Mainstreaming

Climate Change in Urban Development

LESSONS FROM CAPE TOWN

EDITORS: Dianne Scott, Helen Davies and Mark New

Mainstreaming Climate Change in Urban Development

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List of acronyms

ACC	African Centre for Cities
AIDS	acquired immunodeficiency syndrome
APO	annual plan of operation
BioNet	Biodiversity Network
BNG	Breaking New Ground
BRT	Bus Rapid Transit
CAPA	Climate Adaptation Plan of Action
CAPE	Cape Action for People and the Environment
CBA	Critical Biodiversity Area
CCD	climate-compatible development
CCT	City of Cape Town Municipality
CCTT	Climate Change Think Tank
CDF	conservation development framework
CDM	Clean Development Mechanism
CFR	Cape Floristic Region
CIP	Conservation Implementation Plan
CLACC	Capacity Strengthening in Least Developed Countries for Adaptation to Climate Change
CMC	Cape Metropolitan Council
CMIP	Coupled Model Intercomparison Project
CMP	Coastal Management Programme
CO_2	carbon dioxide
COP	Conference of the Parties
CORC	Community Organisation Resource Centre
CSAG	Climate Systems Analysis Group
CTSDF	Cape Town Spatial Development Framework
CWCBR	Cape West Coast Biosphere Reserve
CWG	Coastal Working Group
DCCP	Dassenberg Coastal Catchment Partnership
DEA	Department of Environmental Affairs
DEA&DP	Department of Environmental Affairs and Development Planning
DiMP	Disaster Mitigation Programme
DRM	Disaster Risk Management Department
DWAF	Department of Water Affairs and Forestry
DWS	Department of Water and Sanitation
ECAP	Energy and Climate Action Plan
EEDSM	Energy Efficiency Demand Side Management Programme
EIA	environmental impact assessment

EMG	Environmental Monitoring Group
EPC	energy performance contracting
ERC	Energy Research Group
ERMD	Environmental Resource Management Department
ESD	Electricity Services Department
FAC4T	Framework for Adaptation to Climate Change in the City of Cape Town
FPA	flood-prone area
GCM	global climate model
GEF	Global Environment Facility
GHG	greenhouse gas
GIS	geographic information system
GJ	gigajoule
GWh	gigawatt hours
HIV	human immunodeficiency virus
HSDG	Human Settlements Development Grant
HVAC	heating, ventilation and air conditioning
ICM	integrated coastal management
IDA	Incremental Development Area
IDP	Integrated Development Plan
IEMP	Internal Energy Management Protocol
IIED	International Institute for Environment and Development
IMEP	Integrated Metropolitan Environmental Policy
IPCC	Intergovernmental Panel on Climate Change
IPTN	Integrated Public Transport Network
ISN	Informal Settlement Network
IUCN	International Union for Conservation of Nature
KTP	Knowledge Transfer Programme
LBSAP	Local Biodiversity Strategy and Action Plan
LDCs	Least Developed Countries
M&V	monitoring and verification
MCDA	Multi-Criteria Decision Analysis
METT	Management Effectiveness Tracking Tool
MoU	Memorandum of Understanding
MSL	mean sea level
NAPA	National Adaptation Plans of Action
NGO	non-governmental organisation
NIMBY	not in my back yard
NWA	National Water Act
ODTP	Organisational Development and Transformation Plan
PA	protected area
PAME	Protected Areas Management Effectiveness
PMT	Project Management Team

PPP	public participation process / public-private partnership
PSC	Project Steering Committee
PU	planning unit
PV	photovoltaic
RADAR	Research Alliance for Disaster Risk Reduction
RCP	Representative Concentration Pathway
RDP	Reconstruction and Development
RCM	Regional Climate Model
SANBI	South African National Biodiversity Institute
SCM	Supply Chain Management
SDI	Shack/Slum Dwellers International
SEA	Sustainable Energy Africa
SEED	Sustainable Energy for Environment and Development
SHI	Social Housing Institution
SHRA	Social Housing Regulatory Authority
SSN	SouthSouthNorth
SUDS	Sustainable Urban Drainage Systems
tCO_2	tons of carbon dioxide
tCO_2e	tons of carbon dioxide equivalents
TCT	Transport for Cape Town
TMF	Table Mountain Fund
TOD	transit-oriented development
TRA	temporary relocation area
UCT	University of Cape Town
UK	United Kingdom
UKZN	University of KwaZulu-Natal
UN	United Nations
UNEP-WCMC	United Nations Environmental Programme World Conservation Monitoring Centre
UNFCCC	United Nations Framework Convention on Climate Change
UN-Habitat	United Nations Human Settlements Programme
Urban-LEDS	Urban Low Emissions Development Strategy
USA	United States of America
USAID	United States Agency for International Development
WCWSS	Western Cape Water Supply System
WCWDM	water conservation and water demand management
WDM	water demand management
WEF	World Economic Forum
WSUD	Water Sensitive Urban Design
WWF	World Wide Fund for Nature

Foreword

Unlike many other social, economic or environmental challenges, climate change leaves none of us immune from its implications or consequences. It represents a real and true problem of the commons where at both the global and local level we really are firmly all in this together.

How we respond to climate change through mitigation and adaptation will require a new, sincere and committed effort of collaboration, sharing and partnership if we are to avoid the worst of what may lie ahead. *Mainstreaming Climate Change in Urban Development: Lessons from Cape Town* presents the furthering of a partnership between researchers, academia and local government officials which began in 2009 with the Cape Town Climate Change Think Tank. This book represents the powerful outcomes possible when there is collaboration between academic researchers and practitioners in the co-production of knowledge.

Mainstreaming Climate Change in Urban Development: Lessons from Cape Town offers value and insight to academics, researchers, students and government officials alike. It takes the reader on a journey through the real and meaningful complexities experienced 'on the ground' in the application of policy and the rollout of considered learned approaches in a complex urban environment. This book has something for all areas of interest and expertise in the wide discourse that is climate change. From the difficulties of climate change policy development to the pitfalls of energy efficiency and the needs of fiscal reform, *Mainstreaming Climate Change in Urban Development: Lessons from Cape Town* gives the reader a broad experience of the challenges faced in addressing climate change. This publication also depicts the increased focus at municipal level on the importance of ecosystem conservation and the development of meaningful ecological corridors in building climate resilience for the future. Specifically, the implementation of the Dassenberg Coastal Catchment Partnership demonstrates that the success of any of our efforts in combating climate change depends on collective, forward-thinking partnerships between organisations that invest in the future. It showcases that implementing actions for climate change brings a broad benefit to the development of the City – in this case the conservation of species and the potential of regional ecosystem development in the context of climate change in an area where employment creation is essential.

Cape Town has just narrowly survived a severe drought, and this book reflects on both water security and stormwater/flood attenuation, two linked issues that represent some of the greatest challenges to an urban environment with high levels of housing informality in a changing climate. The recent experience of the drought has left Cape Town in no doubt about what a water-scarce future might be like.

Mainstreaming Climate Change in Urban Development: Lessons from Cape Town is another successful step in the strengthening of the collaboration and partnership between academic researchers and practitioners, and in the global sharing of the lessons learned. It is an important read for anyone in the field of climate change in cities.

Gregg Oelofse
Environmental Resources Management Department
City of Cape Town

CHAPTER 1

Introduction: co-producing knowledge on climate change and urban development

Dianne Scott, Helen Davies, Anna Taylor and Mark New

> *A major component of becoming more resilient is our response to the greatest challenge facing the globe today: climate change … Without concerted action by governments across the world, the consequences for our planet of human-made climate change, which are already being felt, will be catastrophic. We believe that the fight has to be made at the local level and driven by city action. (City of Cape Town Mayor Patricia de Lille and Chief Resilience Officer Craig Kesson, in De Lille and Kesson 2017: 105)*

Cities are critical sites for addressing climate change (Bulkeley 2013; Rosenzweig et al. 2010). As homes to large and growing populations, high concentrations of economic activity and extensive infrastructure, cities are significant sources of greenhouse gas emissions and energy consumption, and are highly exposed to the impacts of changing climate conditions, while also being hubs of innovation that can drive positive change (Bai et al. 2016). It is therefore imperative that considerations of climate change be factored in to the multiplicity of decisions that shape the development trajectory of cities, along with many other pressing agendas. The new Goal 11 of the United Nations Sustainable Development Goals demonstrates the significance of cities in achieving inclusivity, resilience and sustainability (UNDP 2016 in Bai et al. 2016). Enabling these agendas and expected outcomes requires knowledge stemming from practice, policy and science. Making cities and urban development both low-carbon and climate-resilient, and undertaking climate-compatible development, also require that cities document, critically reflect on and share what they are doing and learning about addressing climate change. By doing so, others can seek inspiration and find evidence of what works and, as importantly, what does not work in a variety of urban contexts.

Building on the extensive climate change mitigation and adaptation work undertaken since the late 1990s by the City and reflected on in Chapter 3, the purpose of this book is to record the progress made and challenges faced — as of the end of 2016 — across various functions of the City of Cape Town Municipality (CCT, also referred to as the City) in mainstreaming climate change into urban policies, processes, programmes and implementation practices in a context of rapid urbanisation and uncertainty about the exact nature, timing and magnitude of city-scale climatic changes. Mainstreaming is understood to be the process whereby climate change adaptation and mitigation goals, strategies and measures are integrated into existing urban policy domains, institutional structures and resource allocations, such as water and energy management and spatial planning (Uittenbroek et al. 2014). In practitioner circles, this integration of climate change considerations is often referred to as departing from 'business as usual', where 'business as usual' is shorthand for the conventional approaches taken to managing environmental resources, planning the spatial configuration of cities and constructing infrastructure that either did not pay attention to the climate or assumed a static characterisation of the climate based only on historical data. Departing from 'business as usual' requires a recognition that the past is no longer a suitable proxy for the future when it comes to the climate, and that greenhouse gas footprints of cities must decline in line with global and national targets.

