that Phuthaditjhaba experiences water shortages (Mohammed and Mukwada 2019). There is still room for further developing tourism products by creating cultural, culinary and agritourism products around Phuthaditjhaba. However, this development if pursued would increase pressure on an already stressed system. The interconnection between the need to develop tourism for economic development and the responsible consumption and sustainable cities therefore needs deep consideration. It is imperative for local government to evaluate what fraction of the GDP of Phuthaditjhaba comes from tourism and how much each specific tourism project will contribute to the city's GDP. Tourism activities that contribute more to the city's GDP while also benefitting the environment, culture and society should be supported. The implementation of every tourism activity should be guided by bylaws for responsible consumption.

10.5 Discussion

The findings of this paper show that tourism activities in Phuthaditjhaba should be evaluated against the indicators from as many SDGs as they can fulfil. A tourism activity that satisfies as many indictors of SDGs as possible will be recommended for implementation while those that fail to satisfy the SDGs will be revised or remodelled. The mountain city of Phuthaditjhaba, has considerable potential for development through increased and improved tourism activity.

A matrix can be used to evaluate current and new tourism project/activities against the SDGs indicators (Table 10.2). While the matrix does not necessarily cover all the indicators under each of the SDGS, it is an example to be followed by expanding it and including as many indicators under each SDG as are applicable to a tourism development project or activity.

Table 10.2 (the holistic tourism project/activity evaluation matrix) proposed as a tool for evaluating new or existing tourism projects in a fragile environment like Phuthaditjhaba. The tool can be used by either investor (while developing their tourism projects) local government (when evaluating projects for implementation) or by the community on an ongoing basis. The use of this tool therefore helps all the key stakeholders to ensure that tourism projects or activities are designed for fulfilling SDGs.

Table 10.2 Holistic tourism project/activity evaluation matrix

	SDG 1 End poverty in all its forms			SDG 2 End hunger…				SDG 5 Gender equality..			SDG8 Inclusive growth			
Tourism project/activity	Proportion of population living below poverty line after project **implementation**	Proportion reduction of poverty by gender/age	Proportion improvement in access to basic services	Reduction of prevalence of malnutrition	Reduction of prevalence of food insecurity	Increase in income for small-scale farmers	Reduction in food price anomalies	Reduction in violence against women and girls	Proportion of women in managerial positions	Reduction in tome spend on unpaid domestic labour	Growth in local GDP/Capita	Reduction in informal employment	Increase in average hourly earnings	Tourism direct GDP as proportion of total GDP
Project/activity 1														
Project/activity 2														
Project/activity 3														

	SDG 11 Sustainable cities			SDG 12 Sustainable consumption & n production				SDG 13 Climate action		
Tourism project/activity	Policies for sustainable consumption	Proportion of solid waste collected	Disaster risk reduction	Policies for sustainable production and consumption	Food waste index	Local recycling rate	Renewable energy generating capacity	Local disaster risk reduction	Global citizenship education	Approve/recommend remodelling
Project/activity 1										
Project/activity 2										
Project/activity 3										

10.6 Conclusion

As reflected in the results of the analysis, tourism development in Phuthaditjhaba can be holistic if the products are evaluated against SDGS as indicators. The chapter used SDGs 1, 2, 5, 8, 11, 12 and 13 as examples to show how they can be used as indicators for holistic tourism products. The chapter concludes that (1) Phuthaditjhaba can be developed into a thriving tourism city if holistic tourism products are developed; (2) Innovative tourism products that reduce poverty, that increase decency of work, that reduce climate change and that enhance economic development should be promoted because they enhance the sustainability of the city of Phuthaditjhaba.

This chapter recommends that (1) the local government of Phuthaditjhaba develop and mainstream indicators suggested under each SDG to evaluate new and existing of tourism activities or businesses. (2) Current policies on tourism development be reviewed to enhance both backward and forward compliance with SDGs. Tourism businesses and activities that are already in existence may be recommended for modification in line with SDG requirements while new buildings will follow new bylaws that are compliant with SDGs.

Research that measures the tourism contribution to the GDP of the city of Phuthaditjhaba will help in measuring the expected economic development through tourism as well as the anticipated impact on poverty. Further research to develop and test the tool for evaluation of tourism businesses/products against SDGs as indicator is necessary. Interdisciplinary studies are also needed on the possible cooperation between the tourism industry and local communities in the development of new tourism products (cultural, agritourism) including the practicalities of offering them to tourists for poverty reduction.

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11 Exploring the of Establishment of an Urban Forest in Phuthaditjhaba to Create a More Sustainable Future Urban Environment

Susan Jean Taylor

Abstract

This document review evaluates modes of appropriate urban tree planting that could quickly (within 20 years) create a tree canopy in Phuthaditjhaba to provide social benefits, deal with a future urban heat island effect and create resilience to climate change. Phuthaditjhaba (pop. 54 000), a dense rural–urban settlement in QwaQwa, South Africa, faces looming threats linked to climate change, including health impacts as heat waves become more common and severe in southern Africa. One of the ways of creating a more liveable and sustainable urban environment is through tree planting in streets, schools, clinics and homesteads. Phuthaditjhaba, located in a montane grassland biome, is virtually treeless and a future tree canopy in this city would need to be envisaged and planned for. Challenges to growing trees here include the harsh climate and the shortage of water, the lack of a 'green' vision from the local municipality, as well as the cost of purchasing or growing thousands of suitable saplings. Modelling and various other forms of data and information gathering can assist in optimising tree species selection and planting, but data for Phuthaditjhaba is not available. Creating an urban tree canopy in Phuthaditjhaba would contribute to the United Nations Sustainable Development Goal 11 of making cities inclusive, safe, resilient and sustainable. This study also reflects on ways to create livelihoods in this remote semi-urban setting through tree growing, tree planting, arbocare and landscape restoration measures.

Keywords

Heat island effect · Urban Africa · Urban climate extremes · Urban canopy · Climate adaptation

11.1 Imagining a Sustainable Urban Future

The threat of extreme temperatures has become a recognised climate hazard worldwide and presents a challenge to urban planners, public health officials and the disaster management community in Africa as resource-poor countries may be ill-equipped to handle these challenges (Scott et al. 2017). South Africa's towns and cities must also plan for increasingly uncertain times linked to climate change and implement actions that allow for climate resilience and sustainable urban development.

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While there are many pathways towards urban sustainability, tree planting appears to be a path that can quickly deliver a range of benefits to urban residents. In urban areas, green spaces, green infrastructure and natural ecosystems can be a source of environmental, ecological, aesthetic, health and economic benefits to different socio-economic classes of residents (Adegun 2019; Pataki et al. 2021; Paumgarten et al. 2005) and may also ultimately provide a low cost form of urban climate adaptation (Ordóñez 2015) as well as providing for some climate mitigation through carbon sequestration (Pataki et al. 2021). As cities are recognised as being major emitters of CO2 emissions, tree planting in urban areas is seen as a cost-effective way to partially mitigate urban emissions through above ground carbon storage (Ren et al. 2019).

Urban tree planting can be a cost-effective way to manage climate change impacts and protect residents (and livestock) from hotter climate change conditions and the urban heat island effect by providing shade and a cooler microclimate (Tan et al. 2016; Won et al. 2015; O'Neill et al. 2009), Mature trees with larger crowns that are in a healthy condition will provide more ecosystem services than younger, smaller trees, and a city with greater urban tree canopy cover will experience more ecosystem services like heat mitigation than a city with lower canopy coverage (Edmond 2017).

From the Paris Agreement of COP 21, the mass planting of trees have been proposed as a key climate mitigation solution to deal with the 'climate emergency', but noting that urban greening, while having climate change benefits, is not the same as the controversial mass planting of trees or mass rehabilitation of natural forests to sequestrate carbon as a so-called effective climate change solution (Lewis et al. 2019; Lindenmayer et al. 2012). The mass tree planting to absorb carbon is controversial, particularly where it may involve the replacement of non-forest biomes with trees (Veldman et al. 2015). For example, in the Drakensberg Afromontane region, the establishing of plantations in the natural areas of the grassland biome would be met with strong resistance.

To create a more sustainable Phuthaditjhaba will require imagining or envisaging a different future that embraces the principles of the UN SDGs. Yet, to create a sustainable city (Goal 11) in Phuthaditjhaba, residents and the municipality will need to strive towards a 'greener' future city. This will involve on-going tree planting as the city expands, amongst other activities. This paper is a contribution to the thought processes required in envisaging and planning tree planting in Phuthaditjhaba, but understanding the actual process to achieve the benefits of tree planting in Phuthaditjhaba will require additional research to determine what trees to plant and where, to determine the effects of shade on buildings and home interior comfort, the benefits of a 'greener' urban environment on human health and mental health, and also for livestock health in the surrounding environment.

11.2 Municipal Structure and Planning for Climate Change at Phuthaditjhaba

The municipal structure in South Africa consists of large district municipalities divided up into clusters of smaller local municipalities. Both types of municipalities must prepare Integrated Development Plans (IDPS) on a five year cycle. There is also a role for SALGA (South African Local Government Association) in ensuring that municipal planning includes mandatory urban greening. SALGA is a national, voluntary political association that serves human settlements and municipal planning, and includes membership of South Africa's 257 municipalities. SALGA's website had various webinar offerings during 2020 on 'Trees and Climate Protection' and 'Greening and Open Space Management', with these linked to national arbor month**.**

The Thabo Mofutsanyana District Municipality *Climate Change Vulnerability Assessment and Response Plan* (2016) highlights agriculture and the water sectors throughout the entire Free State province as the most vulnerable to climate change impacts (Thabo Mofutsanyana Climate Change 2016). Informal and agriculturally-based

livelihoods will be at risk. Also of note is the risk of increased isolation of rural communities (with roads not maintained, railway links and bridges damaged from flooding and erosion) and also the increased migration away from these areas over time. In terms of greening, the Thabo Mofutsanyana *Climate Change Assessment* mentions developing better commonage land management (p. 72), but there is no mention of urban greening, tree planting or investing in 'green infrastructure' that could provide increased resilience in towns and farms within the municipality. *The Climate Change Vulnerability Assessment and Response Plan* (2016) also does not mention the impact of increased heat stress as a health risk for the human population in this area.

Phuthaditjhaba (28°32′00″S 28°49′00″) is a remote and under-developed rural–urban settlement in South Africa and is seen as the 'capital city' of a rural area known as QwaQwa. The apartheid Bantustan of QwaQwa was created in 1974 as an artificial nation for the Sotho-speaking people. After the first democratic elections in South Africa in 1994, Phuthaditjhaba and surrounding rural QwaQwa and its villages form part of the Maluti-a-Phofung (MAP) local municipality, one of the local municipalities within the Thabo Mofutsanyana District Municipality in the Free State Province, South Africa. The other small towns in Maluti-a-Phofung are Harrismith and Kestel. The rural areas include communally-owned land of and commercial farms. As at 2016, the Maluti-a-Phofung local municipality had a population of 353 452, with the population of Phuthaditjhaba said to be 54 661 (MAP Profile 2018; MAP 2017; MAP Annual Report 2015; Municipalities of South African 2012).

Phuthaditjhaba is 1664 m above sea level. The climate is mild, and generally warm and temperate. This climate is considered to be *Cwb* according to the Köppen-Geiger climate classification. The warm season is from November to March and temperature averages 24.4 °C in summer with highs that can reach 29.7 °C and with an average low of -0.5° C in winter (May to August). The rainy season is between October and March each year, with a total average annual rainfall of 1020 mm (climate-data.org, no date). There is almost no rain during winter, but snow and frosts can occur during June and August (Weatherspark, undated). These weather and climate conditions would influence the selection and planting of urban trees. Phuthaditjhaba is already experiencing impacts attributed to climate change, including heat waves, droughts and strong wind (Melore and Nel 2020).

Currently Phuthaditjhaba consists of a low density rural–urban sprawl with a modern economic centre, a shopping mall, a sports stadium, a showcase municipal complex and modern hospitals. Surrounding Phuthaditjhaba are the rural villages of QwaQwa located on difficult montane topography. Over the years very few urban trees were planted and thusPhuthaditjhaba has no urban parks or green belts or street trees, although it can be said that there are many semi-natural vegetated spaces in the landscape because of its rural nature. Both rural QwaQwa and Phuthaditjhaba are perhaps unique in that the village and urban areas are in close proximity to the Golden Gate Highlands National Park (containing QwaQwa National Park) and the Maloti-Drakensberg Mountain range; within sight of the Drakensberg Escarpment, the UNESCO World Heritage Site (The Maloti-Drakensberg Park World Heritage Site) which includes the uKhahlamba-Drakensberg Park in South Africa —which is a collection of 12 protected—and the Sehlabathebe National Park in Lesotho. Yet, there has been no attempt to bring the 'montane landscape' into the urban environment to foster urban greening.

Despite its scenic location, the settlement is beset with many challenges relating to underdevelopment and a lack of local economic activities. HIV/AIDS and tuberculosis are prevalent. Also, the Maluti-a-Phofung municipality was put under provincial administration in 2018 because of the collapse of governance and the misappropriation of municipal funds (Felix 2020). This situation required the province to take over the day-to-day governance of the municipality as per Sect. 139 of the South African Constitution as a measure to correct the poor management situation (Head 2019).