Beyond documenting progress, the book further aims to share experiences with other cities, particularly those in the global South. As part of the knowledge partnership between the CCT and the University of Cape Town (UCT) under the Mistra Urban Futures Knowledge Transfer Programme, the peer-reviewed chapters have been co-produced by City officials and university academics. In addition to documenting the knowledge and experiences of these officials, the aim of the project was for them to have time and space to engage with academic thinking and research relevant to their functional area — related to climate change — and for academics to engage with the complexities of local government decision-making in order to provide relevant research to support the mainstreaming of climate change concerns into urban planning and development. This form of co-production aims to speed up the ability to transform to a more resilient city.

The authors were challenged to document how their 'business as usual' practices have shifted through incorporating climate change considerations into their work. The central tenet of the book is that climate change responses, whether focusing on adaptation or mitigation, occur within a crowded and contested urban policy space, competing or aligning with other priorities for attention and resource allocation. Addressing climate change in cities requires drawing together scientific, technical, political and administrative expertise and initiatives in new and different ways. While the book focuses on the CCT's climate change responses, it also explores whether the method of knowledge co-production used in this project contributes to building a resilient city (Chapter 4).

The book follows on from *Climate Change at the City Scale: Impacts, Mitigation and Adaptation in Cape Town*, edited by Cartwright et al. (2012). This, in turn, was a record of the thinking and experiences of the Cape Town Climate Change Think Tank, a 'knowledge partnership' which operated from 2009 to 2012 and produced knowledge on a range of urban climate issues such as urban governance, adaptation and mitigation in the context of Cape Town (see Chapter 4). This book continues to explore climate change at the city scale and in the context of urban development. Including climate change factors with all their complexity in existing decision-making processes is a conceptual, practical and organisational challenge (Cartwright et al. 2012). Climate-compatible development is a profound challenge facing not only Cape Town, but cities the world over.

The book follows the methodology of knowledge co-production (Patel et al. 2015; Polk 2015) with a specific focus on how climate change has been mainstreamed into the work of numerous functions in the metropolitan municipality. Co-production of knowledge assumes that there are many sources of knowledge other than science,[1] and that societal actors and academics collaborate to integrate their understandings of societal problems and their solutions (Callon 1999; Klein 2013; 2014; Polk 2015). There is therefore a shift to producing more socially relevant knowledge. Integrating practitioner knowledge and academic knowledge is, in a sense, experimental, with both parties learning as much through the experience of co-production as through enhancing their content knowledge (Patel et al. 2015). In line with this method of co-production, all chapters in the book were peer-reviewed by both a City official and an academic expert, and the book in its entirety has also been peer-reviewed. This is no mean feat, as the quality and utility criteria applied by reviewers in government and in academia do not always align, and for officials, this is not their core business.

Why is the case of Cape Town considered interesting? While the CCT is a well-functioning local government institution, and has been noted as 'a leading city in terms of its response to climate change' (Cartwright et al. 2012), Cape Town is a highly unequal city, with a pernicious apartheid legacy of spatial and economic inequality and poverty, resulting in many complex and persistent development challenges. The use of only narrow, specialist scientific knowledge in making decisions has been widely criticised in the literature related to solving the 'wicked' challenges of our complex contemporary society (Vogel et al. 2016). From the evolution of the Climate Change Think Tank to the publication of *Climate Change at the City Scale* in 2012 to the Mistra Urban Futures Knowledge Transfer Programme and this book, a growing body of interdisciplinary and transdisciplinary knowledge on the interlinkages between the climate and urban development has been developed in the context of Cape Town that has

1 That is, the generation of evidence in the context of particular questions or hypotheses, through research design, data generation, analysis and interpretation.

strengthened the interface between science, policy and practice. While not unique to Cape Town, these kinds of partnerships and resulting knowledge are relatively rare. As such they are worth showcasing to others within Cape Town as well as to those concerned with similar issues in other cities in South Africa and internationally in order to promote and support climate change mainstreaming elsewhere.

The chapters in this book have been written through several lenses, with contributions from social and natural scientists, such as economists, engineers, ecologists, geographers, marine scientists and planners, and municipal practitioners, trained in these disciplines. As editors, we have interrogated the responses to climate change and urban development in our own research, teaching, training, policy-making and implementation. The authors adopted a range of collaborative strategies as they worked together to co-produce the chapters (described more fully by Scott et al. in Chapter 4) and brief reflections on the strategies employed are included in the concluding chapter of the book.

One of the book's clear messages is that while elements of climate change mainstreaming have been achieved in the CCT, many existing efforts at addressing climate change have not yet been mainstreamed into CCT functioning at a broad scale in a strategic way and that this will probably have serious consequences for the city if not addressed, including impacts on social, economic, food and health security, and infrastructure and environmental functioning and integrity (Taylor & Davies, Chapter 3).

The process of creating this book began with invitations to officials across the municipality to apply for the opportunity to take some time away from their normal day jobs in order to reconnect with recent research in their field and write up an analysis of practical work they had recently been engaged in related to climate change. Each selected official was paired with an academic working in the same or a similar field, and the pairs were invited to learn about and explore the experience of co-production. Because not all officials who were engaged with climate-change related aspects of work applied (often due to existing demands on their time), and from these only a subset of applicants was selected, not all climate change efforts under way in the CCT are reflected in this book. Furthermore, Cape Town's efforts at the mainstreaming of mitigation have been well documented elsewhere, and the city is widely recognised as being a leader in South Africa and internationally (Cartwright et al. 2015). As a result of the self-selection and selection process and previous knowledge capturing exercises, the book is, admittedly, focused more on adaptation rather than mitigation aspects of climate change, but with the mainstreaming lessons being applicable to both mitigation and adaptation. We believe that the learning that has taken place through the production of the book serves both to better equip the City officials involved in the co-production of chapters to engage in a wide array of complex decision-making processes and draw on the latest research, thereby contributing to a more resilient and sustainable city, and to better equip the academics involved to conduct needs-informed research and to integrate practice-based knowledge into their teaching and training endeavours.

The structure of the book

Following this introductory chapter, Chapter 2 by Ziervogel, Pasquini, Taylor and New provides an institutional, development and material context for Cape Town, to help readers understand the background against which the practices described in the following chapters are located; the chapter also provides a review of the literature on climate change responses in Africa and globally. The literature review has two thrusts: to describe how vulnerability and adaptation to climate change have been responded to in Africa; and to offer an overview of the significant contributions to global urban climate change knowledge. This review shows that the increasing use of climate information for decision-making and the focus on the governance arrangements in cities are two important, but relatively recent, innovations at the global level that have not yet found a place in the majority of African urban climate change responses.

The context of Cape Town is described in Chapter 3 by Taylor and Davies, who provide an overview of the development trajectory and the historical and projected climate conditions of the city and highlight the local interconnections between climate change and development. The chapter examines who was doing what in the CCT to adapt to and mitigate climate change as at the end of 2016, with a focus on the role of local government in enabling climate change response action.[2] Of importance to the work being done in various departments in the CCT is the fact that a new CCT Climate Change Policy was approved by the CCT Council in July 2017 (CCT 2017), to provide a framework for all CCT functions to work more collaboratively within the City and with other city stakeholders. This policy aims to mainstream climate change into all CCT work and is, therefore, particularly designed to 'realise co-benefits between climate change-specific goals and sustainable urban development goals more broadly, such as improved resource security, reduced costs, improved air quality, improved quality of life, long-term fiscal efficiency and the protection of lives, livelihoods, the economy, ecosystems and investments' (Taylor & Davies, Chapter 3).

2 It should be noted that the CCT institutional structures referred to by authors across the chapters were in existence at the time of writing, but have undergone significant changes in the course of an overall restructuring of the City in 2017 as part of its Organisational Development and Transformation Plan (ODTP). Appendix A to this book sets out the structure prior to the implementation of the ODTP, and Appendix B presents the new structure adopted in terms of the ODTP.

Chapter 4 by Scott, Anderson, Davison, Greyling, Patel, Thesen and Van der Merwe provides some background and the rationale for the adoption of the method of co-production in this book. First, it provides a literature review of the concepts of co-production and the 'third space' as a virtual space where co-production can take place; second, it presents a history and critical evaluation of the co-production processes that took place between UCT officials and the CCT academics from 2012 to 2016; and third, it outlines the structured process that was designed for authors as they entered the process of co-writing that culminated in this book. These three framing chapters provide an important context for understanding the empirical chapters in the book which relate to different sectors in the Municipality (Chapters 5 to 14).

The empirical chapters of the book cover four themes, the first of which is *resource management*, dealt with in Chapters 5 and 6. In Chapter 5, Mohamed, Tait and Kruger report on the CCT's shift to markedly improve energy efficiency in the face of climate change in a systemic way whereby climate change has become the central logic of their activities. In Chapter 6, Sinclair-Smith and Winter explore the critical issue of managing water security in a changing climate including a discussion of the water management during the recent 2015 to 2018 drought. The chapter reveals that Water Demand Management (WDM), a policy to conserve water, is a systemic approach which has been in place for some time and enabled the city to better withstand the drought conditions that prevailed.

The second theme, *spatial planning*, is considered in Chapter 7, where Sasman and Cirolia conceptually explore the connection between social housing and climate change, leading the way in spatial planning to mainstreaming climate change. In Chapter 8, Holmes, Anderson, Pugnalin, Wood and Dorse explore two case studies of conservation planning as an experimental pilot project to include climate change into conservation planning.

The third theme, dealt with in Chapters 9 to 11, is *risk management*. In Chapter 9, Chippendale, Sowman and Colenbrander focus on coastal risk management and demonstrate how collaborative governance for climate change has been systemically incorporated into their work. Chapter 10 by Noorbuckus and Ziervogel describes how a disaster risk flood management strategy using gravel platforms in an informal settlement also serves as a form of climate adaptation as a co-benefit. Taylor, in Chapter 11, discusses how climate change is systemically being factored into flood risk management. Taylor is the single author of this chapter by dint of being an embedded researcher as part of the Mistra Urban Futures, Knowledge Transfer Programme, in which students worked in the municipality but were registered for their doctoral degrees at UCT.

The fourth theme, *governance*, is the focus of Chapters 12 to 14. Chapter 12, by Wood, Anderson, Dorse, Holmes and Mossop, assesses the management effectiveness of the CCT's protected areas as a potential tool for climate change resilience. In Chapter 13, Dorse, Wood, Scott and Paterson introduce the Dassenberg Coastal Catchment Partnership which marries biodiversity conservation, governance and climate change adaptation. In Chapter 14, Cartwright (also an embedded researcher in the City as part of the Mistra Urban Futures, Knowledge Transfer Programme) and Savage use the CCT's Fiscal Reform Programme to demonstrate how the budget can be used to facilitate a transition to urban resilience.

In the conclusion, Chapter 15 by Scott, Taylor, Davies and New, the concept of 'mainstreaming' is interrogated and the chapters of the book are positioned according to what is termed 'systemic', 'experimental' and 'conceptual' mainstreaming. A number of important events and developments have occurred since the writing and reviewing of these chapters: the selection of Cape Town as one of the Rockefeller 100 Resilient Cities in May 2016; the adoption of the Organisational Development and Transformation Plan (ODTP) by the CCT to significantly change the organisational structure of the municipality in April 2017; the Council's approval of the Climate Change Policy in July 2017; and the drought of 2015 to 2018 associated with severe water scarcity. The chapter concludes with a

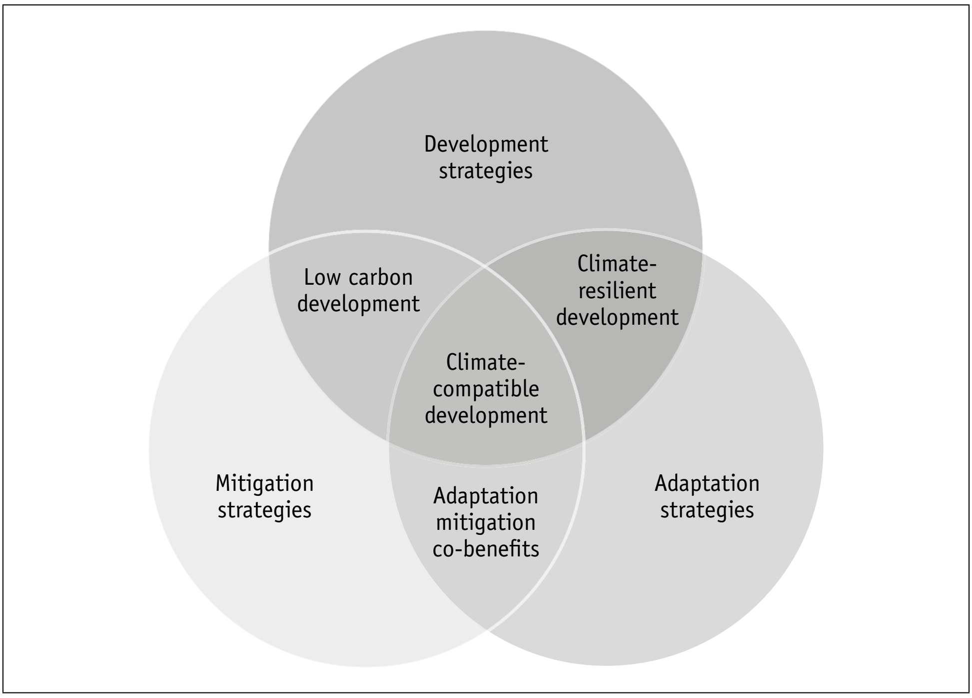

Figure 1.1: The idea of climate-compatible development: mitigation (reducing or avoiding greenhouse gas emissions) and adaptation (reducing sensitivity to risks by building resilience into infrastructure, housing, operations and other parts of the city) is mainstreamed into city development strategies
Source: CDKN, 2010

critical discussion of the implications of these developments for the mainstreaming of climate change.

The book as a whole contributes to the international literature on cities and climate change by presenting a range of experiences, challenges and lessons learned by one city government, the CCT, in incorporating climate change into city work. As such, the book addresses climate change at the city scale, where the institutional, material, political, economic and development context is specific to Cape Town, but many of the experiences it describes will have relevance to other cities in Africa situated in their own contexts. It documents a realisation that cities need to mainstream climate change into their development policies, programmes and implementation processes, i.e. undertake climate-compatible development (Figure 1.1).

In addition, the book demonstrates that co-benefits might arise: co-benefits may be either developmental benefits from climate policy action; climate benefits from other social, economic or environmental policy actions, or the combination of climate and non-climate benefits, both of which can be included through an integrated policy programme (Mayrhofer and Gupta, 2016).

When co-benefits are taken into account, the total gains from climate-change-related response actions make a more compelling business case for policymakers. This is particularly important in a developing country context, where budgets need to be prioritised between multiple needs, such as health and housing.

Showing how these can be delivered in a way that enables government action and communities to be more resilient in the long term makes these actions more tangible and desirable to all.

The book exposes some of the challenges of doing this, and considers how this might be done across different sectors (Tait & Euston-Brown 2017). It contributes particularly to a larger emerging intellectual and policy project in Africa grappling with the challenges of introducing climate change considerations into development agendas, in contexts where climate change is not regarded as a priority in comparison with development issues such as economic growth and job creation, infrastructural development and service provision (Pieterse & Parnell 2014; Pelling et al. 2018).

The CCT's response to the drought was not simply to cope with the current drought and continue with 'business as usual', that is, accept water shortages, institute short-term emergency measures, wait for the rains to come and then return to previous levels of water usage and continue exploiting existing water supply sources. Rather, the CCT's response has been to to build resilience to further future climate change and droughts, which is being done through a combination of improved water system management, water demand management, diversification of water supplies (including groundwater, desalination and water reuse), alien vegetation clearing and collaboration with multiple stakeholders.

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CHAPTER 2

Climate change challenges in African cities: four perspectives on progress and opportunities

Gina Ziervogel, Lorena Pasquini, Anna Taylor and Mark New

Internationally, there is a growing focus on urban climate change adaptation. New policies and plans that factor in and act on the current and potential climate impacts on cities are rapidly being developed. Reducing climate risks depends on the local context for understanding the underlying vulnerability that results from local sensitivities and adaptive capacity, and on understanding the nature of the specific climate hazards both now and in the future. Because of the specificities of the local context, adaptation plans are hard to 'copy and paste', and hence need to be developed locally in each city. The development of context-specific adaptation solutions takes considerable time and expertise, and even in many highly developed cities, these plans are only recently starting to be implemented (Carmin et al. 2012).

Despite the inherent complexity of developing adaptation responses, adaptation has received comparatively greater attention than mitigation in African cities — although it should be noted that there has been a slow rate of uptake, as climate change has not been seen as the most important challenge to consider, given the urgency of other development pressures (Ziervogel et al. 2010). Historically, in the global North, there has been more emphasis on mitigation than on adaptation, because of high historical greenhouse gas emissions. The minimal attention given to mitigation in African cities reflects the status of African countries as low greenhouse gas emitters (with the exception of South Africa), therefore not requiring immediate emissions reductions under international agreements. It could also be linked to the historical prioritisation by many African governments of rural rather than urban areas, with consequent reduction of the priority to address the high concentration of emissions linked to infrastructure and the urban form (Parnell 2015). This in turn reflects decades of under-investment in energy and transport infrastructure that has constrained economic growth and development.

Some African cities are beginning to develop city-wide and/or sectoral adaptation plans to mainstream climate risk reduction measures into development programmes, service provision and infrastructure investments. Another approach has been to develop local-level responses that focus more on the neighbourhood scale of assessing and reducing vulnerability to climate risks for households and individuals. The first part of this chapter considers how these two types of response have been taken up in African cities, first exploring the nature of city-level climate responses and then looking at how vulnerability and adaptation have been addressed at the local level. Reflecting on the progress cities have achieved in these two areas helps us to understand where the issue of climate change has been placed firmly on urban African agendas, and where it has received less support.

The second part of the chapter outlines two areas of research that have made significant contributions to global urban climate knowledge, but have not had as much traction in African cities. Internationally, innovation is emerging in urban climate responses (Bulkeley & Castán Broto 2013), and we reflect in the chapter on two particular areas of innovation and on the extent to which these innovations might be drawn on more strongly in African cities to further the climate change agenda. Firstly, we look at the increasing amount of climate data that is potentially available from global and regional modelling initiatives, and techniques for applying these data to city-scale information needs. Second is the importance of engaging with governance complexities when responding to climate change in the urban context.

In summary, the overall aim of this chapter is to highlight areas of progress in regard to climate change adaptation in African cities, as well as to identify international areas of innovation that could potentially be better integrated into future responses to urban climate change in Africa. Pulling together the progress made on adaptation and the areas of development internationally, the chapter helps to position climate change responses in the City of Cape Town Municipality in the African and global context.

Responding to climate change at city and national scales

Countries across the African continent have begun addressing the issue of climate change, with a focus on targeting the most vulnerable communities, ecosystems, infrastructures and economic sectors (Mertz et al. 2009; Niang et al. 2014). This is largely a consequence of international policy processes, notably those linked to the United Nations Framework Convention on Climate Change (UNFCCC). While addressing climate change began as a predominantly national pursuit, with a largely rural orientation, the high rates of urbanisation in many African countries point to the need for existing and emerging cities to be an important focus of climate change efforts (Cartwright 2015; Revi et al. 2014; Simon 2010). With high concentrations of people, economic activity and resource use, cities are central both to efforts aimed at mitigating climate change, through reductions in the emission of greenhouse gases, and to those efforts directed at adapting to changes in the climate, limiting the extent of negative impacts, and harnessing any beneficial opportunities that altered climate conditions might present.