People in Phuthaditjhaba and the surrounding rural area of QwaQwa generally have very fragile livelihood systems which can be expected to become more precarious as climate change impacts are felt (Melore and Nel 2020:4; UNICEF 2011; Meadows and Hoffman 2003; Slater 2002). The bulk of persons in Maluti-a-Phofung municipality reside in Phuthaditjhaba and more than half depend on social grants (Melore and Nell 2020:5). Over 50% of the community of the entire Maluti-a-Phofung municipality is unemployed (2018 figures), with around 25% of the Maluti-a-Phofung Municipality earning around R400 per month and another 12.5% is earning in the region of R800 per month, all below the national baseline of R800 pm for a basic living wage (Maluti-a-Phofung IDP 2018). From published municipal reports, it is hard to find unemployment figures specifically for Phuthaditjhaba or the other individual towns in this municipality, but figures are likely to be dire. The Free State province has the second highest overall unemployment rate in South Africa, second to the Eastern Cape (Polity 2021).

The Thabo Mofutsanyana District Municipality Climate Change Vulnerability Assessment and Response Plan (2016) outlines the impacts projected for the Free State province and this district municipality for the 2020–2050 period (Thabo Mofutsanyana Climate Change 2016). There is a projected increase in average temperatures of 2.3 °C and an increase in the number of very hot days, up to 142.15 very hot days per annum in the Free State province. Also, projected is a possible increase in the number of heat wave events by 17.5 days per annum over large parts of the province, which may impact on human and animal health, on crop yield and may lead to the increased occurrence of fires in grassland areas. There is uncertainty around rainfall projections, with some models and projections indicating a decrease in rainfall of more than 65.39 mm per year and other projections indicating an increase of 35 mm per year. The rainy season is likely to start later and last for a shorter amount of time.

There are already hints of the types of difficulties that climate change might bring to Phuthaditjhaba, for example, dealing with protracted droughts and difficulties in securing a reliable water supply for Phuthaditjhaba. The Fika Patso dam which has supplied Phuthaditjhaba for decades has almost dried up (Motsoeneng 2016) requiring an emergency pipeline to be built from the nearby Sterkfontein Dam to supply the town with water (SANews 2020). Yet, while Phuthaditjhaba is under-developed, poverty-stricken and suffering from a variety of problems linked to poor municipal governance, it is not an over-crowded, un-serviced, high-density slum with appalling living conditions as experienced by 62% of sub-Saharan Africa's urban dwellers (Schäffler and Swilling 2012). It could be argued that Phuthaditjhaba is a relatively new and small city and if good governance and economic opportunities can materialise, there remains the strong possibility that resilience and sustainable development can be achieved.

11.3 Global Efforts to Achieve Urban Sustainability and Climate Resilience

Urban populations around the world have increased fivefold since 1950 to the extent that there is now an urgent need to reduce the environmental impacts caused by urban dwellers as well as improve their quality of life, creating sustainable development (Ferreira et al. 2021). Since the 1992 Earth Summit, there has been a concerted global effort to promote a more sustainable type of human development that will also create resilience in times of climate change. These hopes are encapsulated in the United Nations Sustainable Development Goals (UN SDG) and the United Nations Vision 2030 document on Sustainable Development which outlines 17 Goals towards achieving multifaceted and interlinked forms of sustainable development (UN SDG 2015). Goal 11 aims to make cities inclusive, safe, resilient and sustainable, while dealing with climate change for both the rural and the urban domains is part of the UN SDG Goal 13: Take urgent action to combat climate change and its impacts.

In Africa, achieving a widespread sustainable urban domain in African cities may not emerge for some time for compelling reasons linked to chaotic urban transitions and a disintegration of formal urban planning (Yeboah and Obeng-Odoom 2010), but this does not mean that African municipalities and their residents, business and civil society should not continue to promote human development that has less impact on the natural environment (Buyana et al. 2019).

11.4 Increased Urban Heat as a Health Threat

Heat is a growing health risk, due to burgeoning urbanisation, an increase in high temperature extremes, and demographic changes in countries with ageing populations (Tuholske et al. 2021). Hot extremes including heatwaves have intensified in cities and there have already been record-breaking monthly mean temperatures and heat waves in many parts of the world due to climate change (IPCC ARC 2014: 15)The 2003 European heat wave killed 70 000 persons, mostly the aged (Muthers et al. 2017; Robine et al. 2008). The psychological, social and cultural dimensions of a changing and hotter climate are also of concern, as are the impacts of increased heat on human health, mental health and well-being as well as livelihoods, society in cities and settlements, and water supply and food production (IPCC AR6 Summary for Policymakers:14).

Projections for climate change in Africa show an increased vulnerability of cities to climate change impacts (Jagarnath et al. 2020). The CORDEX (Coordinated Regional climate Downscaling Experiment) model shows that weather patterns in African countries are anticipated to become more variable and intense, with a greater frequency and duration of heat waves (Dosio and Panitz 2016), including in South Africa (Dosio 2017). A Heat Wave Magnitude Index has been developed to be able to quantify heat waves over time (Dosio 2017). Observations in South Africa already show an increase in the number of 'hot' days (National Treasury 2018; UNICEF 2011). The intensity of extreme heat events now poses a significant threat to South Africa, with a trend of more frequent, more intense heat wave trends already becoming clear (Van der Walt and Fitchett 2021). In South Africa, average temperatures are already rising and mean monthly temperatures are projected to reach 2.0 °C by the 2050s and 4.2 °C by the 2090s under a high-emission scenario (RCP8.5), while other emission scenarios could see fewer of these changes. One of the most serious heat consequences for South Africa is the projected increase in the number of 'hot days' (TMax > 35 °C). By mid-century, the Northern Cape, North West and Limpopo are expect to see an increase of 20 to 40 days 'hot days' per year, and by the end of the century projections that hot days will occur more than 120 hot days per year across the country's interior (World Bank Report South Africa 2021). Heat impacts will present significant public health challenges in South African towns and cities, and adverse health effects will occur depending on the quality of housing and the existing health of the persons living in the house (Wright et al. 2019).

Precipitation and evaporation changes will be highly variable over South Africa, but a decrease in the number of raindays is expected across all hydrological zones (World Bank Report South Africa 2021). Drought will be a growing risk, made more severe by increased daily temperatures.

11.5 The Urban Heat Island Effect

The process of urbanization and the increasing amount of built infrastructure alters local environments, changes wind flows and creates hot impervious surfaces, leading to an increase in the ambient temperature of the urban environment known as the urban heat island (UHI) effect (Kraus and Scharf 2019). While already well known in other parts of the world, African cities are beginning to experience this effect. Nairobi, for example, with a population of four million, is showing signs of the urban heat island effect that

is of growing concern (Ongoma and Mwangi 2020). Preventive actions include: establishing heat wave warning systems; making cool environments available (through air conditioning or other means); public education; planting urban trees and other vegetation; and modifying the built environment to provide proper ventilation and the use materials and colours that reduce heat build-up and optimize thermal comfort (O'Neill et al. 2009). It does not appear as if the heat island effect has been noted or studied in Phuthaditjhaba. A study by Melore and Nel (2018) showed that Phuthaditjhaba already manifests the impact of climate change with increasing summer temperatures, fluctuations in rainfall leading to periodic severe shortages of water, increased incidences of drought, strong winds, flash floods causing soil erosion and rock falls from hillsides, along with a reduced biodiversity (Melore and Nel 2018).

11.6 Aim of This Study

The purpose of this paper is to draw attention to the urgent need for tree planting in Phuthaditjhaba as a way to create a more liveable and sustainable urban environment and protect current and future residents from the impacts of heat as well as other potential manifestations of climate change. In Phuthaditjhaba, urban street tree planting could be an important low-cost action to mitigate climate change. The paper seeks to alert town planners, policy makers and decision makers in Phuthaditjhaba and the Maluti-a-Phofung local municipality that resources will be needed to deal with the human health impacts of climate change. The paper aims to show that urban tree planting can be a straightforward, practical activity that involves digging holes and planting trees, and that this bas, low cost activity can create jobs and a local horticultural economy and help Phuthaditjhaba prepare for climate change. The paper also highlights the limitations of tree planting and that many factors influence the outcomes of urban tree planting.

11.7 Green Assets and Green Infrastructure

Urban greening and establishing a green infrastructure in towns and cities has become part of the international contemporary theory and practise of landscape architecture and ecological design around the world (Rottle and Yocom 2010). Green Infrastructure refers to ecological systems, both natural and engineered, that act as living infrastructure. Green Infrastructure elements are planned and managed primarily for storm water control, but also exhibit social, economic and environmental benefits (Kim and Song 2019). 'Green assets' and 'green infrastructure' also refer to the vegetation and landscapes of parks, public open spaces and servitudes within a city, often to allow water to move in the landscape (Pauleit et al. 2017). The term 'urban forest' refers to all trees within an urban area, including those in parks, golf-courses, school yards, street plantings, wastelands, nature reserves, riverine areas and so on and all deliver ecosystem services (Wu 2016). Mass planting of trees is also seen as a nature-based solution to climate change and air pollution i.e. mitigation, but probably has more value in adaptation efforts. The planting of new urbane forests would require that trees are planted on large spatial scales beyond municipal boundaries, and maintained over the long term, to ensure effectiveness (Pataki et al. 2021).

11.8 Developing Useful Relationships with Urban Trees

In the developed world, urban trees in parks, yards, streets and vacant areas have been features of urban design and landscape architecture for some time and have created public value for residents, including beautifying the environment. In more recent times, urban tree planting and other uses of vegetation in the developed world are considered to have benefits in terms of urban

cooling, habitat creation for wildlife, reducing stress and illness in residents, as well as increasing property prices (Pataki et al. 2021). However, Pataki et al. (2021) warn that urban greening advocates must use evidence, rather than received wisdom, to inform urban policy and decision making, and that urban greening initiatives can distract from more fundamental problems driving urban inequality, i.e. urban tree planting is but one aspect of creating sustainable and equitable cities.

In the developing world, residents' relationships with trees and tree planting rely on practical resource needs. For example, in rural areas, the use value of trees is in usually terms of fruit, firewood, building materials and livestock fodder and these uses are reasons for planting or protecting trees. There are also cultural and gender issues related to planting trees in rural areas. Other less obvious benefits from trees are derived from customary local practices like planting hedgerows to demarcate land boundaries and secure tenure (Dewees 1995). A study in Malawi showed that the marital status of women and where they lived influenced their likelihood of planting trees in the homestead. This is related to the form of marriage and inheritance patterns in Malawi, as well as the status of the married woman and how they acquire land (Hansen et al. 2015).

In rural South Africa, trees are valued for their direct use value. Shackleton et al. (2006) found that in many places fuelwood is still used, with rural households either collecting their own or purchasing wood. Fortunately, the wood is often collected from alien invasive species and so contributes to alien tree clearance. Pote et al. (2006) showed the value of natural wooded ecosystems to South African communities in terms of fuelwood and construction timber, especially for those living next to these ecosystems. Paumgarten et al. (2005) found that in villages in the Eastern Cape and Limpopo Provinces of South Africa, villagers utilise a range of trees in home-gardens for various purposes, although predominantly for fruit and shade. Trees were either planted or actively retained in a household's home-gardens. The most preferred species were exotic fruit trees in Limpopo Province and a mix of exotic fruit and shade trees in the Eastern Cape. Trees also provided shelter and shade for livestock and generally improve the aesthetics of a property.

In Johannesburg, the Trees for Homes initiative sought to improve the lives of poor informal settlement residents at Zandspruit, a large informal settlement to the north of Johannesburg, through tree planting, with somewhat limited success. There were many issues complicating the successful planting of urban trees in informal settlements, notably political disempowerment, insecure tenure and the fear of being evicted before benefits of tree planting accrue (Mwazvita et al. 2016). This work showed that community and political attitudes to tree maintenance and care in different settings are also important and local governments need to be responsive to the different opinions relating to urban trees and understand who benefits from these trees and who will care for them (Saldarriaga et al. 2020). All these aspects attest to the cultural and practical difficulties in planting trees in any human-dominated setting, and would potentially also need to be understood in Phuthaditjhaba.

11.9 Modelling the Likely Success of Tree Planting in Urban Areas

While urban forestry or urban greening is advocated around the world as a way to enhance the liveability of towns and cities, as well as mitigating the effects of climate change, in practice, implementing urban tree plantings can be complex. Not much is known about of the way that trees respond in different urban localities, or how to get trees to perform optimally in a city street setting and how soon they will begin to provide benefits to urban residents (De Lacy and Shackleton 2014). It is therefore desirable to base the planting of urban trees on spatial and other data especially as the investment in tree planting and care can be substantial, and the failure of the trees to thrive is costly.

In order to capture and quantify the heat island effect in cities, here are now many

sophisticated software options enable the modelling of the urban climate, including heat and air flows and the effect of buildings on air flows and urban temperatures, as well as modelling the potential impact of the urban tree canopy structure on urban heat.

To model the functioning of trees in the urban environment, micro-climate models, heat impact models and urban tree canopy models, to name a few. Urban Canopy Models (UCMs) are able to represent the amount of tree canopy that exists and that could potentially exist in a locality based on a number of pre-selected factors, as well as any changes in the urban forest (USDA Forestry 2019). These types of models can inform urban managers how to manage their urban forestry programmes and where to plant trees. UCMs also can model the exchange of moisture and heat between the city and its various surfaces (like buildings, roads and vegetation) and the atmosphere and allow for understanding and predicting heat flows in cities (Schoetter et al. 2020).