The rise of the climate change agenda in African cities

Although cities across Africa have a long record of responding to local climate variability and disasters, these responses have not been framed as adaptations to long-term global climate change. Rather, concepts and practices of global climate change adaptation and mitigation have mostly been brought to African cities through the work of international agencies and networks such as the Capacity Strengthening in Least Developed Countries for Adaptation to Climate Change (CLACC) network led by the International Institute for Environment and Development (IIED), the United Nations Human Settlements Programme (UN-Habitat), ICLEI Local Governments for Sustainability, C40 Cities Climate Leadership Group and Cities Alliance (Weisser et al. 2014).

As in the rest of the world, the climate change mitigation agenda was the first to arrive, but has found limited purchase in most African countries and cities. With low levels of historical emissions and being classified as developing countries with small economies, there has not been a strong lobby, either internationally, nationally or locally, to focus on emissions reductions in Africa. South Africa is a notable exception, given its high emissions (Tyler et al. 2013; Winkler 2010). The climate change adaptation agenda has found a stronger resonance in the African context, where many people are reliant on natural resources for their livelihoods and highly susceptible to weather- and climate-related impacts, including droughts, floods, large storms, heat waves, shifts in the timing of the rainy season and storm surges along the coast. As a result, African countries have become increasingly vocal in international climate change negotiations on the issue of climate change adaptation and the funding thereof, as a matter of climate justice. However, despite this resonance, the initial emergence of climate change adaptation within a strong environmental framework, rather than an economic or developmental framework, has meant that the adaptation agenda has struggled to gain real political traction either nationally or sub-nationally, or to receive any serious attention within the business community. Recent attempts to reframe climate change adaptation as an economic and developmental issue are starting to change this, but there is a long way to go before climate change adaptation features at the heart of resource allocation and investment decisions in either the public or private sector.

Thirty-two African countries have completed National Adaptation Plans of Action (NAPAs), as agreed in 2001 within the UNFCCC. Based on the international policy community's recognition of the high levels of climate vulnerability in Least

Developed Countries (LDCs),[1] a programme of work and an expert group were set up to support these countries in identifying activities deemed to be a priority for urgently reducing key climate risks and vulnerabilities that would otherwise increase and/or become more costly to address over time (Huq et al. 2004). The idea was that these activities or projects would address 'urgent and immediate needs' that would be ranked in importance, profiled and have costs calculated as a basis for accessing funding and progressing with implementation.[2] This process of national adaptation planning was to be country-driven, action-oriented, participatory (at least in part), and based on existing information (not requiring any additional research). The expressed objective was for these adaptation plans to be mainstreamed into national and sectoral development plans. While it is a considerable achievement that by the end of 2013 all of the LDCs, including 32 African countries, had developed and submitted NAPAs, the process and outcomes have in many cases not been as successful and impactful as envisaged by the international community. Analysis of the NAPA process and NAPA documents undertaken by Osman-Elasha and Downing (2007) and Hardee and Mutunga (2010) shows how the intended alignment between national adaptation plans and development plans has not been achieved, largely due to structural and institutional barriers that inhibit the exchange of information among sectors and agencies, and bias the priorities in favour of natural resource management measures over social, economic, demographic and spatial planning measures.

In addition to the NAPAs, a number of other African countries, including Kenya, Tanzania, Ghana, Nigeria and South Africa (not designated 'least developed'), often with the support of international agencies, have also prepared or are well into the process of preparing national climate adaptation plans and/or strategies. However, there is little published research that critically analyses the process of developing, and/or the contents of, these plans.

For the most part, cities and urban issues are very poorly reflected in these national adaptation plans, even though many of these countries have high rates of urbanisation (Revi et al. 2014; Satterthwaite et al. 2007; Stringer et al. 2010). In spite of the imminent transition of many African countries to a largely urban population, the policy focus and the framing of national adaptation priorities

1 This is the language used in the UNFCCC process. LDCs are considered to be the world's poorest countries. The criteria used to designate an LDC include low income, human resource weakness and economic vulnerability (see https://unfccc.int/process-and-meetings/the-convention/glossary-of-climate-change-acronyms-and-terms, accessed 23 January 2019). Currently 48 countries are designated by the UN General Assembly as LDCs; of which 32 are in Africa; see the list of LDCs at http://unfccc.int/files/cooperation_and_support/ldc/application/pdf/ldc-list-31jan08.pdf, accessed 19 January 2019.

2 See https://unfccc.int/topics/resilience/workstreams/national-adaptation-programmes-of-action/introduction, accessed 26 January 2019.

remains one of rural development and natural resource management (Kiunsi 2013). This makes translating these national adaptation plans to the local level a challenge in urban areas.

Climate change planning at the city scale

The capacity of metropolitan local government authorities to undertake climate change mitigation and/or adaptation varies considerably across countries. Limitations on capacity are particularly acute in the African context, where democracy and the devolution of state powers are still in their infancy and as such local governments are, for the most part, poorly mandated and resourced to deal with cross-cutting and multi-scalar issues such as climate change (Satterthwaite 2011). In addition to frequently cited issues relating to low levels of climate change awareness, knowledge and leadership, and the planning and implementation of climate change actions in cities across Africa which are shaped and constrained by a number of other institutional factors (Leck & Roberts 2015; Pasquini & Shearing 2014; Taylor et al. 2014). First and foremost, the legislative framework that stipulates what local governments can and cannot do is based on mandates established by national government. These often exclude a number of issues pertaining to climate change such as coastal management and energy production. A closely related factor is fiscal arrangements between national and local governments, as well as with international donors, particularly the levels of autonomy city governments have to set budgets and collect taxes in order to raise the revenue needed to make public investments in climate risk reduction measures and limiting emissions. With large segments of city populations under-serviced with water, sanitation, energy and waste management, the near-term orientation of local political representatives to deliver basic services as quickly, cheaply and widely as possible means that climate change does not feature as a priority. While this short-term orientation is not unique to African contexts, the political instability of many countries and the deficit in public infrastructure and service provision magnify this factor quite considerably. The very limited existence of and accessibility of city-scale data on climate, demographics, land use, land cover, economic activities, energy usage and transport patterns, together with a shortage of human capacity and analytical expertise in city governments and local universities, makes local climate change assessment and planning particularly challenging.

Despite these limitations, some cities in Africa are leading the way on the continent, having made considerable progress in terms of taking up the climate adaptation agenda and, in a smaller number of cities, the climate change mitigation agenda. Largely independently of the national adaptation policies and plans discussed in the previous section, some cities have begun to develop their own plans, motivated by a combination of growing concern over local climate-related risks and vulnerabilities and encouragement by international agencies and networks like the ICLEI, UN-Habitat, C40 and Cities Alliance.

There is a small but growing body of research on city-scale adaptation planning in African cities. The South African cities of Durban and Cape Town feature strongly in the urban adaptation literature.[3] In both cities practical experimentation and research on a sector-based approach to city-wide adaptation planning have been undertaken. Efforts are now focused on integrating these sectoral adaptation efforts, together with climate change mitigation efforts, into a more coherent and coordinated urban response to climate change. In Dar es Salaam, Tanzania, Kiunsi (2013) and Shemdoe et al. (2015) describe why climate adaptation planning and action is much needed at the city scale, but how low awareness of climate change and difficulties in coordinating across four local authorities inhibit this. However, they also indicate that there is a significant increase in research being undertaken on climate change in Dar es Salaam, and that there are various large-scale development initiatives under way that contribute to adaptation, particularly those aimed at the formalisation and upgrading of settlements and extension of water and sanitation infrastructure networks and service. Recent work in Maputo, Mozambique, has found that climate change considerations are now evident in city-wide spatial plans and that participatory urban planning offers important entry points for engaging local actors in identifying and implementing suitable adaptation measures; however this places new demands on local government which are not currently supported (Castán Broto et al. 2013; Castán Broto et al. 2015). The need for increased political interest in and will to address climate change, bringing in local actions through real forms of public participation, and overcoming fragmentation and silo-based planning and activities cuts across the work in all of these cities. There is also a more general commentary emerging on the importance of working in small cities (defined as having a population of less than 500 000) given that the majority of Africa's urban population live in cities of this nature. These are the cities that are likely to see significant growth in the coming decades, and yet there is limited planning, management and financial capacity within such cities (Silver et al. 2013; Wisner et al. 2015).

Responding to climate change at the local level

City-level responses need to be complemented by local-level responses and by responses that ensure citizens' needs are being met through adaptation. One such response has been the growing climate justice movement that has been taken up

3 For work on Durban see Anguelovski et al. 2014; Carmin et al. 2012; Cartwright et al. 2013; Leck & Roberts 2015; Roberts 2008, 2010; Roberts et al. 2012. For work on Cape Town see Cartwright et al. 2012; Mukheibir & Ziervogel 2007; Taylor 2016; Taylor et al. 2014; Ziervogel & Parnell 2012.

more by activists than by academic researchers. One of the concerns of the climate justice movement is that those least responsible for greenhouse gas emissions are those least able to cope with the climate impacts. Addressing the related issues of development challenges and inequality needs to be a core aspect of adaptation to climate change (Aylett 2010).

Although climate justice is an international concern, and Africa is seen as deserving of international adaptation funding, in reality support for the most vulnerable groups is lacking on the ground. Many international NGOs and civil society organisations have worked with rural groups on climate change adaptation, but it has only been in the last few years that this work has started to include urban communities. In urban contexts there has been insufficient attention paid to how city-level responses impact on households and how local adaptation responses might be better supported and help to reduce inequity. Yet understanding of how climate variability impacts on households and of the current extent of local adaptation to climate change in African cities is needed to inform identification of the types and levels of adaptation support required.

Within the African context, there is no solid body of work that captures urban responses to climate change mitigation or adaptation responses at the community or sub-city scale (Simon & Leck 2015). In part, this is because these responses are newly emerging and are in progress. From the academic perspective, these responses relate to different fields, such as disaster risk management, community engagement, political science and water management among others, so cannot be captured in one place (Simon & Leck 2015). However, there has been significant growth of sub-city-level responses to climate change in African cities, and these responses are increasingly being recorded. The disaster risk reduction field has a longer history in assessing and reducing risk. This academic and practical local experience should be drawn on, particularly with regards to climate-related disasters, which are central to adaptation (Fraser et al. 2017). The examples that do exist often relate to what communities are doing, and have done in the past, to cope with climate risks, with fewer examples of preparation for a future change in climate risks.

Understanding local vulnerability

Given the ineffective and unrepresentative governments in many African cities, the importance of supporting household adaptation has been acknowledged (Satterthwaite 2011). Some argue that in order to adapt to climate change it is necessary to understand the nature of climate risks, and which groups and sub-groups are most vulnerable to climate impacts based on their levels of exposure to climate hazards, their sensitivity to impacts and their capacity to respond to and deal with such exposure and limit damages and losses (Bicknell et al. 2009). However, assessing local vulnerability has not been a priority in African cities. Some cities, for example Mombasa in Kenya, and Cotonou, in

Benin, have described their vulnerability to climate impacts (Bicknell et al. 2009) and there are some examples of vulnerability assessment at the sub-city scale, including understanding local flood risk in Lagos, Nigeria, and understanding local experiences and perspectives on flooding in Warri, Nigeria (Adelekan 2010; Odemerho 2014). Across African cities, monitoring of hazards, vulnerabilities and impacts has been lacking (Pelling et al. 2018). Even when vulnerability assessments exist, these local understandings seldom inform practice and city-level responses (Preston et al. 2011; Waddell 2016). It is unclear whether vulnerability assessments are needed to ensure that local priorities are addressed. Perhaps in many places there is sufficient understanding of local vulnerabilities, yet these are ignored in the interest of maintaining the status quo.

Developing local adaptation responses

Although urban areas have the potential to provide resources, services, expertise and networks in a way that rural areas often do not, the flipside is that in many African towns and cities governance and implementation are weak and services and resources are inadequate (Satterthwaite 2011). Even where government is implementing responses, city governments have limited ability to engage in neighbourhood processes. As is happening internationally, the role of local citizens and community groups in developing their adaptive capacity and responding to climate impacts themselves is recognised as important in Africa (Revi et al. 2014; Wamsler 2016).

In the complex processes involved in governance of urban challenges, the importance of going beyond government to include multiple other actors such as civil society, the private sector and other organisations in adaptation is clear (Ziervogel et al. 2016). Growing importance is being placed on participation and co-production as core components of urban adaptation (Aylett 2010; Chu et al. 2016). Yet bringing local stakeholder groups into city-level climate planning processes is challenging. However, examples of this are starting to be seen to a limited extent in African urban adaptation responses (Awuor et al. 2008; Aylett 2010). This is a welcome change from rural adaptation work, where the initial focus was on adaptation outcomes such as changing irrigation practices and planting drought-resistant seeds or improving access to climate information. While adaptation outcomes are important, they need to be supported by adaptation as a process that builds the capacity of different groups to adapt in different ways as and when needed (Tschakert et al. 2013; Ziervogel & Parnell 2014). These processes require time and expertise (Chu et al. 2016) and there is not yet evidence of whether African cities will prioritise such processes, which can often be highly contested.

The nature of local adaptation responses

There are many different strategies and responses that can be framed as adaptation to climate change, including addressing the drivers of vulnerabilities, building response capacity, managing climate risk and reducing climate impacts directly (McGray et al. 2007). This broad range of responses includes more traditional development approaches that build capacity to respond to current climate and other stresses, as well as responses that explicitly include consideration of future climate impacts (Eakin et al. 2014). In the context of urban local responses, most of the responses are focused on reducing vulnerability and impacts of current climate events. For example, at the household level, many of the cases that look at flood risk illustrate how households are building stronger foundations, repairing houses and clearing drainage in order to reduce the impacts of flooding (Moser & Stein 2010). Small businesses in Mombasa have also been changing their practices to reduce the impact of flooding, including limiting their stock when floods are expected and unplugging electrical equipment (Moser & Stein 2010). More collective responses are starting to emerge that point towards the international call for transformative adaptation at the system scale (O'Brien 2012). Moser and Stein (2010) provide the example of a local women's project in Mombasa where there has been a collective response to maintain water wells, with support from Action Aid Kenya, illustrating a shift to more long-term responses that anticipate future climate impacts.

These bottom-up responses are critical in building a more adaptive civil society and need to be encouraged, particularly in cities where there is high exposure to climate risk yet limited support for marginal groups. Yet support for local capacity development is often not seen as the remit of local governments, and so tends to fall through the cracks. In addition, the development gap in many African cities suggests that extreme levels of capacity need to be built, implying that bottom-up responses alone are insufficient. Stronger engagement between local communities and city-level actors is therefore needed to strengthen climate governance so as to include multiple perspectives and explore innovative adaptation responses.

The challenges of integrating physical climate information into city-level decision-making

Climate services aim to provide science-based information, forecasts and projections that help decision-makers to manage the risks and opportunities of climate variability and climate change (Hewitt et al. 2012). At the city level, there are a number of ways in which climate information can support responses to climate change; these range from awareness raising, to vulnerability and risk assessment, to quantitative impact assessment, and the design and assessment of both climate-resilient development options and specific climate adaptation options (as shown in Table 2.1). In each case, it is important that climate information is based on rigorous analysis of the data, and presented in a way that is appropriate to the audience, while always being defensible and honest about the quality and robustness of the underlying scientific evidence.

This section summarises some of the challenges involved in providing useable and defensible climate change projection information at the city scale, and highlights some of latest research that is attempting to address these challenges. It then explores the extent to which these new techniques are being applied in African city contexts.

Table 2.1: Vulnerability, impacts and adaptation activities and purposes for which climate projection data might be used

Activity	Purpose	How climate projections might be used
Awareness raising	• To explain climate change • To provide broad understanding of risks at the city scale • To obtain a mandate for more detailed work	• To underpin narrative or quantitative scenarios of how climate might change, coupled with descriptions of potential implications for the city
Risk and/or vulnerability (RV) assessment	• To identify key RVs to climate • To assess how the climate factors affecting RVs might change • To identify new RVs that might emerge under climate change conditions	• To provide information on how climate phenomena causing RV might change • To provide information on how the risks of such phenomena have changed in the recent past (attribution)
Impact assessment	• To describe quantitatively (most often using impact models) or qualitatively how specific climate change projections impact on biophysical, social-ecological and/or socio-economic systems	• To provide weather and climate data inputs for impact models

→

Activity	**Purpose**	**How climate projections might be used**
Adaptation design and appraisal	• To identify options for reducing RV to climate change • To assess the effectiveness of options • To identify time scales on which options might need to be implemented	• To provide weather and climate data inputs for models that incorporate adaptation options
Climate-resilient development planning	• To 'mainstream' climate change considerations into development planning, so as to avoid development options that are vulnerable to emerging climate risks, and seize alternative opportunities that are offered by climate change	• To undertake climate 'screening' of specific development plans/ projects • To undertake climate 'screening' of city-scale development strategies

Source: The authors

Uncertainties involved in global climate projections

The main sources of information on physical changes in climate are global climate models (GCMs) (Edwards 2011; Flato 2011). Uncertainty about future emissions provides a fundamental constraint on the ability to predict climate change, hence the reliance on emissions scenarios to drive GCMs (Moss et al. 2010). But GCMs themselves are imperfect, because of both the way in which the real climate system is simplified and mathematically represented in model form, and an incomplete understanding on the part of scientists of some key scientific processes (Räisänen 2007). For example, a mid-range emissions scenario (the RCP 6.0)[4] applied to 25 different models results in a spread of simulated global mean temperature rise of 1,4–3,4 °C by 2100 (Collins et al. 2013: Chapter 12, Table 12.2).

As one moves from global to more regional scales, the relative spread between GCM projections generally increases (Hawkins & Sutton 2009, 2011). At even finer spatial scales, such as cities, today's GCMs hit a resolution barrier below which they are unable to provide defensible projections. This is because typical GCM spatial resolutions range from about 250 × 250 km to 50 × 50 km, so at best the GCM can represent the large-scale (>100 km) features of climate and weather systems that

4 The RCP 6.0 is a 'Representative Concentration Pathway' that leads to an increase in radiative forcing of 6.0 W/m^2 by 2100 (see Moss et al. 2010).

affect a city (Figure 2.1). What they cannot do is simulate the way these large-scale systems influence local weather and climate, and consequently how local weather and climate might change (see Figure 2.1 a) and b)).