An example of a micrometeorological model for cities is UMEP (Urban Multi-scale Environmental Predictor), a city-based climate service tool that can identify heat waves and cold wave, the impact of green infrastructure on runoff, the effects of buildings on human thermal stress, solar energy production and the impact of human activities on heat emissions (Lindberg et al. 2018). DASH is another model that allows energy flows within cities to be modelled and can be coupled to an urban land surface model to examine urban heat fluxes (Capel-Timms et al. 2020).

Loughner et al. (2012) used modelling that linked a weather forecasting model with an urban canopy model to show that added vegetation does actually decrease air temperature in urban streets, reduces building wall and road temperatures, this achieved through a 50% tree cover which provide shade and evapotranspiration. The value of tree planting models and associated estimates of carbon capture and other benefits can be used to justify the budget for expanding existing urban forests (Pincet 2010).

Cavan et al. (2014) explain how the different characteristics of urban areas can be designated and mapped to provide geographical zones along with their urban climate patterns. This information helps to clarity the temperature regulating services provided by urban vegetation and assist in planning for urban greening. Mussetti et al. (2019) explain how their model, COSMO-BEP-Tree v1.0, is a coupled urban climate model with an explicit representation of street trees. The COSMO-BEF-Tree model was found to realistically respond to changes in the parameters defining the performance of street trees: leaf area density and stomatal conductance and allowed for city-wide studies on the cooling potential of street trees (Mussetti et al. 2019). These types of models can help city managers determine the optimum configuration of urban trees and the urban canopy and calculate how much shade is created or carbon sequestrated by trees (Werbin et al. 2020).

The ANUCLIM package is widely used to generate bioclimatic profiles from known species locations and these can be used to predict tree bioclimatic envelopes to be matched with the urban climate envelope for maximum tree efficiency (Xu and Hutchinson 2013). The climatic limits of tree species also need to be factored into urban tree planting decisions, using information about species and their optimum environmental habitats and limits.

11.10 Modelling the Future Tree Canopy at Phuthaditjhaba

Unfortunately, it is not currently possible to perform this types of sophisticated modelling for Phuthaditjhaba as there is no local climate data (Mukwada personal communication 2019). While it is not yet possible to deploy the various proprietary software products available to map the urban climate in Phuthatitjhaba and model where in the landscape to place urban trees, aerial photography or satellite imagery could be used to identify open areas in need of vegetation cover (Merry et al. 2013). Also, the use of unmanned aerial vehicles (drones) to survey the landscape for suitable tree planting areas, and then, monitor the development of newly planted trees, is a cost effective way for managing the new tree

plantings and monitor tree health. Other forms of information gathering, involving stakeholder and expert consultations, could be adequate to initiate tree planting in Phuthaditjhaba, on the basis of 'any trees are better than no trees'.

Other practical challenges of street tree planting are not to be underestimated, for example, selecting compatible trees that will survive in this landscape and then ensuring they survive after planting.

11.11 A Quick Survey of the Urban Landscape in Phuthaditjhaba

An informal drive-through landscape analysis of Phuthaditjhaba along the Mota Road, the main thoroughfare from the University of Free State's QwaQwa campus to the Witsieshoek Mountain Lodge, showed a hilly landscape with a regular arrangement of homesteads, each with formal or informal dwellings. Using Google Earth, it can be seen that the overall plan of Phuthaditjhaba appears logical and formal (Fig. 11.1). Although many properties do have trees, the general impression of Phuthaditjhaba is of a vast, treeless and semi-rural landscape, also revealed by Google Earth (Fig. 11.1). This is in contrast to other towns in the eastern Free State province which are well-endowed with street trees and trees in private gardens, school yards and town squares, many planted during early settler days and now mature (author observations).

There are many pedestrians walking at the side of the Mota Road, but the pavements at the side of the roads in Phuthaditjhaba are not formally defined or paved. There are no storm water drains to remove water from the road and pedestrian areas, resulting in vast muddy areas. Mature trees (exotic species) are evident in some homesteads, schools, churches and missions and on the sides of some roads. Taxi ranks, shopping centres and bus stops do now have pavement trees and are thus very hot in summer (author observation). At the edge of the urban areas are hills, fields, rivers and valleys which are very badly encroached upon by alien woody vegetation (author observations, 2018). There are also areas of commonage in QwaQwa for small scale farmers, but there are major resource management problems in these communal grazing areas (Masiteng 2004).

Fig. 11.1 Google Earth image of part of Phuthadijhaba, QwaQwa, in the Free State Province, South Africa, showing dense and well-organised settlements located on the flatter parts of a generally mountainous terrain, while in the hilly areas, the rugged landscape has meant that the dwellings are much more informally laid out (Google Earth image, 2018)

11.12 Creating a Desire for Urban Greening

Figures 11.2 and 11.3 show the local rural–urban landscape. Using local photographs, a photomontage (Figs. 11.4 and 11.5) was created using Paint.net, a free imaged editing software, to show a small increase in the presence of trees can enhance the aesthetic appearance and shade comfort of homesteads in Phuthaditjhaba. The types of trees in the photographs are not known to the author, but are growing in the area.

These images were included as a suggestion as to how a visual interpretation of concepts and the aesthetic of urban greening at Phuthaditjhaba could be marketed to local decision makers and funders. As well as visual interpretations, information about the threat of climate change and impact of heat on the health of residents of Phuthaditjhaba would need to be shared during stakeholder discussions about the benefits, costs and limitations of urban tree planting. Getting widespread buy-in is likely to be a challenge because of all the difficulties and constraints currently facing South African municipalities (Averchenkova et al. 2019).

Fig. 11.2 General view on the Mota Road, one of the main roads through Phuthaditjhaba. There are some trees along this road, but not in areas where people are present on a day-to-day basis, for example walking to shops. Image 2018. *Source* Author

Fig. 11.3 View east from the Mota Road, showing the sprawl of homesteads and single storey dwellings in a generally treeless environment. Winter 2018. *Source* Author

Fig. 11.4 View east from the Mota Road, the main road through Phuthaditjhaba to the Witsieskhoek Lodge, showing rural nature of homesteads and the generally treeless environment. *Source* Author, Winter 2018

Fig. 11.5 Photomontage, using Paint.net, a free image editing software, showing the potential visual and shading effect of increasing the number of trees in the landscape. *Source* Author, 2018

11.13 The Need for Quantitative Research

Although sophisticated methods are available to model how an area would respond to urban greening and allow investigations to understand how different percentages of vegetation, different types of vegetation (trees, shrubs and grasses) and the use of different planting forms (copses, avenues, thickets, parks) would enhance the microclimate of this city and its streets, there is no useful data available currently. However, discussions about the various climate change-related ecosystem service benefits of urban greening and tree planting is known from the published literature and international examples. Also, in the absence of detailed research and modelling, the 'rough guess' approach to establishing an urban forest in this impoverished setting would involve mixed street plantings in different settings and different densities with homestead trees, street trees, trees in school yards, church and clinic gardens, and trees in natural areas, wastelands and parks, potentially creating public areas that are safe and shaded during heat waves.

11.14 Phuthaditjhaba Tree Planting Master Plan

Trees for urban planting in Phuthaditjhaba need to be thoughtfully selected to be compatible with the ecologically sensitive montane grassland landscape. Trees that already grow in the area, and are not invasive, could be considered. If very large trees are needed in certain settings, they would have to be from outside the area or even exotic species. Because Phuthaditjhaba is located in a high altitude montane grassland biome, there are very few natural trees in the region, although

there are forest patches and suitable trees species may be found in these forests. However, as these forests are found on moist southern slopes (Adie et al. 2017), they may not cope in a dry urban setting but should be investigated none-the-less.

A 'Recommended Phuthaditjhaba Street Tree Planting List' should be developed containing a listing of trees generally recommended for planting within the pavement strip area. This list would guide both the municipality and NGOs wishing to work with community tree growing projects on appropriate trees to consider. The list should include a variety of tree shapes and sizes that can be utilized in a variety of circumstances. The street trees selected for Phuthaditjhaba should be drought and frost resistant, and where desired, have dense crowns to provide shade. Long-lived trees should be selected, and while it is important to select indigenous tree species, species survivability could be a more important attribute (Gilbert et al. 2014). Another important aspect to consider is underground water availability and to not plant physiologically 'thirsty' trees that strongly remove soil water through transpiration, for example eucalypts. It would be preferable to purchase saplings at least 1.2 m tall, rather than beginning with seed cultivation, to save time. If available, saplings up to 5 m in height can be transplanted, although bigger saplings will cost more. Constraints on water supply to the new trees need to be resolved as young trees do have to be watered once a week for the first 1 – 2 years. However, most of the annual rain falls in summer months, so trees should be planted just before the first rains. As the tree planting could be phased over several years, the budget and risk could be spread out, perhaps over a five year period. This period might also be useful for local entrepreneurs to become established to provide trees to the municipality and plant them.

A well-designed urban tree planting scheme should attempt to create a diverse urban forest structure, with street plantings and a variety of wooded habitats, and also be flexible enough to respond to future needs with an understanding of how urban landscapes function now and might function in the future (Gilbert 2014). The following considerations are essential for successful urban tree planting: choose suitable regions for planting trees and identify priority land tracts based on planting feasibility and protection; choose the right tree species for the local site conditions and then, keep the trees healthy and ensure resources for tree maintenance (Werbin et al. 2020).

Taken at its most straightforward, a simple tree planting Master Plan should contain a list of approved trees for street trees, as well as street tree planting and maintenance guidelines of residents, municipal officials and/or property developers. In general, urban street trees must be neat, medium-sized (20 – 30 m tall) trees that do not have aggressive root systems. They should preferably be evergreen so as not to drop leaves, and should not produce messy flowers or fruit that drop on pavements. It is preferable to plant long-lived trees that will survive in an urban setting. High tree mortality due to drought or disease can be a serious setback. Efforts would need to begin to either source the saplings or set up a local nursery to produce these.

For close spacing, street trees should be planted 6–20 m apart, depending on the species and their canopy spread. Trees that will grow very large need to be planted 20–50 m apart. It is obviously more cost effective to plant trees further apart and this also allows for more growth of the tree canopy over time, but will take longer to form a closed canopy. Also, if trees are planted close together, they develop tall with fewer side branches, while if planted further apart, the trees tend to produce branches close to the ground which require management and frequent pruning.

An estimate of the length of roads using Google Earth in one section of Phuthaditjhaba revealed about 120 km of roads. Planting a tree every 10 m of road for 120 km would require 12 000 trees, while planting trees 20 m apart would require only 6 000 trees. These are not insurmountable numbers of trees to source and plant, and at a basic ZAR500.00 per tree, 12 000 trees would cost ZAR6 million, while 6 000 trees would cost ZAR3 million. The total length of roads in Phuthaditjhaba would need to be determined for a full cost. These cost estimates

exclude the cost of labour, fertilizers and water, fencing to protect the young trees and on-going maintenance of the trees.

11.15 Bylaws and Urban Trees

In most urban cities around the world, urban tree planting is the responsibility of the municipality and is supported by policy, budgets, bylaws and guidelines and requires the services of professional people trained in horticulture to implement and maintain the tree plantings. This is not the case in many of South Africa's small towns and cities. Bylaws to keep livestock off the streets must be enforced. Municipal bylaws relating to municipal trees are needed for any urban tree planting. It must be illegal to damage or destroy urban street trees in Phuthaditjhaba, with penalties which may include fines.

An important constraint to tree-planting in South African townships, small towns and informal settlements are vandalism and theft of trees, livestock damage, and inadequate water for tree survival (Guthrie and Shackleton 2006). Roads, properties and common lands are not usually fenced in South African towns, so livestock graze along the road verges and will eat any new trees planted and even completely strip or remove more mature trees. Thorny tree species were damaged significantly less (13%) than non-thorny species (77%) when used as street trees (Shackleton et al. 2017).

11.16 Generating Livelihoods from Growing and Supplying Trees

Planned carefully, a widespread urban greening activity could create a horticultural economy in Phuthaditjhaba, creating livelihoods for hundreds of persons, noting that planting and maintaining a full complement of street trees at Phuthaditjhaba could take many years, thus enabling a full business lifecycle perhaps of 20 years. A local tree-growing horticultural economy could include growing and planting a wide variety of useful indigenous decorative and shade trees, fruit and fodder trees and other plants for a systematic urban greening programme, also involving green infrastructure for flood control (wetland vegetation, lawns) and other landscape design plantings (hedges, lawns, flowering plants, fruit trees, vegetables) and urban agriculture. This economy could be developed with start-up, donor funding or private sector investment, based on a well thought through ten year business plan. Landscape restoration, alien plant removal and appropriate indigenous shrub and tree planting (Venter et al. 2020) would also require different types of plants to restore the quality of natural areas in and around Phuthaditjhaba and could provide for local investment and business entities of a 'green economy'. Planting thousands of trees in an area with a critical water shortage would need to be addressed creatively.

11.17 Who Must Act?

Constraining factors hindering the establishment of a comprehensive urban tree planting in South African municipalities need further research, but are likely to include a lack of political support and scarcity of resources, as well as little sense of urgency about climate change impacts on the urban society. Insufficient funds and a lack of specialised or technical personnel for design and implementation of a tree planting programme have been found to explain the lack of new urban tree planting in South Africa (Averchenkova et al. 2019). To ensure that a tree planting policy is developed and put into action in Phuthaditjhaba, relevant stakeholders (politicians, municipal officials, special interest groups, not-for-profit organisations, traditional leaders and local communities) must be consulted and consensus reached that such a policy is indeed necessary investment for a future liveable and sustainable city.