Climate downscaling attempts to overcome some of the spatial resolution issues in GCMs. The overall reasoning behind downscaling is that local climate change is a function of both larger-scale changes in climate which can be represented by GCMs *and* finer-scale processes that interact with the larger-scale changes (Wilby & Wigley 1997).[5] The most common examples are topography, and in coastal areas the configuration of the coast, and in the case of cities the built environment's effects on urban climate, such as heat islands. Downscaling aims to capture important small-scale weather phenomena such as, in the case of Cape Town, cut-off lows. Unfortunately, downscaling does not often provide more precise local (city-scale) climate change information. While this approach may indeed add local factors missing from GCMs, it also adds more room for within-model variation. This has been illustrated in a number of studies that compared the spread of projected climate changes from GCMs and from downscaling models (Haylock et al. 2006; Rummukainen 2010; Schmidli et al. 2007).[6]

Given these limitations of both GCMs and downscaling methods, good practice suggests that climate information should be based on not one, or a few, model results, but that large numbers of model runs should be employed in order to understand the full range of possible changes in climate. This is reasonably tractable for GCMs, where the major modelling centres around the world provide their model data though the Coupled Model Intercomparison Project (CMIP) data archives.[7] To date, access to a similar range of model outputs has proved difficult for downscaling methods, in which a range of downscaling models need to be run with a suitably wide range of driving GCMs.[8]

Dealing with uncertainty in climate model data in practice

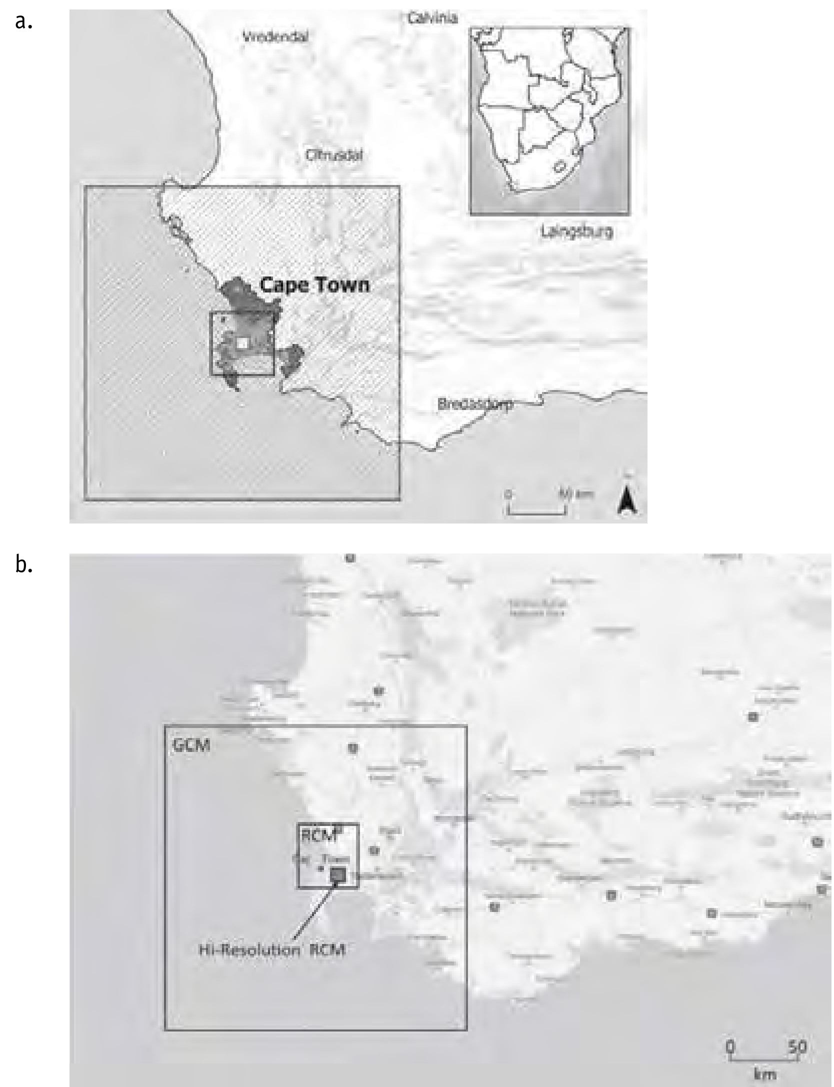
There are two main approaches that have been adopted to address uncertainty and the spread of possibilities that emerge when generating local-scale information through downscaling; they are termed here *bypass* and *embrace*.

5 The two key downscaling approaches are: (i) Regional Climate Models (RCMs), which run at higher resolution than GCMs but over a smaller geographical area; and (ii) Statistical Downscaling Models.

6 For example, Rummukainen (2010) showed that, over Europe, RCMs increased the spread in projected changes in temperature and precipitation by 25 per cent and 45 per cent respectively, compared to that of GCMs.

7 See https://cmip.llnl.gov/, accessed 28 January 2019.

8 For example to exhaustively downscale 20 GCMS with 20 RCMs requires 400 GCM-RCM combinations.



Figures 2.1a. and b.: Spatial resolution of Global Climate Models (GCMs) and Regional Climate Models (RCMs) in the context of Cape Town. The area that falls within the Cape Town Metropolitan Municipality is shown, with dark grey indicating built-up areas, and light grey indicating agricultural and conservation areas. The area marked by diagonal lines shows a typical GCM 'grid box' resolution (250 × 250 km); the cross-hatched area shows a typical 'grid box' resolution (50 × 50 km) for an RCM used for climate change projections; the smallest solid area represents the current state-of-the-art resolution (10 × 10 km) RCM used for weather forecasting in Europe and the USA, but not for climate change simulations. Even high-resolution RCMs running in 'climate change' mode cannot resolve the spatial patterns of weather and climate across the city.

Source: Mark New

The bypass approach assumes that most of the data any climate information system produces are difficult to use with any confidence, and/or that the range of possibilities becomes so large that making actual decisions about adaptation becomes intractable (Wilby & Dessai 2010). 'Bypassing' therefore takes a vulnerability reduction approach, arguing that reducing vulnerability to existing weather and climate threats goes a long way towards also adapting to climate change. This is a fair assumption in many instances, where the adaptation decisions play out over five to ten years, perhaps even over two decades; on these time scales, much of the climate risk will be similar to that recently experienced, perhaps with some additional risk due to the emerging climate change signal. However, in the city context some decisions may have longer-term implications. For example, flood risk zoning that does not take long-term climate into account may lock a city into development in areas that will become intolerably vulnerable under climate change impacts by the middle of the century and beyond.

The embrace approach recognises that the use of multiple climate model outputs provides information on the range of possibilities with regard to climate change, and attempts to develop methods of analysis that inform us about the implications of different outcomes across the possibility space. In its full application, it aims to quantify the spread of possibilities with regard to future climate changes, then to assess the associated range of impacts or vulnerabilities, and finally to test different response options across the array of future impacts.

There are three main approaches to analysing the data from climate models (Figure 2.2).[9] The first is 'agnostic' about the likelihood of scenarios across the possibility space, justified by fact that climate model projections are impossible to validate and so all should be considered equally likely (Smith 2002; Stainforth et al. 2007).[10] The second takes a traditional statistical approach to the data analysis, treating each model projection as an unbiased sample of the full range of possible outcomes should an infinite number of plausible models be run; the approach then generally fits a distribution to the sample (see for example Lopez et al. 2009). The third approach is similar to the second, but assumes that some projections may be better than others; it then uses metrics of model performance to produce a weighted distribution, often based on a Bayesian analysis. The most advanced application of the Bayesian approach to downscaled projections is the 2009 UK Climate Projections.[11]

9 Note that all approaches assume that there are sufficient combinations across emissions, multi-GCM and downscaling models, and thus that the possibility space has been robustly captured; but see for instance Rougier (2007) for some of the statistical issues associated with this assumption.

10 While it is possible to evaluate a model's ability to represent current and historical weather and climate, long-term forecasts cannot be evaluated, so model evaluation is at best a partial measure of prediction ability.

11 See http://ukclimateprojections.metoffice.gov.uk, accessed 19 January 2019.

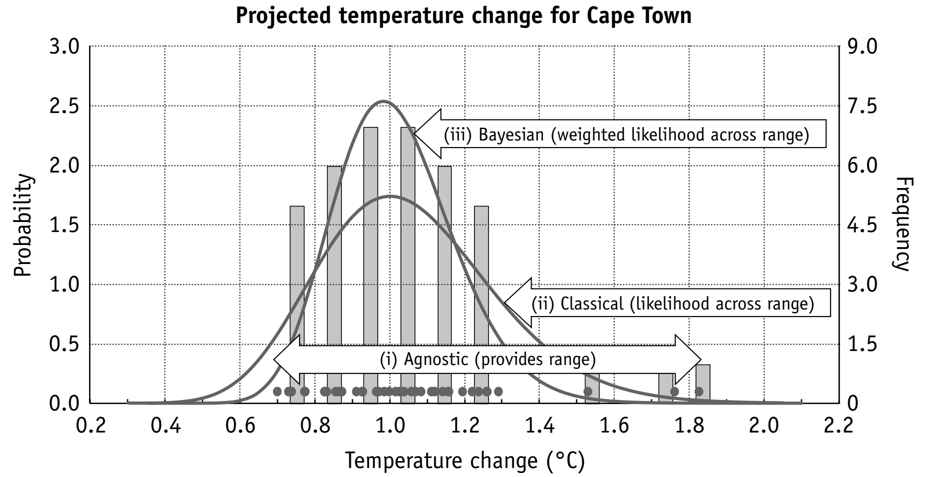


Figure 2.2: Different approaches to the analysis of multi-model downscaled climate change projection data to quantify the likelihood of different climate changes. (i) 'Agnostic' applies no likelihood across the range of changes captured by the data; (ii) 'Classical' fits a distribution that assumes all realisations are equally reliable; (iii) 'Bayesian' weights the fitted distribution by model reliability, in this case narrowing the range of possibilities because the more extreme projections are less reliable (according to the metrics used here). *Source:* Mark New

Assessing impacts and adaptation options

Quantitative assessment of impacts using climate change projections typically makes use of models of the impact system of interest. In cities these might be models of water resources, flood inundation, building heat stress, stormwater systems or coastal erosion. Any such impact model is typically run multiple times with a range of downscaled climate projections to assess the spread of possible impacts. Impacts can be expressed in probabilistic or non-probabilistic terms, depending on the way the climate inputs were derived (see previous section, pp. 21–22). Examples of such approaches from outside Africa include New et al. (2007) for water resources, Fung et al. (2013) for aquatic ecology, and Jenkins et al. (2014) for heat stress in cities. It is important to note that most of these probabilistic impact assessments make use of a single-impact model, and so do not capture uncertainty in modelling of the impacted system. The few studies that have used multiple-impacts models show that the additional uncertainty can be considerable, depending on the type of system being modelled (see for example Araujo et al. 2005: 19; New et al. 2007). Thus a full assessment of the range of impacts in a system should include this additional uncertainty through use of multiple-impact models or some form of uncertainty analysis.