If a formal mandate (and budget) was issued by government for urban greening in preparation for climate change, then municipalities would have to develop and implement such plans. This

mandate should come via SALGA, with SALGA ensuring that the less well-resourced municipalities in South Africa receive adequate resources for urban tree planting as an urgent climate adaptation measure that will also create more sustainable and liveable urban environments.

11.18 Discussion and Recommendations

The theory and practice of ecological design for a sustainable 'green' city is very evocative and urban greening appears attractive for a variety of reasons, including aesthetic benefits, creating social and mental wellbeing in urban areas, and providing for urban heat island mitigation and shade provision for general hotter conditions. Various tree species can also provide fruit, timber, fuelwood, fodder and other harvestable materials for certain communities. Trees also take up carbon dioxide during photosynthesis and store it as wood, and above ground carbon storage by trees can be part of mitigation planning. The Thabo Mofutsanyana district municipality has a climate change strategy, but urban tree planting is not listed as an action. The Maloti-a-Phofung local municipality, within which Phuthaditjhaba is located, appears trapped in a crisis of inadequate provision of basic infrastructure and services to residents. There is no attempt to begin dealing with future threats linked to climate change, for instance, investing in urban street tree planting to create shade to help residents deal with heat waves. It is likely that the residents of the Maluti-a-Phofung Local Municipality and Phuthaditjhaba may not see urban greening as a priority as they battle daily to get water and struggle with a few hours of electricity each day. Yet, it could be argued that climate change adaptation activities should begin immediately, perhaps initially as a tree planting programme, in order to avoid disadvantage to residents in the form of rapidly manifesting climate change impacts.

Despite the crisis of meeting residents' current basic needs, it would be important for both the Thabo Mofutsanyana District Municipality and the Maluti-a-Phofung Local Municipality to develop an affordable urban greening and tree planting strategy and begin planting trees immediately. To give effect to urban tree planting, the Maloti-a-Phofung local municipality within which Phuthaditjhaba is located, will need to develop either a basic 'get started now' tree planting scheme which can be developed over time into a more comprehensive Tree Planting Master Plan, working towards the over-arching aim that by 2050, urban greening is well underway, and an urban canopy is strongly developed across Phuthaditjhaba.

A widespread and vigorous campaign for urban tree planting must be established, highlighting the long term benefits of urban trees. This could be done through research collaboration and information sharing with environmental NGOs, schools, churches, civil society and municipal officials, to create local campaigns, policies and plans. A wise urban tree planting strategy must create awareness about the benefits of tree plantings several years before proceeding to ensure acceptance by stakeholders. A local horticultural economy could be created through the growing and supplying of good quality saplings and other urban greening vegetation.

Urban tree planting should form a mandatory aspect of South African municipal climate change adaptation planning, disaster risk reduction planning, as well as planning to create sustainable urban settlements and urban greening and tree planting should be championed by SALGA. If urban tree planting is to be carried out in Phuthaditjhaba, it should begin immediately.

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Imagining the Future Phuthaditjhaba —Vision 2121

12

Louw van Biljon

Abstract

The following issues need to be clarified before an approach is formulated which will facilitate the planning of a sustainable Phuthaditjhaba, South Africa: What is the essence of a long-term vision? How long is long-term? It is suggested that the short time horizons used in Integrated Development Plans (IDPs) and Spatial Development Frameworks (SDFs) are much too immediate and it is proposed that 100-year planning and a vision which corresponds to that time span should be employed. 'Backcasting', as a method to formulate such a vision, is proposed. This idealised strategy is counterpoised with current planning practice and the socio-spatial constraints of Phuthaditjhaba. Phuthaditjhaba's Integrated Development Plan (IDP) and Spatial Development Framework (SDF) are analysed and an assessment made whether these two tools address or impede sustainable development.

What is meant by a sustainable city/community? A comparative analysis of the UN's Sustainable Development Goals (SDGs) are made with three case study approaches to sustainable development. From this, a synthesis of substantive principles is proposed. It is also proposed that communities—rather than towns or cities—be acknowledged as the building blocks of sustainability. How then should a community be defined? Defining and demarcating communities based on people's perceptions and experiences of their spatial environments is proposed, leaning on the methodology of Image and Place studies. Recommendations for planning are made whereby it is hoped that Phuthaditjhaba could become its vision as a sustainable montane city in Africa.

Keywords

Phuthaditjhaba · Sustainable communities · Visioning · Backcasting · Imageability · Place studies · Eco-Districts Protocol · Urban planning

12.1 Introduction

Phuthaditjhaba is a remote montane city, located in the south-western corner of the Maluti-a-Phofung municipality in the Free State Province of South Africa. It is bordered by Lesotho, Golden Gate Highlands National park and the KwaZulu-Natal province (see Fig. 12.1). This chapter explores the planning of Phuthaditjhaba in a reference framework provided by the United Nations' Sustainability Development Goals (SDGs). This is done through a visionary

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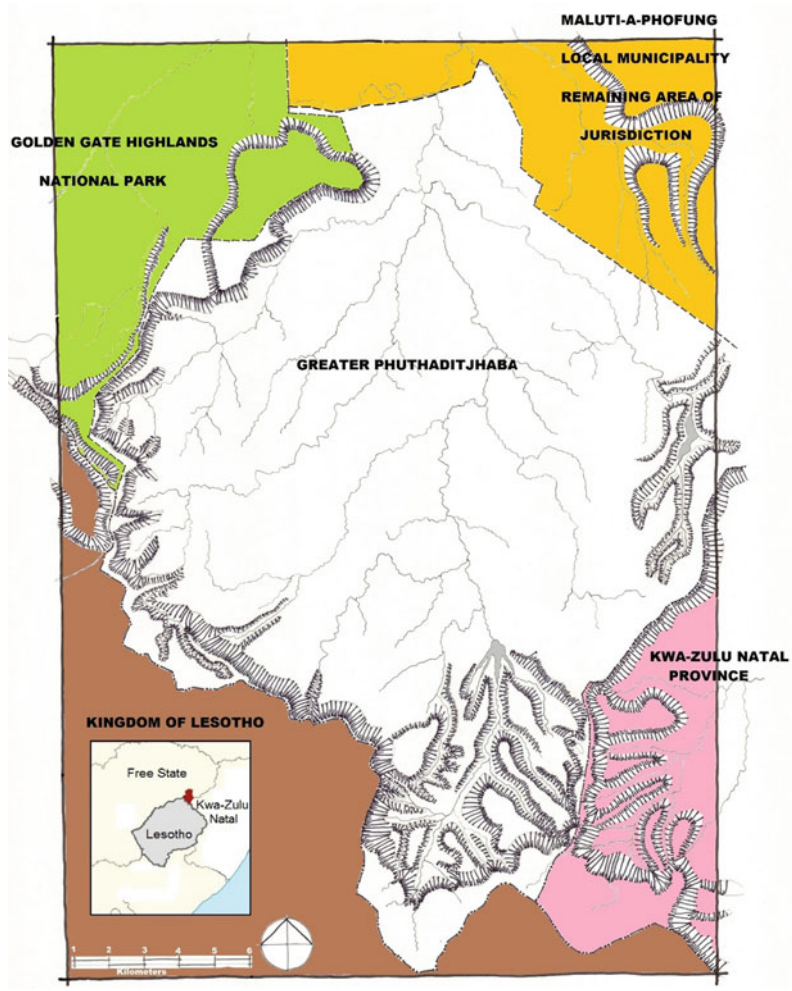

Fig. 12.1 Map showing the area of Greater Phuthaditjhaba and its surrounding administrative areas. *Source* Author[1]

imagining of Phuthaditjhaba as a sustainable mountain city, one hundred years hence. The vision will be brought to fruition through a tailored planning approach, focussed on sustainable communities.

The exploration begins with the formulation of a hundred-year vision and an explanation of the method used to draft the vision. There are, however, two impediments which can thwart attainment of the idealised vision, firstly, Phuthaditjhaba's geographical setting and socio-political dynamics and secondly, the existing planning regime. These two impediments are then unpacked, with a focus on the shortcomings of the current planning regime. The SDGs are then contextualised by a comparative analysis with three case studies (a sustainability rating tool, a municipal Spatial Development Framework [SDF] and a theoretical set of sustainability principles for community planning).

Thereafter—and flowing from it—substantive principles for sustainable communities are described and the case is made that sustainability must be tackled at a community scale; that sustainable communities must form the building blocks for city-wide sustainability to be attained.

[1] All maps drawn and rendered by the author. Settlement distribution gleaned from Google Earth, SA 1:50 000 topo-cadastral maps, the Phuthaditjhaba Spatial Development Framework (2013), various views in https://spisys.co.za/ and personal observations.

How such communities could be identified and spatially demarcated, follows. It is postulated that—in the fragmented urban conglomeration that is Phuthaditjhaba—communities based on spatial identity or image (vested in place), may be the appropriate method of identification.

Lastly, recommendations and proposals are made which should facilitate the planning of Phuthaditjhaba for the 2121-vision.

12.2 Vision 2121

Our vision for Phuthaditjhaba is described 100 years in our future, for the year 2121:

Phuthaditjhaba, the city of the warrior of the mountains. Maluti, Drakensberg and Red mountain ranges envelop the city. Ancestral land of the San, historical land of the Basotho, conquered land of the Boers, annexed by the British, now South Africa. All now living under the same crisp blue sky with snow underfoot in winter and verdant crops in summer. To tourists, space to roam, rocks to climb, rivers to raft, antelope to view, rock art to wonder at. Fresh water from the mountains to savour, indigenous flowers to appreciate, friendly, happy, industrious people to commune with.

The city is nestled in series of valleys, diverse with fauna and flora, consisting of compact communal villages surrounded by intensely cultivated fields and orchards. Natural capital has been restored to pre-colonial health, supporting a thriving tourism industry. Livestock farming has decreased significantly, now only practiced under strict control on veld with the appropriate carrying capacity. Crop farming has also decreased, but has intensified and inter-cropping is the norm: grains interspersed with indigenous marogo (a wild spinach) and herbs, rendering insecticides unnecessary. In general, organic agricultural practice is once again the norm. The functional urban areas are zoned according to permaculture norms, with intensive gardening, raising fowl (largely guinea fowl), small livestock, flowers and orchards surrounding communities. In the following concentric zone, grains are grown, interspersed with forestry and aquaculture. Beyond that is the wild, zoned and rotated for tourism, hunting and conservation.

Phuthaditjhaba is a service centre of high order, an educational, research, commercial and manufacturing hub, the latter intensely involved in beneficiation of the district's agricultural produce. Phuthaditjhaba does not import any of its food from external sources, with the exception of some luxury items.

The city is energy-independent. Fossil-free electricity is generated at source, from solar and hydro-electric: micro-hydro generating plants in the Namahadi, Kgotjwane, Metsi-Matsho and other rivers provide the base-load for the city. One hundred percent rooftop solar coverage was achieved in 2030 (made compulsory through a municipal bylaw enacted in 2025). A system of mini-grids was established throughout Phuthaditjhaba by 2033, fed by the solar and hydro schemes. Green hydrogen plants piggy-back on each hydro-electric generating installation: the water dammed by the weirs plus the abundant sunshine are the resources for the manufacturing of hydrogen, which is distributed via pipelines to the various hydrogen filling stations located in Phuthaditjhaba (similar to the 2010's practice developed in Freiburg, Germany).

The city's population growth has stabilised; the population is 100% literate with an 80% matriculation rate. The Gini-coefficient is 0.5. Birth fatalities have declined to 0.02% and the HIV-infection rate is zero. All households have security of tenure with fully serviced dwellings. Full employment reigns.

Each community is self-governing, with communal representation at city level for the governance of shared facilities, roads, tourism, disaster management and regional development issues.

The vision was given form by formulating and implementing a hierarchy of actions (translated from the SDGs). For instance, SDG 7 (affordable and clean energy) 'was attained' through the goal: energy-independence, which was taken from: No resource import (see the paragraph on sustainability principles).

1. No resource import
   a. Energy independence
      i. Mandatory roof-top solar for all new buildings from 2023.
      ii. Mandatory roof-top retrofit on all buildings by 2035.
      iii. Smart electricity meters installed for all users by 2025.
      iv. Demand-management programme in force by 2025.
      v. Micro hydro-electrical potential study to be finalised by 2022 and generation, operational by 2035.
      vi. Hydrogen-based generation feasibility done by 2022 and operational by 2030.

   b. Food-self-sufficiency
      i. Fallow public land to be converted (as garden allotments) into productive agricultural units by 2030.
      ii. Residents encouraged (through rates discounts) to cultivate back-yard vegetable/fruit gardens (from 2023 onwards).

The sustainability principles should be refined into achievable actions with dated programmes, as proposed by the bullet-points above.

Following this pattern, the vision is made operational via the hierarchy of goals. The further down the hierarchy, the more specific the goals become. For Phuthaditjhaba, the goals were formulated by local communities, assisted by planners. The SDGs were the frame of reference for the goals.

The reasoning behind such a long-term view is discussed in the next paragraph, wherein a vision for 100 years hence is formulated, employing the *Backcasting* method.

12.3 500-Year Planning

The limited time-frames held in both Integrated Development Plans (IDPs) and Spatial development Frameworks (SDFs—see discussion below on 'Impediments')- hamper longer term strategic planning. For sustainability to be effectively facilitated, longer timeframes must be held: at least 50 years but preferably 100 years. Tonn (1986) argues for a much longer time horizon than the norm. He says that even a 50 year time-frame cannot address issues which may become permanent problems. He argues for a 500-year time-frame because typical 500-year planning problems "…entail a causal loop that runs from society to the physical/natural system back to society" and are "…those that (1) take centuries to develop or show their full effects, or both, and (2) either take centuries to solve or require centuries of continued effort to forestall" (Tonn 1986, p. 187).

Problems which typically arise are of biodiversity and natural resource nature, such as: species extinction/biodiversity loss, climate change, groundwater contamination, soil erosion, surface water pollution and bush encroachment. Socio-economic issues include structural unemployment, poverty and intergenerational inequities. The structure of the local government management system may be inadequate to deal with change and need to be redesigned. Urban sprawl requires long-term solutions to be countered. Biophysical issues can and must be tackled with a 500-year view, but socio-economic problems have to be solved within a shorter time-horizon—arguably within 100 years. Longer-term strategies may become just too abstract to be of interest for the current generation to initiate.

IDPs and SDFs typically start off with a municipal vision and mission statement pre-formulated by officialdom. Mostly, the visions are nothing more than rhetoric and slogans, or even wish lists. They are seldom tied to a date or time-frame. In rare cases the envisaged future is twenty years hence, to run concurrent with South Africa's National Development Plan (NDP 2012) or the SDGs.

Robinson (2014, p. 85) declares that a development vision should be a statement indicating the long-term development path which a city would like to follow, including an idealised end-state. A well-stated vision is logical, has its roots in the present but reaches into the medium to long-term future, and provides an indication of

achievable steps. He also implies that the envisaged future will be longer than 20 years.

Tonn (1986, pp. 185–186) is of the opinion that because of the limited time horizon of our goals, added to the dearth of advocacy from any profession for very long-term planning, we will probably fail to ensure healthy habitats for future generations, nor will we be able to prevent environmental catastrophes—and he was writing almost four decades ago. Advances in science have shown the eco-climate crises to have exponentially worsened since Tonn's 1986 paper. Tonn does not try to predict the future with 500-year planning, but he proposes a framework whereby we should attempt to maximise human socioeconomic development. He says that we must set policies which target the critical systemic elements, such as the nature of economic activities. Tonn's proposal is not without some moral dilemmas. He recognises his dilemma, but at least he raises the issue that our planning time-horizon must be extended—beyond that of the current norm.

"The goals of 500-year planning are (1) to safeguard the physical/natural system for future generations and (2) to protect present and future populations from health and safety risks caused by misuse of the environment as well as from environmental catastrophes that would restrict the future human race by cutting off certain possible futures" (Tonn 1986, p. 186).

Such an approach requires a comprehensive (re-)formulation of a community's developmental vision, with much more substance than the standard, one-line slogans common to IDPs and SDFs. A visionary approach, formulated as part of The Natural Step (TNS) proposed by Cook (2004), is a method called 'backcasting'. In the process of *Backcasting* we formulate a future-oriented vision by placing ourselves in the future and imagining that we have achieved success. We then look back and ask the question: "How did we achieve this?" (Cook 2004, p. 39). Backcasting was used to formulate a proposed vision for the Thabo Mofutsanyana District Rural Development Plan by this author (2016). It is replicated here in amended format, tailored for Phuthaditjhaba. It is quite long (refer to Vision 2121 above), following Robinson's view (2009, p. 84) that typical defects of vision statements are the tendency to produce single paragraph visions, bland and devoid of substance.

12.4 Impediments to Planning a Visionary, Sustainable Phuthaditjhaba

12.4.1 Phuthaditjhaba's Geo-Socio-Political Regime

Phuthaditjhaba is not like many other cities: it has no identifiable centre, no higher-density districts, no 'older' neighbourhoods. The conglomeration collectively known as Phuthaditjhaba is the result of a merging of tribal villages and social housing tracts. See Fig. 12.2.

Under Apartheid, it was designated as the capital of QwaQwa, the 'homeland' of South Africa's seSotho-speaking people. Now Phuthaditjhaba is the seat of the local municipality, Maluti-a-Phofung (at 4338km^2, about two-and-a-half times the size of Johannesburg). Phuthaditjhaba officially refers to the formally established town: its various office and industrial areas, suburbs, shopping centres and public facilities. Over time, new formal suburbs were established adjacent to tribal land, interspersed with traditional villages. This aggregation grew together more-or-less as a non-city: no real centre and no sense of place. Gertrude Stein's derisive comment about suburbia in general, is apt here: "The trouble… is, whenever you get there, there is no there there" (undated). Phuthaditjhaba has no definite centre nor historical core, as one would expect from a city. The official central business district (CBD) is a mall in the vicinity of the municipal offices. Phuthaditjhaba is subsumed in this large municipal area, typified by a discrete urban landscape and different tribal and civic authorities vying for power. Given this context, emphatic, participatory planning is a

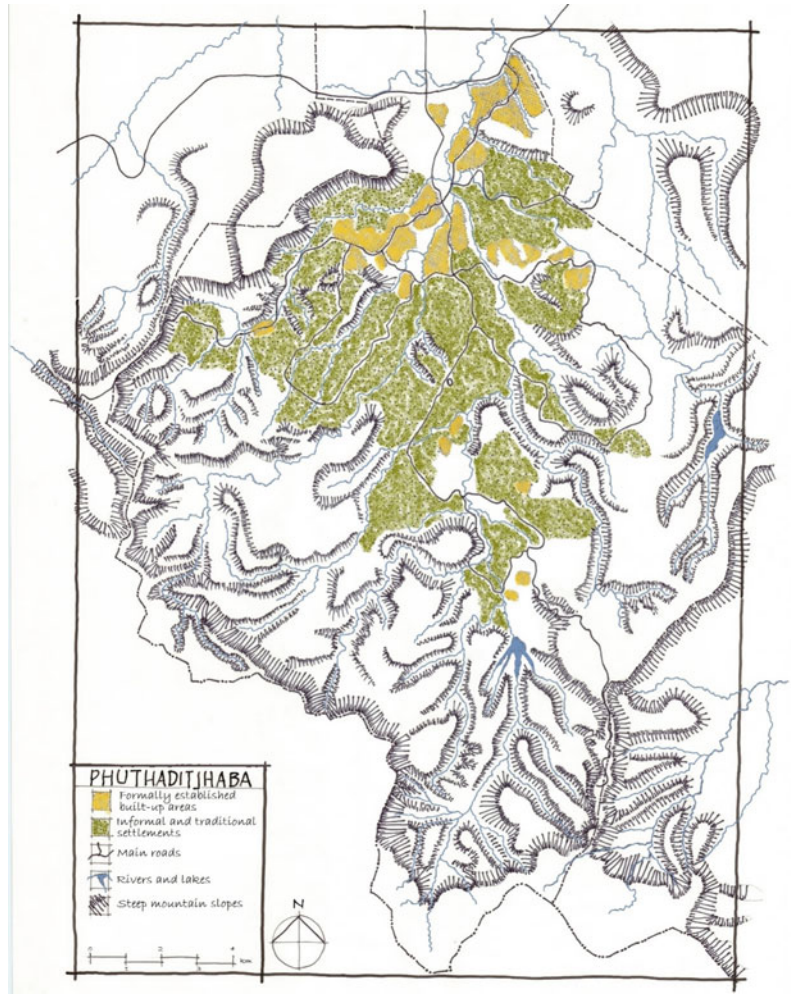

Fig. 12.2 A map of Phuthaditjhaba showing formally established built-up areas (yellow) and informal and traditional settlements (green). *Source* author

challenge. The question is: how can the uniqueness of Phuthaditjhaba be recognised and celebrated through planning?

12.4.2 The Current Planning Regime

South Africa's statutory base for municipal planning requires three legs: the Integrated Development Plan (IDP), Spatial Development Framework (SDF) and Land Use Schemes (LUS). The latter is not strategic in function and is not pertinent to this discussion. The IDP and SDF of Maluti-a-Phofung (MAP) local municipality is analysed with reference to the United Nations' SDGs—to ascertain how (and if) the IDP and SDF formulate strategies which could enable sustainable communities in MAP's jurisdiction, specifically in Phuthaditjhaba, in line with the SDGs. MAP's current SDF dates from 2013. The 2018–2019 IDP was analysed for this study, being the latest IDP available at the time of writing.

The current time-horizon for IDPs is five years: municipal IDPs are formulated every five years, during the inaugural term of office of a new council (De Lille 2017, p. 188) and reviewed annually. IDPs are typically *focused on the municipal budget*, not on actual development planning strategy. Spatial Development Frameworks also have a five-year time horizon, being the time-frame of statutory required review-

cycles. In practice though, an SDF is reviewed every eight-to-ten years. The time horizon for spatial planning trending and strategizing rarely extends further than twenty years. Furthermore, postulated alternative scenarios (in the Phuthaditjhaba case and generally) usually only cover two possibilities: current status quo extended and a high-growth scenario, with the latter usually chosen as the preferred.

The Maluti-a-Phofung's IDP starts off with rather typical vision-mission-strategic goals statements:

- Vision: "To be a sustainable, service oriented, tourist destination of choice" (IDP, 2018/19, p. 12).
- Mission: "To collectively provide sustainable and quality municipal services" (IDP, 2018/19, p. 12).

In Section B of the IDP (2018/19, pp. 36–38), the SDGs are listed but not prioritised, so one has to assume that all are regarded equally important for MAP. The spatial vision for MAP is noted as "An ecologically and socially sustainable urban and rural spatial development pattern focussed on providing quality livelihoods" (IDP 2018/19, p. 59). Other than these statements, the IDP does not elaborate on achieving sustainability.

With regards to the SDF, the Terms of Reference (ToR) for the consultants who were appointed to draft the SDF make no reference to the Millennium Development Goals (MDGs), which were in effect at the time. The term "sustainability" also does not appear in the ToR. To their credit, the consultants endorsed "sustainable development" as an underlying principle to their approach: "An integrated and holistic systems approach is necessary to ensure the long-term sustainability of development of the planning area." (SDF 2013, p. 15). This is reiterated in 'Strategic Interventions' (SDF 2013, p. 17).

The MAP SDF's definition of sustainable development is quoted from the Brundtland (1987) report (SDF 2013, p. 47). The goals of Agenda 21 is also quoted, stating that these are pertinent to the SDF (2013, p. 48). One of these is particularly relevant to this study: "Managing fragile ecosystems: sustainable mountain development", in reference to Phuthaditjhaba which is surrounded by mountains, and borders the uKhahlamba Drakensberg World Heritage Site and forms part of the Maloti-Drakensberg Transfrontier Conservation Area (TFCA) (Fig. 12.3).

Sustainable development is deemed important in the planning approach of the SDF, substantiated by references in its 'Growth & development pillars' (SDF 2013, pp. 56–57) to sustainable jobs and sustainable rural development. Subservient to that, the 'Drivers' in the SDF identify sustainable human settlements and tourism, as an oblique aside to the mountainous setting.

The stated scenarios (SDF 2013, Sect. 5.3 Development Strategies, pp. 352 onwards) are very much economy-based. The only reference to sustainability is made in scenario 2 ('High-Growth') and there it implies 'economic/financial' sustainability of the municipality. A 15 to 20 year time-frame is taken here. The 'economic growth' paradigm of the SDF is understandable, due to pressing poverty-related issues like unemployment. Economic growth is perceived as the solution to all problems. This is also evident in the *Strategic Objective 1: Economic development and job creation supporting and guiding development*, focussed on concentrating economic activities along movement corridors and diversifying the MAP economy (agriculture, manufacturing, transport, tourism, wildlife).

The SDF (2013, p. 397) does acknowledge the importance of the biophysical environment, as is evident by the formulation of *Strategic Objective 5: Protect biodiversity, water & agricultural resources*. The SDF for Phuthaditjhaba ticks all the boxes required by national, governmental and district spatial planning policies. It follows the set guidelines for 'sustainable spatial urban form' and addresses social, economic and biophysical concerns.