The real utility of probabilistic approaches comes into play when assessing adaptation options. By altering the impact system model to reflect possible adaptations, the effectiveness of each option across the range of possible climate changes can be assessed. This can allow for a choice of options that are robust across future uncertainties, but not necessarily optimal for any particular climate change outcome (Groves et al. 2013; Lempert et al. 2013; Lopez et al. 2009). Alternatively, adaptation pathways can be designed which provide a sequence of options of choices through time, as stronger evidence of local climate change emerges (Wise et al. 2014).

Use of climate change information in recent studies in Africa

An analysis of peer-reviewed literature and reports available via the internet indicates that very few of the impacts, risk assessment and adaptation assessment studies in African cities, or indeed in the wider African context (such as agriculture, water resources, coastal zones, biodiversity) have attempted to address the issues relating to use of climate data and information discussed above. However, it is worth noting that these advances in research have also not often translated into real-world application outside Africa either. This is especially so for quantitative impacts and adaptation assessments (see Table 2.1), where the technical expertise and modelling capabilities required are quite demanding. For the case of African cities, one study (Daron 2015) explored how assessment of various options for protecting a railway line in Cape Town from coastal erosion stands up to a range of possible changes in sea level and wind regime. The study highlighted a number of challenges in real-world contexts that limit the use of such approaches, including 1) the considerable time investment and data needs for such a rigorous analysis, which are often not available in real-world planning contexts, especially in Africa; and 2) the fact that city decision-makers are generally not able (due to financial, political or time constraints) or willing (due to lack of awareness of their utility) to support longer, more comprehensive studies. Several recent reviews or case studies of the potential risks to cities of climate change have indicated that one of the main challenges in Africa is awareness-raising about both the key risks for cities from climate change, including the large uncertainties in city-scale climate change, and approaches to building climate resilience in cities in ways that maximise the utility of climate information (Woolhouse & Lumbroso 2015).

Incorporation of extensive multi-model downscaled inputs into impact assessments in other sectors in Africa is also rather limited. Many studies of water resources and agriculture have made use of GCM outputs, and then applied simple disaggregation of the GCM variables of interest (usually temperature and precipitation) to provide 'higher-resolution' inputs to hydrological and crop models. Unfortunately, such simple downscaling, while providing the impression of higher resolution, does not add any additional information about local climate change. Most of these studies also use only a limited number of GCM outputs, so do not capture the full range of even the large-scale changes. One recent study

(Wambura et al. 2015), of the Wami river basin in Tanzania, used an intermediate form of statistical downscaling of a large number of GCMs to explore the uncertainty of future water resources. The results showed clear differences in possible future impacts when using more than a few simply downscaled GCMs.

The majority of other studies on climate risk in African cities have been strongly vulnerability-based, as has been expanded on in an earlier section of this chapter (see page 17). These studies have typically identified present-day risks and exposure, and have suggested approaches to reducing these vulnerabilities, but they have not often explored what future climate change means for the underlying risks or the proposed adaptation responses.

Understanding governance of urban climate adaptation

While climate science is important for understanding climate change impacts and the effectiveness of potential responses, recent research has stressed that efficient, accountable and equitable governance systems and processes are just as important for ensuring that climate adaptation and mitigation responses are selected, implemented and sustained. Internationally, significant progress has been made in identifying and implementing climate change governance mechanisms in cities. In this section we consider some of the main elements of urban governance of climate change that have emerged from international literature and lessons. We then examine the status and progress of African cities — where research on climate change governance and practice on reconfiguring governance for climate change have been limited — in relation to these critical elements. There is an extensive general literature on urban governance available. In this chapter we focus specifically on that portion of the literature that deals with the urban governance of climate change.

Governance is 'the sum of the many ways individuals and institutions, public and private, manage their common affairs. It is a continuing process through which conflicting or diverse interests may be accommodated and cooperative action may be taken' (Commission on Global Governance 1995: 2). As such, climate change governance focuses on the many ways that a range of actors negotiate their interests as they address the challenge of climate change and take cooperative action to mitigate its effects and/or to adapt to it.

As early as the 1970s, 'cross-sectoral policy' demanded the integration of environmental issues into other sectors (Frölich & Knieling 2013). This demand reflected the realisation that decisions on urban environmental issues are generally tackled through a departmental or a sectoral approach. While such an approach may have some advantages, for example the specialisation of divisions and personnel (Puppim de Oliveira et al. 2013), sectoral approaches often end up with limited coordination and cooperation between governmental bodies and divisions and thereby prevent the development and implementation of integrated policies.

In recent years, the concept of 'mainstreaming' has been used to argue that climate issues have to become integral aspects of multiple sectoral policies (see for example Swart & Raes 2007). Mainstreaming across different sectors is particularly important in the urban context since conflicts between competing priorities are more evident there, and shared interests in avoiding socio-ecological crises are stronger among actors who co-habit the same governance and physical spaces.

International research thus suggests that city governments should adopt a coherent and collaborative approach to the management of climate change, bringing together previously uncoordinated agendas including climate change mitigation, climate change adaptation, disaster risk management, water and sanitation, sustainable development, and so forth (see Birkmann & Von Teichmann 2010; Bulkeley 2010; O'Brien 2012; Pelling 2011; Satterthwaite & Dodman 2013). Reflecting this recognition, multi-level and collaborative forms of governance have emerged as important for progressing cross-sectoral climate change integration, since they focus attention on vertical and horizontal policy integration and on collaboration between diverse stakeholders (see Corfee-Morlot et al. 2011; Frölich & Knieling 2013; Leck & Simon 2013). The horizontal or networks approach in multi-level governance sees public and private actors interacting across levels of social organisation (linking for example informal institutions, community associations, private business, research institutes and local governments). This conception of governance focuses attention on the relationships and networks between actors.

The role of networks beyond the city scale

At the 'beyond the city' scale, the important influence that networks have for urban climate planning and implementation has been extensively recognised. Both the grey and the academic literature highlight the important role that inter-organisational collaborations, such as transnational city-to-city networks or city-to-international donor networks, play in driving climate change governance (see Bulkeley 2010). For instance, ICLEI Africa is currently implementing a five-year European Commission-funded project entitled *Sustainable Urban Resilient Water for Africa: Developing Local Climate Solutions* in six southern African cities: Port Elizabeth (South Africa); Bulawayo (Zimbabwe); Walvis Bay (Namibia); Lusaka (Zambia); Blantyre (Malawi); and Francistown (Botswana). The project aims to contribute to sustainable, climate change-resilient urban planning and action from the water sector perspective (ICLEI 2013; ICLEI Africa 2014). For a mitigation example, the Urban Low Emissions Development Strategy (Urban-LEDS) project, also funded by the European Commission, and implemented by UN-Habitat and ICLEI, has the objective of enhancing the transition to low-emission urban development in emerging-economy countries, South Africa among them. The project offers seven local governments in South Africa a methodological framework for integrating low-carbon strategies into all sectors of urban planning and development.[12] The recognition that Mozambique's coastal cities are among the most vulnerable in Africa has prompted a partnership between the United States Agency for International Development (USAID) and the government of Mozambique's National Institute for Disaster Management. The Coastal City Adaptation Project works to improve the government's ability to provide city services that are sustainable and resilient to natural disasters in two cities along the Mozambican coastline: Pemba and Quelimane (Chemonics n.d.; Gerston 2015).

The role of networks at and within the city scale

At the 'within the city' scale, only a handful of cities on the African continent are known as 'endogenous' climate change leaders, and all are located in South Africa. The metropolitan areas of Durban, Johannesburg, Pretoria (the municipality of Tshwane) and Cape Town have taken the lead in assessing, articulating and starting to address a number of issues under the climate change umbrella. Accounts of the climate change-related efforts of the local governments in these cities, working in collaboration with universities, local consultancy partners and/or NGOs, are appearing in the literature (see ASSAf 2011; Cartwright et al. 2012; Taylor et al. 2014; Pasquini et al. 2015). These collaborations showcase the importance of the horizontal networks approach. However, informative accounts of engagements between local governments, community/civil society associations and private businesses, in South Africa as well as the rest of Africa, are still lacking.

Furthermore, the South African cases, as with other African cases, still demonstrate a highly sectoral approach to climate change governance. For instance, disaster management and coastal management are two sectors that frequently drive attention to and governance of climate change issues, as the Pemba, Quelimane and Cape Town cases illustrate. Mitigation efforts often drive climate change governance, as in the City of Tshwane, which is focusing on waste management, renewables, energy efficiency and transport (WWF 2015). Within cities there is little outreach and collaboration between local government departments and between sectors. Even Durban, in South Africa, a city globally recognised as an adaptation leader, still has an adaptation approach characterised by sectorally focused plans and projects (Roberts & O'Donoghue 2013), although it is in the process of attempting to develop a city-wide climate change strategy (Leck & Roberts 2015).

There is still some way to go towards achieving effective climate change governance in most parts of Africa, considering the following:

(a) Across Africa most examples of climate change action are driven by external funding and networks; at the same time, endogenous initiatives remain difficult (though not impossible) to undertake for the majority of towns and

12 See http://urbanleds.iclei.org/, accessed 19 January 2019.

cities in Africa, whose availability of personnel and levels of resource and institutional capacity are still low (see Carmin et al. 2012; Simon 2010).

(b) The integration of mitigation and adaptation issues across different sectors and their respective polices is a central mechanism of effective climate change governance, but even the most advanced cities (in terms of climate change governance) on the continent are struggling with the cross-sectoral integration of responses to climate change.

In this context, it is important to note that research focused on horizontal network governance at the intra-city level remains inadequate in the African urban context. Comprehensively mainstreaming climate change at the city level necessitates greater attention to the networks and relational arrangements, attributes and processes that exist across the varied stakeholders within a city.