However, what the SDF does not do is acknowledge Phuthaditjhaba as a unique montane city with different characteristics and concerns than those of a non-montane city; it does not link the development strategies to the

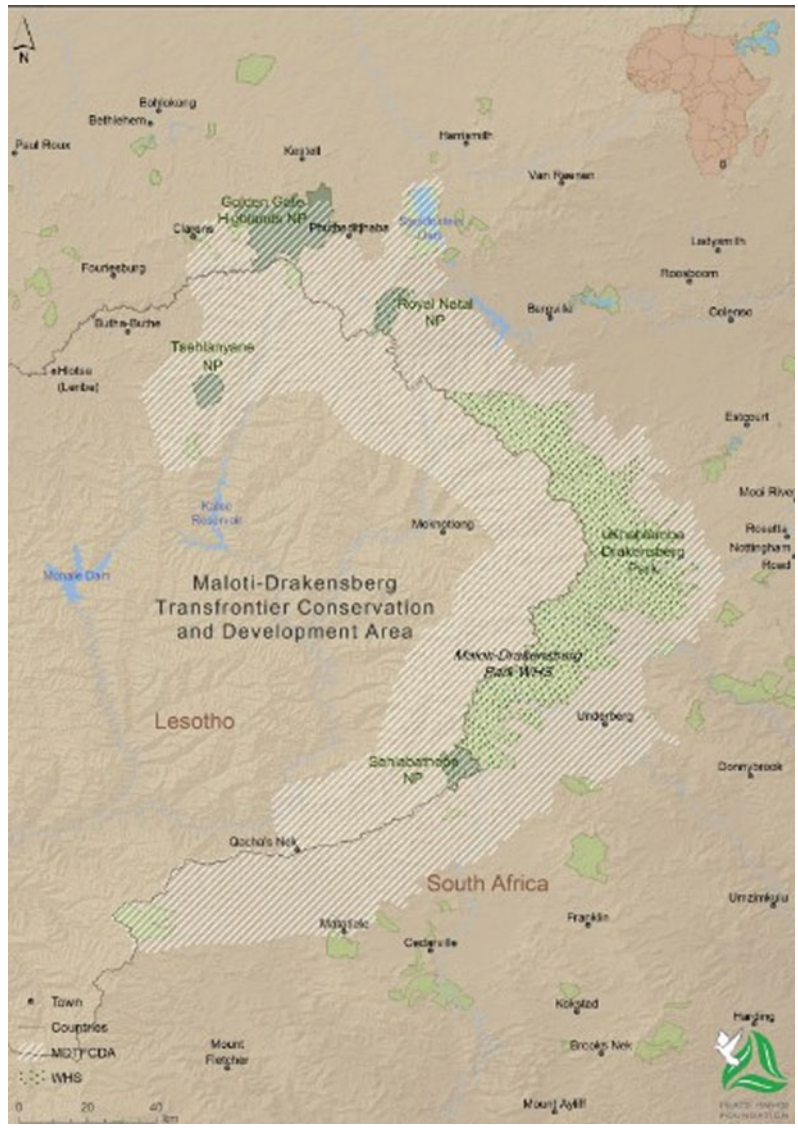

Fig. 12.3 Maloti-Drakensberg Transfrontier Conservation Area. *Source* https://www.peaceparks.org/tfcas/maloti-drakensberg/

Millennium Development Goals (reminder: this SDF was written before the SDGs were formulated) nor does it entertain the notion of sustainable communities (although it does allude to the enabling/support of communities via its call for the creation of precincts/neighbourhoods).

Issue has to be taken with the IDP's fixation on 'economic growth', which is grounded in a neo-liberal economic paradigm—not favoured in sustainability circles. The term 'economic development' is more apt: sustainable development's objective is not to enhance consumerism, but rather to ensure happy lives; not to attain an affluent lifestyle but rather to enhance the quality of life (Dresner 2008, pp. 74–80).

The special characteristics (if any) of a montane city need to be identified—how it differs from other cities with specific issues which apply to a montane city, but not elsewhere. Some characteristics and suggested solutions:

- Geomorphology: extreme slopes; erosion; challenging storm water management; less buildable space; concentrated settlements;

higher net densities; more natural areas; more obvious ecological corridors, thus more urban open space.
- Transportation: more onerous accessibility; difficulty for pedestrians/cyclists; alternative modes of transport (e.g. cable cars, funiculars); long commuting times. Solution: Promote localised employment to obviate the need for commuting.
- Services: the higher cost of infrastructure due to the difficult topography; Solution: localised water and sanitation mini-networks.
- Legibility: does the landform facilitate higher imageability or does the topography promote insular communities?
- Vicinity to catchment headwaters: maintenance of water quality is imperative. Solution: effective erosion prevention schemes.
- Mountain landscapes: Tourism opportunities abound thanks to spectacular landscape.

To recap, specific factors which can inhibit the planning of Phuthaditjhaba as a sustainable montane city are the lack of a long term view of its future, the challenging landscape, dispersed urban form and concurrent, discrete, socio-political context.

Given these existing impediments to planning for sustainability, alternatives to overcome—or rather replace—current practice must be found. In the following paragraph, precedents which point to better solutions are compared to the SDGs (to ascertain to what extent they comply). An alternative approach is then distilled from this comparative analysis.

12.5 Alternative Approaches for Sustainable Community Planning: A Comparative Analysis

The SDGs imply certain substantive traits inherent to communities which purport to be sustainable. To identify appropriate traits (and deduce substantive principles), three different approaches to sustainable community planning are compared to the SDGs. How they correlate with the SDGs and translate into principles of substance is then deduced. The three approaches investigated are: The EcoDistricts Protocol® (EDP); the Grabouw Pilot project* (Grabouw is a town in the Western Cape province of SA); and Herbert Girardet's view on sustainable cities.

The SDGs are discussed to establish a baseline, followed by EDP. Grabouw and Herbert Girardet are discussed very briefly (readers are referred to the sources).

12.5.1 UNDP's Sustainable Development Goals

The United Nations Development Programme's (UNDP) Sustainable Development Goals, 2015 (SDGs) is the beacon of this book. Seventeen SDGs were formulated in 2015, with the objective for humanity of attaining all by 2030.The focus of this book is SDG 11: Sustainable Cities and Communities. A critical look at the SDGs reveal that there are overlap and repetition, and differentiation between goals of substance and of procedure is not always clear. However, a proficient planning team should be able to view the SDGs through a montane filter and use the applicable SDG indicators in their planning analyses and proposals.

12.5.2 EcoDistricts Protocol®

Although the EDP is procedural in essence, it is based on substantive principles. It was developed to enable spatially defined districts to self-assess with regard to sustainability, with the aim of being accredited as sustainable urban districts. The Protocol requires complete buy-in by most (if not all) stakeholder groups within a district and it demands continuous participation during implementation of the Protocol.

For the Protocol to be initiated, it is mandatory for a district to commit to the three (sustainability) imperatives (EDP 2018, p. 8), namely Equity, Resilience and Climate protection. These three imperatives cover the whole spectrum of sustainability concerns. The Imperatives are

supported by six priority areas (EDP 2018, pp. 9–14), namely Place (create inclusive and vibrant communities), Prosperity (support education and economic opportunities that build prosperity and accelerate innovation), Health and well-being (nurture people's health and happiness), Connectivity (build effective connections between people and places), Living infrastructure (enable and connect to flourishing ecosystems) and Resource regeneration (work towards net positive energy, water and waste).

Each priority area consists of a number of objective categories. The performance of each of the objective categories and their subservient objectives are measured against the three imperatives. To follow the Protocol towards sustainability and certification, four steps are to be successfully completed by a district. These are: Commitment to the imperatives, Formation of a collaborative governance structure, Roadmap (a performance-based action plan—approved by EcoDistricts) and Performance (assessment and—if successful—certification). To retain certification, assessment must be successfully repeated every second year (EDP 2018, p. 15).

The Protocol sets specific targets, for instance, to become a net-positive district with regards to water, waste and energy. This is a measurable goal. The EDP was designed to be applied in existing communities. However, the Imperatives, Priority Areas and Objectives can be used by planners as guiding substantive planning principles for new communities. The EDP suggests that any sustainability drive must be community-based: initiated and managed. It cannot be steered (with any legitimacy) by outside, centralised or distant authorities or entities. For this reason communities with common purpose must be identified and then equipped to 'become sustainable'. For an EDP-type process to be successful in Phuthaditjhaba, we have to know who Phuthaditjhaba's communities are so that they can be empowered to become sustainable. The EDPs' imperatives and priority areas all align to the SDGs and are relevant for Phuthaditjhaba.

12.5.3 Grabouw Pilot Project

This study was conducted by the Development Bank of Southern Africa (DBSA) for the Theewaterskloof Municipality in the Western Cape, to formulate sustainability principles for developers who intend to invest in the town of Grabouw (for the sake of clarity, I refer to the study report as "Grabouw" instead of DBSA). The principles are as poetic as they are relevant. They all align with the SDG 11's objectives and they are relevant to the Phuthaditjhaba context:

> *Sense of justice*: means the meeting of fundamental human needs and participatory democratic governance.
> *Sense of limits*: renewable energy, zero waste, sustainable transport, construction and water usage.
> *Sense of place*: health, well-being, soulfulness, safety.
> *Sense of history*: cultural diversity, community, memory.
> *Sense of craft*: local economy, fair trade, equity, local food supplies, skills development.
> *Sense of nature*: reverence for life, biodiversity and preservation, ecological approach.
> (DBSA 2006, p. 26).

12.5.4 Herbert Girardet's Vision for "*Creating Sustainable Cities*"

Girardet (1999, p. 72) quotes Richard Rogers (1998), from *Cities for a Small Planet*. Therein, Rogers states that the sustainable city is:

- *A Just City*, where justice, food, shelter, education, health and hope are fairly distributed;
- *A Beautiful City*, where art, architecture and landscape spark the imagination and move the spirit;
- *An Ecological City*, which minimises its ecological impact, where landscape and built form are balanced and where buildings and infrastructures are safe and resource efficient;
- *A Creative City*, where open-mindedness and experimentation mobilise the full potential of

its human resources and allows the fast response to change;
- *A City of Easy Contact and Mobility*, where information is exchanged both face-to-face and electronically;
- *A Compact and Polycentric city*, which protects the countryside, focuses and integrates communities within neighbourhoods and maximises proximity;
- *A Diverse City*, where a broad range of overlapping activities create animation, inspiration and foster a vital public life.

So, to glean the substantive principles required to guide communities towards sustainability, one needs to look wider than SDG 11, and even wider than all the SDGs. From this discussion and other studies, I have identified nine principles of substance for sustainable communities. These are described below.

12.6 Sustainable Community Principles

The substance of sustainability is that it has to nurture the triple bottom line—the *environmental*, *social* and *economic* domains. The sustainability requirements for each domain are (somewhat edited from the original description in *Urban Green File 2007, pp. 18–23*):

12.6.1 Environmental Principles

A healthy environment is in homeostasis—the rate of entropy is slow. A healthy ecosystem is diverse, non-polluted, non-compromised by invaders, generates enough energy for own use and recycles its waste as resource for the next metabolic level. In this scenario, natural capital is preserved. The same must apply to our making of habitats.

The first principle is Diversity. A prerequisite for healthy natural capital is an ecosystem which maintains the highest possible level of biodiversity. All human activities (extraction, construction and operation) must follow a nurturing programme to retain and restore ecological integrity and biodiversity. The level of local biodiversity must be ascertained during the planning process and benchmarks set, as is prescribed by the EDP. Grabouw calls it: 'Sense of Limits' and 'Sense of Nature' (DBSA 2006, p. 26). Girardet calls it 'Ecological City' (1999, p. 72). SDG 15 is the corresponding goal, but diversity is also addressed by SDGs 6, 7, 11 and 13.

The second principle is Zero Waste. Waste is actually a resource (Girardet 1999, p. 35; McDonough 2002, pp. 92–116). No waste must leave its source. Sewage and garden waste can become energy and compost. Solid household and commercial waste are (re)- manufacturing resources. The only waste which may be exported from source is hazardous waste—on condition that it be de-contaminated. EDP's priority areas of 'Living Infrastructure' and 'Resource Regeneration' apply. The corresponding SDGs are 3, 6, 7, 9, 11 and 15 but these SDGs do not specifically address the principle of zero waste. Zero waste corresponds to Grabouw (2006, p. 26) and Girardet (1999, p. 72) as above.

Principle three: No Resource Import. Every place has some local, in situ natural resource which must be identified for potential utilisation: a clay or a dolerite deposit, good agricultural soil, a wetland, a forest, etc. Local natural resources (natural capital) must be used prudently. In fact, development must be limited to the supply available:

- *Energy*: a demand management programme must be entrenched. Local energy generation lessens demand from the grid. Solar, wind or bio-generation of electricity should be *de rigueur* in every settlement. Passive architecture, solar water heating and rooftop photovoltaic panels must be mandatory. Communal mini off-grids or grid-feed-in must become the norm for electricity provision in settlement development.
- *Water:* South Africa is a water-stressed country. There is no logic behind our use of potable water for the flushing of sewage. Conversion to eco-sanitation alternatives,

rainwater harvesting and grey water systems must be mandatory. Storm water must be ecologically managed. Water-wise gardening must be practised in all public spaces and encouraged in private gardens. Bulk potable water demand will decrease dramatically if all these water management metrics are implemented.
- *Local materials:* for building and for manufacturing (crafts), etc.

No SDG specifically prohibits *resource import* but it is sometimes implied. This principle corresponds to Grabouw's 'Sense of Craft' and 'Sense of Limits' (2006, pp. 26), Girardet's 'non-importation' (1999, pp. 27–46) and EDP's 'Resource Regeneration' and 'Living Infrastructure' (2018, pp. 13–14).

12.6.2 The Social Principles

A resilient community is one which is diverse, safe, healthy, equitable, identifies with place and controls it.

Diversity (again—a continuation of principle one): the opportunity must be created for a variety of income groups to settle in a community, *inter alia*, to prevent the creation of ghettos. A variety of housing, tenure types and mixed land uses will provide support. To be a socially vibrant and economically viable community, people from all walks of life have to reside there.

Principle four is Safety and Health. It includes a healthy habitat: through zero waste and care for the environment, pollution will be prevented, ensuring clean air, water and soil. It will entail crime prevention by designing against it. A locally employed community is a resident community, imbuing the public domain with high levels of informal surveillance. For surveillance to be effective as crime-deterrent, the public domain must be well-made: visible from private domains, with a clear and permeable interface between public and private. This is facilitated by street-oriented buildings (perimeter-block built form) as opposed to pavilion-type buildings. Traffic safety also comes into play. Because commuting will be minimised, traffic volumes and peak-hours will be much less pronounced than currently, making streets friendlier for pedestrians, cyclists and children. Streets must be redesigned for non-auto activities. Lastly, under principle four is the issue of natural hazards. Flood lines must be respected, wetlands avoided, fire-breaks made; storm water systems maintained, etc.

Principle five is Equity. Five distinct types of equity are relevant here: Generational equity, which is probably the most overlooked aspect of community planning. In modern society the elderly is seen as superfluous. A sustainable community will facilitate participation of the elderly in communal life. Public places are designated for them to control and socialise in. The needs of children must be met by ensuring healthy, stimulating and safe playing facilities, explorable nature, places for socialising (hanging out), well-placed and accessible creches. Secondly is Gender equity—which is facilitated by ensuring equal opportunity for all genders to actively participate in community activities. Thirdly, care for the Handicapped. The public domain must be designed to ease access and movement for all manner of disabled persons. Institutional support programmes should abet communal care for the disabled. Fifthly, Land Tenure: Land occupancy must be made secure for all through provision of the full range of tenure types (full title, sectional title, leasehold and rental). Lastly, Access to facilities, schooling, training, nature and quietude adds to an equitable habitat.

Principle six: No Resource Import—nurture local social resources, such as Labour. The people who (are to) live in a (new) settlement must form the core of the labour pool. Training of the local labour force must be obligatory. Secondly, local knowledge and wisdom -local expertise and knowledge of crafts, the terrain, customs, traditions, symbols and the arts must be employed during planning and nurtured for the operational phase of the settlement.

Principle seven is Local Control. The ability for people to control their home environment is crucial. They must be able to influence the

creation and management of their own habitats. Structures must be put in place whereby a local "Community Council"—accountable to the community and participated in by them—runs the local show, with delegated powers on all matters local. Such a council will be subordinate to City Council on wider urban matters, but City or regional councils may not overrule community councils on local matters.

Principle eight is Identity. The city and all community settlements' spatial structures must be legible and imageable. "…if the environment is visibly organised and sharply identified, then the citizen can inform it with his own meanings and connections" (Lynch 1960, p. 92). Spatial planning can foster identity, reinforced by a hierarchy of visual clues: landmarks, nodes, edges, gateways and channels of circulation. However, place's special qualities must be 'discovered': informed by ancestral graves, archaeological and symbolic artefacts and places or unique natural features. These elements must be incorporated into the design with the purpose of imbuing a unique sense of place. *Genius Loci* (spirit of place) is the embodiment of the quality of the whole place. A site's *genius* has to be respected and celebrated in design. People want to identify with *loci*. If (their) *place* is special, people develop pride in it and care all the more for it. Spatial identity fosters communal identity.

The SDGs which are achieved under the 'social' heading are numbers 3,4, 5 and 11. Grabouw's 'Senses of Craft, History, Place and Justice' (2006, p. 26) are all addressed, Girardet's 'Culture' and 'Participation' (1999, pp. 70,71) are attended to and the EcoDistrict Protocol's priority areas of 'place, prosperity, health and connectivity' (2018, pp. 9–12) are satisfied.

12.6.3 Economic

The economic paradigm followed here is vested in Aldo Leopold's *Land Ethic* (Leopold 1949). Following from that, *Natural Capitalism* (Hawken et al. 1999), propose an alternative paradigm about the modern economy. It emphasises services rather than goods, zero waste and replenishing the earth's natural capital (those environmental services which we take for granted and for free but which is becoming finite: clean water, fresh air, biodiverse ecosystems and healthy topsoil). The *Steady-State Economy* of Herman Daly (in Dresner 2002, pp. 28, 29) set the foundation for the concept of the *Circular Economy,* currently vying with Neo-Liberal Capitalism for our future. The stated intention here is to preserve Phuthaditjhaba's natural capital within a socio-economic scenario of full employment with zero waste.

Local, diverse economic base (economic version of principle one):

Every community must be regarded as an independent entity (albeit part of a larger entity such as a city or region). It follows that such an entity should have an economic reason for its existence—it must be economically viable, otherwise it is parasitical. An economic base should preferably be based on the primary sector (agriculture, forestry, fisheries or mining). A concerted effort must be made to identify natural resources for the creation of a fledgling primary sector. The aim is to 'grow' the local economy, eventually to include all sectors. This underpins—yet again—the notion of *diversity*. A local, community economy will obviate the need for commuting. Eliminating the need for commuting is imperative to attain sustainability.

Local control (economic application of principle eight):

"Central…is the need to identify and optimally utilise the comparative advantages of the … area. Based on these comparative advantages, economic development opportunities can be identified. Furthermore, sustainable development requires specific institutional capacity. For the development process to be successful, communities must have capabilities to manage and maintain their own development programmes. This capacity must be structured and channelled into community institutions" (Urban Econ 2007). The importance of local, communal control over a local habitat and resources cannot be stressed enough.

Under the heading of 'Economy', the following SDG's are satisfied: 1, 2, 8, 11, 16 and

17. The EcoDistrict Protocol's 'Prosperity and Resource Regeneration imperatives' are satisfied (2018, pp. 10, 14); so are Girardet's 'Non-importation of Energy' and 'Popular Participation' (1999, pp. 43–46, 71) and Grabouw's 'Senses of Justice, Limits, Craft and Nature' (2006, p. 26).

Lastly, principle nine is taken directly from Girardet: a Compact and Polycentric Urban Form, especially relevant for Phuthaditjhaba: communities will live in compact villages or neighbourhoods, separated by ecological corridors to protect the countryside (and natural capital). Population growth should be accommodated in a combination of prudent densification and the establishment of new communities, to form a polycentric greater Phuthaditjhaba. This pattern of built form will also be better suited to this landscape.

12.7 The Principles Summarised

In essence, sustainability is about *demand management*: demand for energy, water, material, land and capital. By reducing users' demand on resources, the cumulative demand (pressure) on bulk service delivery is reduced, with consequent reduction of capital and maintenance costs. Through reduction of pressure on resources, entropy is slowed down; less energy is embedded in the process of the creation and maintenance of human habitation.

The modern, motorised society is so structured and biased against sustainability that an extraordinary change of mind-set has to happen to facilitate sustainable communities. We will have to accept drastic changes in lifestyle and a much more prudent usage of resources.

Nine substantive principles for sustainability have been identified. If applied appropriately, sustainable communities should be the outcome:

1. Diversity (biophysical, social and economic)
2. Zero waste
3. Local economic base
4. No resource import
5. Safety and health
6. Equity
7. Identity
8. Local governance
9. Compact and polycentric urban form

Once communities in Phuthaditjhaba have been identified and co-opted in the planning process, these principles must be workshopped with them. Every community must be capacitated to eventually become proficient with the principles and implement them in a system equating the EcoDistricts® Protocol model. The vexing question now arises: how do we identify these communities?

12.8 Identifying Communities

It appears from the discussion so far that planning for sustainability on a city-wide scale will probably not translate into success. The most appropriate approach would be from the bottom, up; from individual community scale, to groups of communities (tribes and urban districts), scaled up to the city as a whole. The identification of communities who would be able (and willing) to act in concert is imperative as the first step in the planning process.

It is my opinion that few residents of Phuthaditjhaba identify with it as a 'place' and few regard it as a city; people rather identify with their local, spatially-specific community. If so, it will facilitate sustainable community planning—two of the prerequisites for sustainable communities actually require that a community identify itself spatially as such, so as to enable self-government. It is also essential that actual communities be spatially identified so that metrics for the measurement of levels of sustainability can eventually be established. Identifying (and demarcating) a community in space may be attempted in a manner of ways:

- assume man-made boundaries such as highways or railway lines as defining elements of the community space;
- use tribal area boundaries (in this instance it will only provide partial answers, for large parts of Phuthaditjhaba lie outside the

traditional tribal areas and some tribes will consist of more than one community);
– conduct image and place studies, based on the perception of residents, to identify perceived community spaces.

Image and place studies have been used in the past to determine the legibility of cities, to formulate strategies for urban design and to discover what please city-users visually and experientially (Lynch 1960; Appleyard 1976; Appleyard et al. 1964; Hester 1985; van Biljon 1986).Image studies attempt to describe how people visualise, conceptualise and eventually understand their physical habitats. "Imagebility: that quality in a physical object which gives it a high probability of evoking a strong image in any given observer" (Lynch 1960:9). This approach was introduced to the city planning world through Kevin Lynch's seminal work, *The Image of the City*. "Image (and place) studies… focus on the physiological, psychological, and social dimensions of environments as they are used and experienced by people, and on how those do or should shape design and design solutions" and "…how people use, like, or simply behave in given environments" (Vernez-Moudon 1992: 339, 341).

To reiterate: the first prerequisite for a community to be or become sustainable is that it should have a distinct identity, a uniqueness which differentiates it from other communities, a trait or special place, something tangible or intangible as a common denominator amongst members. Surely some communities in the greater Phuthaditjhaba will have sense of identity with their local place of residence. This can be investigated, hopefully discovered and then 'defined'. A common denominator may be discovered and applied to create an image of greater Phuthaditjhaba, as a gathering of communities. If such an image does not yet exist, one objective for planning then becomes to facilitate the emergence of one or more group images: "It is these group images, exhibiting consensus among significant numbers, that interest city planners…" (Lynch 1960, p 7). Lynch, et al. (1976), Hester (1985) and this author (1986) all used variations of imageability and place studies to ascertain residents' urban image: group interviews were conducted after individuals in the groups were asked to draw mental maps of their living spaces.

These were combined with notations of image evoked in trained observers in the field. It is proposed that similar studies be conducted in Phuthaditjhaba (adjusted to purpose) so as to discover the 'city's' image and identifiable communities. It is hoped that a clear picture emerges on how to link community with place in Phuthaditjhaba. Not only should it assist in spatially defining communities, but it should also give insights into temporal characteristics of Phuthaditjhaba which would otherwise not even be known. These insights will be of incalculable value in the planning of Phuthaditjhaba. "People can and do rebel against imposed environments by refusing to use them as intended…. For environmental professions such differences in perception and production are serious matters. They can unwittingly plan aspects of the environment that have no relevance to the population, while ignoring aspect that are critical" (Appleyard 1976, p. 2).

It is proposed that the planning process of Phuthaditjhaba be preceded by select image, place and environment-behaviour studies (IPEBS). It is expected that the outcomes will provide planners and decision-makers with a formidable palette of information to inform spatial planning of Phuthaditjhaba.

The methodologies chosen for the IPEBS should be geared to the identification of communities of and in Phuthaditjhaba, as should the choice of respondent groups. For instance, we need to know what the perceptions and experiences of women, as opposed to men, are. The same apply to different age groups (with special attention to the elderly and youth). The geographic distribution of certain groups and tribes have to be identified. One could also differentiate between economic status. The content of interviews will have to be carefully tailored, so as to generate responses related to the identification of community space and social space. During group interviews, respondents will be requested to draw

their city or living environment, to add as much detail as they can and to describe everything on the actual sketch. Interviewers must not ask leading questions but may ask questions for clarity and suggest added descriptions. Respondent groups must be chosen to share similar or common characteristics, such as age, gender, home location, occupation, etc. The interviewers have to be pre-trained and well-informed about the area and they must speak the same home language as the respondents. It is suggested that local University of the Free State geography, anthropology and/or sociology students be trained and deployed as interviewers, supported by the town planners. The information thus gathered will then be interpreted by the planners. From recorded and interpreted responses, actual socially cohesive communities could hopefully be identified and spatially demarcated. These demarcated communities should then (eventually) become the building blocks of local government, i.e. voting wards, planning districts and administrative units. The spatial and temporal characteristics of community space so identified must inform planning and management of the sustainability process.

In the illustrated Image-Community map (Fig. 12.4), many assumptions were made by the author- it cannot be regarded as valid, but it does illustrate how such a map can eventually look. It

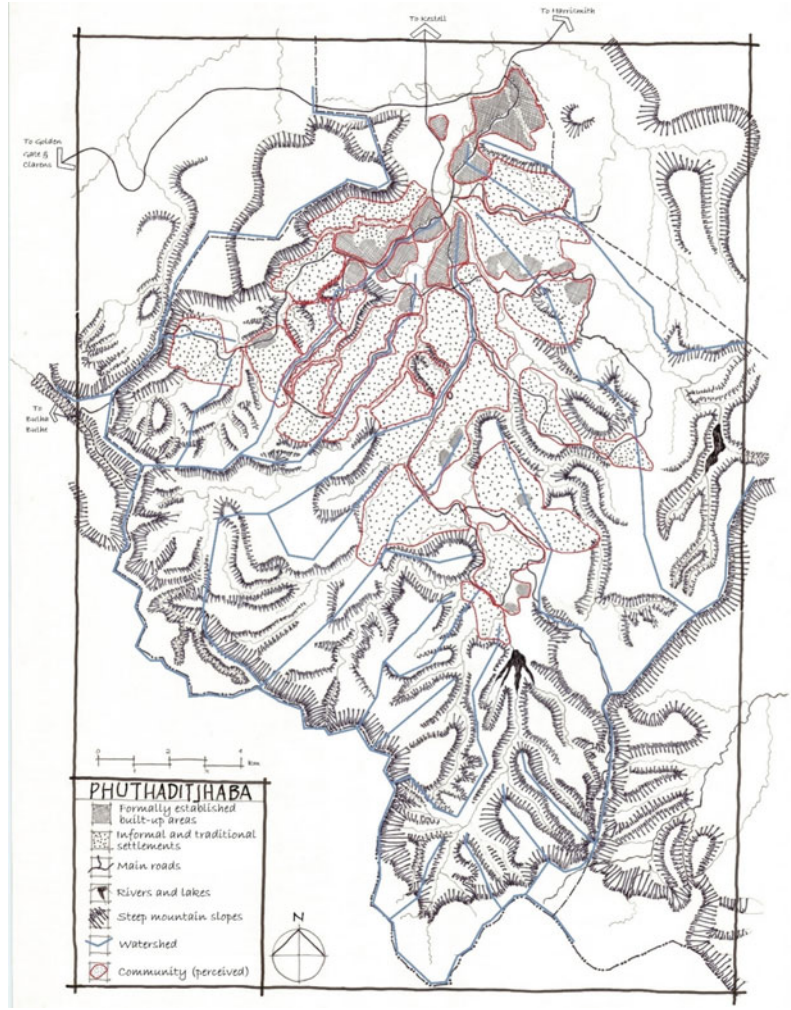

Fig. 12.4 Example map showing potential delineation of communities in Phuthaditjhaba according to imageability and tribal boundaries. *Source* author

is assumed, for the purpose of method, that the communities thus identified (delineated in the map with red border lines) will be used as the socio-spatial entities required for planning purposes. The writer's ad-hoc delineation was done by employing a combination of geographic features and image elements, as were used by Lynch and Appleyard in their studies in 1960 and 1976. The 'perceived' community boundaries was assumed to be formed by edge-elements, such as main roads, rivers, ridges and watersheds (the latter two forming visual termination lines of built-up areas). In a few cases, nodes or single-use areas (such as the 'government hill' and industrial areas), were assumed to form strong visual centres of their resident communities. In many of the informal areas, purely social attributes (such as tribal affiliation) were assumed to determine spatial cohesion.

Image/place studies hold promise as methodology to identify communities. It is proposed that the communities of Phuthaditjhaba be identified via this method.

12.9 Recommendations for the Planning of Phuthaditjhaba's Sustainable Future

Phuthaditjhaba's communities must be identified and spatially demarcated. Imageability/place study methods is proposed for this, using the local campus of the University of the Free State as the appropriate research institution. Once communities have been identified, they must formulate visions and objectives for their communities and city as roadmap to a sustainable future. The vision and objectives must satisfy the nine substantive sustainability principles. The EcoDistricts Protocol®-process should be followed in vision and goal formulation, guided by in-depth analysis of the biophysical and socio-economic status of Phuthaditjhaba: '500-year and 100-year challenges' must be identified and addressed in the planning strategy eventually formulated.

Issues which must be attended to are:

- water catchment management;
- grazing and erosion control;
- eradication of invasive alien vegetation;
- localised employment must be maximised; so that
- the need for commuting can be eliminated;
- the rewilding of nature, so as to;
- optimize tourism potential (Phuthaditjhaba as outdoor adventure tourism destination);
- energy and food self-sufficiency; and
- community self-governance.

If these issues are successfully addressed, Phuthaditjhaba as mountain city will be celebrated and—over time—become a place with a special spirit. Spatial planning worries over sprawl, traffic jams, local economic underdevelopment, inequitable communities, polluted ecosystems and general, population unhappiness will be nightmares of the past. However, given the current local government dynamics, the political sphere will probably be the most difficult arena to conquer. Some changes to the municipal statutory edifice will be required to enable this change in approach from magnum, central municipal governance, to local, communal determination.

Hopefully, when every individual community in Phuthaditjhaba has a celebrated living space, the composite may form a city with image and character. A 'there' when we get there…

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Conclusion

13

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Abstract

In the conclusive chapter we underline that—in line with UN Agenda 2030—many research funding bodies now require researchers to explicitly address the United Nations Sustainable Development Goals (SDGs) in their research design. Consultations with scientists and practitioners in Phuthaditjhaba during research for this book highlighted that the SDGs still do not currently have a prominent role in the scientific research in the region. Nevertheless, throughout this collective volume they have provided authors with an important reference point which helps frame local research in a global agenda. Mountain communities are often especially challenged by increased exposure and vulnerability to global change including climate change, and there is a need for on-going research to highlight local adaptation and mitigation strategies. These communities need to be recognised as partners in research, policy and decision-making processes. While the UN SDGs can be used as a roadmap towards a more sustainable future, this depends on their application by scientists, practitioners and policymakers at local level. The ongoing European-South African research partnership which produced this publication will continue providing a space for co-learning on data collection and analysis methods, within the theoretical framework jointly defined. Only with close collaboration between scientists from multiple disciplines, policymakers and civil society will a sustainable future for this African mountain city be possible.

Keywords

African mountains · SDGs · South-North scientific cooperation · Multidisciplinary approach

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In line with UN Agenda 2030, many research funding bodies now require researchers to explicitly address the United Nations Sustainable Development Goals (SDGs) in their research design. While the SDGs have a global dimension, their application at local research, policy and

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implementation levels can appear abstract. Consultations with scientists and practitioners in Phuthaditjhaba during research for this book highlighted that the SDGs do not currently have a prominent role in the scientific research in the region. That is to say, many researchers were not familiar with the goals and few had previously used them to guide research design, instead applying a multitude of other national and international frameworks as is evidenced throughout this book. Nevertheless, throughout this book they have provided authors with an important reference point which helps frame local research in a global agenda. The development of this book provided an opportunity for exchange amongst all its contributors and thus the transfer of tools and concepts to advance research in Europe and southern Africa. This book therefore represents a first crucial step towards a more meaningful incorporation of the UN SDGs in southern African mountain research.

The Agenda 2030 process recognizes that each country faces specific challenges in implementing sustainable development and achieving the United Nations Sustainable Development Goals. While each country has the primary responsibility for its own economic and social development, achieving sustainable development does not occur only at a national level, but must occur at all levels of governance from international through to individual communities. For developing countries, at both the national and local levels, efforts should be directed towards mainstreaming SDG-related issues in development and strategic planning agendas. It is understood that developing countries need additional resources for effective and meaningful sustainable development and that there are challenges in finding mechanisms to provide this type of funding. Research can help to highlight areas where investment can have impact.

Fortunately, Phuthaditjhaba has the University of the Free State QwaQwa campus, with its local and international partners, to champion research that is deeply local.

Mountain communities are often especially challenged by increased exposure and vulnerability to global change including climate change, and there is a need for on-going research to highlight local adaptation and mitigation strategies. Local communities need to be recognised as partners in research, policy and decision-making processes. For these communities, actions to create sustainable development include innovative locally-embedded initiatives, policies and governance models, tailored to the specific challenges of mountain regions and the multidimensional processes of sustainable development. This is the same in South African mountain communities like Phuthaditjhaba.

While the UN SDGs can be used as a roadmap towards a more sustainable future, this depends on their application by scientists, practitioners and policymakers at local level, as Buschke et al. underline in Chap. 3. The SDG model relies on the availability of data to measure indicators of sustainable development. However, despite the presence of the QwaQwa campus of the University of the Free State and growing interest in research in Phuthaditjhaba, baseline socio-economic, environmental and climate data is incomplete. This would be a first major information gap to fill in order to move towards an SDG-focussed approach to sustainable development and related research in Phuthaditjhaba. Baseline data would allow for the periodic assessment of development in the city as well as allow for future scenario modelling. Alternative data sources could also be identified and exploited, for example satellite imagery and remote sensing to estimate population growth (see Box 2: Phuthaditjhaba: urban fabric and population figures), and qualitative data could be used to respond to some gaps in quantitative data. The ongoing European-South African research partnership which produced this publication can provide a space for co-learning on data collection and analysis methods.

Land use and land degradation in and around Phuthaditjhaba are frequently cited in this book as key topics for sustainability planning of the city. However, two chapters cite SDG 2 (Zero hunger) although neither of these connect it explicitly with SDG 15 (Life on land), which perhaps indicates a research gap that links food insecurity together with land use. Food insecurity continues to be an important societal challenge in

Phuthaditjhaba. It has increased due to COVID-19 and is predicted to increase further due to rising temperatures and changing precipitation patterns (Mukwada et al. 2020). Tackling food insecurity in Phuthaditjhaba will require innovative strategies that make efficient use of the city's financial, technical and environmental resources. In an area whose economy was traditionally agriculture-based and where most homesteads have small gardens, research into the improvement of urban vegetable gardens could be an important contribution to sustainability solutions.

Chapters 4 and 6 describe the difficulties in larger-scale agricultural production in an area of increasing rainfall variability, drought and erosion. However, Adelabu & Franke (Chap. 4) also highlighted how agricultural production could be made more efficient with increased technical expertise and agricultural inputs.

Climate change will exacerbate existing vulnerabilities of the city, while an expanding population increases the exposure of people and infrastructure to climate risks. One of the greatest challenges in Phuthaditjhaba is water availability and quality, with SDG 6 (Clean water and sanitation) being the second most cited SDG in this book. As Sekhele & Otomo underline in Chap. 6, the city suffers from chronic water shortages despite being located in one of southern Africa's principal water producing areas. Water shortages are predicted to worsen due to increased temperatures and more frequent drought due to decreased rainfall reliability (Mukwada 2022). Repair, improvement and expansion of water infrastructure is urgently needed to respond to water shortages that have been affecting the city for many years. Chapters 5 (Mukwada & Mutana), 6 (Sekhele & Otomo) and 7 (Mocwagae & Mphambukeli) explain the context in which these shortages occur. Mocwagae & Mphambukeli (Chap. 7) present the 2019–2020 water crisis as having its roots in the inequality engineered through apartheid and as being misrepresented in the media as an unexpected and singular event, when in fact water scarcity has been an ongoing issue for decades in Phuthaditjhaba. Sekhele & Otomo (Chap. 6) maintain that climate change presents a major challenge to Phuthaditjhaba's water supply. However, Mukwada & Mutana (Chap. 5) warn against attributing water issues solely to climate change and argue for greater scrutiny of planning and management at a municipal level. Their findings show that water security is at the intersection of multiple interrelated SDGs and is central to managing issues of environmental integrity, social equity and the local economy. In order to link research with SDG monitoring, data on water production and demand is urgently needed. This data would aid better planning to address issues of water scarcity and allow scenario modelling which would inform policymakers on how best to prepare for decreasing or variable water supply in future.

The food and water security situation in Phuthaditjhaba is a key factor driving outmigration from the city. Anecdotal data suggests young people in particular are leaving the city in search of employment and a better quality of life. It is hypothesised that this outmigration is changing the demography of the city but there is little research on population dynamics and baseline data is incomplete, particularly on population (see Box 2: Phuthaditjhaba: urban fabric and population figures). Official national statistics vary from unofficial estimates proposed by local researchers. In addition, the population is in constant flux with the arrival and departure of economic migrants both documented and undocumented. The planned 2022 national census will to some extent address this data gap, although the presence of undocumented or highly mobile residents, together with resource constraints in data collection and analysis, remain a challenge to the accuracy of data collected.

The impact of climate change on Phuthaditjhaba is also under-researched and suffers from a paucity of data. The city is however served by one weather station with four others located within 30 km. Furthermore, a planned Long-TermSocio-Economic Research (LTSER) site will monitor ecological and anthropogenic changes in the mountain headwaters of Phuthaditjhaba's watershed. This LTSER site is spearheaded by the Afromontane Research Unit of the

University of the Free State with support from the Global Mountain Safeguard Research (GLOMOS) Programme and South African Environmental Observation Network (SAEON). Long-term monitoring and research is necessary to understand the interactions of hydrological and social-ecological systems in the region and thus develop effective water management policy, and in so doing help address the water scarcity issues affecting so many of Phuthaditjhaba's inhabitants. Further adaptation measures, such as the urban greening explored by Taylor in Chap. 10, can offer some solutions to the future challenges associated with increased temperatures in the urban area.

Greater reference to SDG 10 (Reduced inequalities) would be useful in research endeavours, considering the historical context of apartheid and the persistent inequalities, both local and global, that dictate the lives of many in Phuthaditjhaba. Further research could tie this with SDG 16 (Peace, justice and strong institutions) by investigating the role of dual governance (democratic and traditional) in either tackling or reproducing social inequalities in Phuthaditjhaba. Similarly, SDG 10 could be interwoven with SDG 4 (Quality education) and spur an investigation into the role of the two higher education institutions present in the city, the University of the Free State QwaQwa campus and the vocational Maluti TVET college, as well as the vocational school Seotlong Agriculture and Hotel School, in giving young people access to opportunities.

This book has showcased the current research in Phuthaditjhaba and in so doing highlighted key research gaps that need to be addressed to develop locally-embedded science and thus inform policy making. The writing process provided opportunities for exchange, discussion and learning amongst all contributors and helped establish and foster fruitful research partnerships. There are many facets of sustainable development in Phuthaditjhaba that still need to be explored, and the SDGs have an important role to play in guiding future research, policymaking and implementation by linking local issues to global structures. Only with close collaboration between scientists from multiple disciplines, policymakers and civil society will a sustainable future for this African mountain city be possible.