The importance of linking the climate change and development agendas in urban Africa

Development challenges facing African cities are profound. They include reducing unemployment levels, ensuring minimum housing standards and building the infrastructure to provide basic water, sanitation and energy services to all urban residents. Therefore a development-led approach that is sensitive to current and future climate risks, vulnerabilities, and emissions contributions, in addition to other risks facing African cities, should be prioritised. By contrast, a stand-alone emissions and/or impacts-led climate change agenda risks competing with, and drawing attention and resources away from, other critical developmental agendas. A stand-alone climate change agenda is thus likely to fail to get sufficient political traction and investment to succeed in attaining its goals. However, there are multiple opportunities to engage more directly with the field of climate science that could lead to a 'climate-compatible', 'climate smart', 'climate resilient' or 'climate positive' development approach. Such enhanced engagement between science, policy and practice requires strengthening mechanisms for more holistic and integrated governance, which is at the nexus of the development and climate change agendas. Financing arrangements between local government, national government, and international funding agencies need to be reconfigured to enable proactive, city-scale action on climate change. For example, one option could be to set climate resilience conditions on national funding sources for infrastructure development.

A few types of interventions for strengthening climate change responses at the city scale stand out. Firstly, a diverse group of actors need to be included in the development and implementation of climate change responses, as the network approach to multi-level governance emphasises. Neither government (local and/or national) or households or community-based organisations can substantially reduce climate risks and vulnerabilities single-handedly. Climate governance progress in Africa has shown the importance of collaboration between governments and universities, local consultancy partners and/or NGOs. What is now also required is evidence of engagements between governments, community/civil society associations and private businesses. In particular, engaging communities in understanding local vulnerability and developing and implementing climate adaptation responses is critical to meeting development objectives. This approach builds on the idea that local communities have agency and know their own situation best. It also builds capacity to respond to climate and other risks, so that communities can choose how they would like to build their future. However, the political history of Africa (including that of civil unrest and conflict) makes such partnerships particularly challenging to build and sustain (Lwasa 2010).

On the topic of governance networks, it is clear that links to international city networks should be highly valued and strengthened, and that cities lacking these links ought to pursue them as a matter of priority. It is also important to note that the integration of climate change policies and measures across sectors can potentially lead to a greater integration of climate change concerns into development processes. Such integration is increasingly recognised as critical, since risks associated with climate change and variability alter the contexts in which development occurs. While there is a growing literature on the potential synergies between climate change policies and other urban development goals, examples of this in practice appear to be rare across the globe. However, numerous benefits are expected from integrating mitigation and adaptation across different sectors, such as the potential to make more sustainable, efficient and effective use of human, financial and environmental resources (see Persson & Klein 2008). This potential efficiency is a critical consideration for most African towns and cities, where resources are in scarce supply and are pressurised by conflicts and inconsistencies between policy domains.

An important point to note in any discussion on the implications of climate change for development is the high levels of informality of African cities. Informality and ‘the unplanned’ need to be taken seriously, as this mode of development represents the living conditions of a large proportion of residents and spatial areas in many African cities can be up to 80 per cent in some cities, such as Dar es Salaam (Kiunsi 2013). Getting the basics of spatial planning and land use management in place is a priority (Kiunsi 2013; Parnell 2015) for both formal and informal areas, as informal areas are often highly exposed to a range of hazards and stresses, including flooding, poor sanitation and poor water quality and access. High levels of informality suggest that governance approaches drawn from the global North will require modification for implementation in the global South. While it is important to build on global insights and best practices, these must be subject to critical engagement and revision to account for the local realities of each specific context. In this regard, more research is needed to understand the role of governance in supporting climate change assessment and adaptation in African cities, drawing on the wider body of urban governance literature that tackles questions of devolution, unfunded mandates, informality, complexity and non-traditional actors.

Learning-by-doing should be prioritised (Lwasa 2010; Roberts et al. 2012), and should be developed in a strategic fashion by drawing on international best practice in tandem with understanding local needs. While African cities are still a long way from achieving effective climate change governance, there is the potential for them to 'leapfrog' over initial learning curves by learning from the lessons of other regions. This suggests that effective data collection, record-keeping, analysis, evaluation, and forums for reflection should be integrated into the work of implementing adaptation and development interventions.

In conclusion, it is important to note that despite adaptation having received a greater focus in the urban African context than mitigation, such focus has not necessarily, as we have reviewed, translated yet into systemic or substantial adaptation actions or outcomes on the ground. In part, this may be a reflection of the low availability of published information in the urban African context. Progress may be occurring on the ground, but may not be being researched, recorded or published. And in great part the lack of implementation progress is likely to reflect the all too real difficulties of adaptation implementation, particularly given its dominant framing as an 'environmental' issue, and thus one that does not have much traction with policy agendas. Climate change has not been seen as the most important challenge to consider, given the urgency of other development pressures. In this context, it is an opportune time to review the City of Cape Town's climate change responses, because there exists a wealth of research on climate change for the City (that has been recorded and published), and there has also been a relatively long history of policy discussion related to adaptation.

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CHAPTER 3

An overview of climate change and urban development in Cape Town

Anna Taylor and Helen Davies

This chapter provides context for the chapters that follow. It offers an overview of the development trajectory and the historical and projected climate conditions of Cape Town which provides the background against which to understand the local interconnections between climate change and development. The chapter explores who is doing what in Cape Town to adapt to and mitigate climate change, with a particular focus on the role of a local government in enabling climate change response action. This brings to the surface a number of lessons about mainstreaming climate change at the city scale that may be of relevance to other cities in South Africa, Africa and elsewhere in the world.

The development context of Cape Town

Situated on the coast between two mountain ranges, with a long history of settlement, Cape Town is a city characterised by biophysical and socio-cultural diversity. High levels of socio-economic inequality and spatial fragmentation are also a striking feature. The City of Cape Town Municipality (CCT, also referred to as the City) is a metropolitan municipality spanning an area of 2 359 km^2 as shown in Figure 3.1 (CCT 2014a). Cape Town has a population of approximately 4,2 million (CCT 2018), making it about the tenth-most populous city in Africa (UN World Cities 2016) and the second-most populous in South Africa, after

Figure 3.1: Map showing CCT municipal boundaries and neighbouring municipalities
Source: Figure drawn for authors by A. McClure

Johannesburg.[1] The city's population has grown by 45 per cent in the last 15 years, and this growth is associated with rising demand for land, housing, energy, water and other services such as sanitation, transport and education (CCT 2014b). This is in addition to unmet demand in areas with a long history of under-servicing.

Inequality in Cape Town

Levels of socio-economic inequality remain exceptionally high in South Africa, a legacy of the apartheid regime. Cape Town is no exception, with a Gini co-efficient of 0,61 in 2017, indicating very high levels of income inequality (CCT 2018a).[2] Poverty in Cape Town remains widespread. The number of indigent households in the city increased from 250 000 in 2003 to 377 813 in 2016 (WCG 2018).[3]

The economy

Cape Town has the country's second-largest municipal economy after Johannesburg (Turok & Borel-Saladin 2013). Cape Town's economy accounted for 13,8 per cent of South Africa's GDP in 2017 (EPIC 2017: Q4) and approximately 72 per cent of the Western Cape's GDP in 2016 (WCG 2018). Cape Town's real GDP per capita in 2017 was R106 839, comparing favourably with a national figure of R88 262 (EPIC 2017: Q4). The average among South Africa's metropolitan municipalities was R55 167 in 2014 (CCT 2014b). Cape Town is a hub of agricultural processing and export, with the second-busiest container port in South Africa, after Durban. The city also contains a host of scenic beauty spots and natural attractions that underpin a growing tourism industry. However, the finance sector constitutes

1 The 10 African cities more populous than Cape Town are: Cairo, Egypt (19,12 million), Lagos, Nigeria (13,6 million), Kinshasa, Democratic Republic of Congo (12,07 million), Johannesburg, South Africa (9,6 million), Luanda, Angola (5,73 million), Dar es Salaam, Tanzania (5,4 million), Khartoum, Sudan (5,26 million), Abidjan, Ivory Coast (5,02 million), Alexandria, Egypt (4,86 million) and Nairobi, Kenya (4 million). See http://www.un.org/en/development/desa/population/publications/pdf/urbanization/the_worlds_cities_in_2016_data_booklet.pdf, accessed 26 January 2019.

2 A Gini coefficient of 1 means that all income belongs to a single individual, while a coefficient of 0 means that every resident has an equal share. South Africa's national Gini coefficient ranges from 0,63 to 0,68, depending on the dataset and time period used (Statistics SA 2017).

3 Households that qualify for a Reconstruction and Development (RDP) or Breaking New Ground (BNG) government-subsidised house form the proxy baseline for determining indigence in Cape Town. Any household earning R3 500 or less per month qualified for an RDP or BNG house in 2011. Since the 2011 census data had a cut-off point at R3 200 per month only (and not R3 500) the CCT used this figure as the poverty line in 2011.

the largest contributor to Cape Town's local economy, providing 30,9 per cent of GDP. The structure of Cape Town's economy has moved steadily away from the productive sectors towards specialised service sectors (CCT 2014b).[4]

Employment

The number of jobs in Cape Town's manufacturing sector is declining significantly, while the finance, transport, trade and construction sectors have created new jobs in recent years (CCT 2014b). As labour force growth has exceeded employment growth, the strict unemployment rate in Cape Town increased from 19,2 per cent (CCT 2014b) to 22,4 per cent (EPIC 2017: Q4) between 2005 and 2018 (EPIC 2018: Q1). The informal sector in Cape Town is estimated to account for 9 to 11 per cent of people in employment (CCT 2014b), a very small figure compared to most other African cities. For example, in Dakar, Senegal, and in Bamako, Mali, as many as 79,8 per cent and 82,1 per cent respectively of workers employed in non-agricultural sectors work in the informal economy (UN-Habitat 2014).

Spatial density and transport

Cape Town is a low-density city with a sprawling spatial form and poorly integrated land use pattern (Ewing & Mammon 2010). The Siemens Green City Index, developed by the Economist Intelligence Unit (2012), found Cape Town to be the second-least densely populated among the 15 African cities included in the study.[5] Cape Town's density figure was estimated at 1 500 persons/km^2, far below the average density across all 15 African cities of 4 600 persons/km^2, which was in turn well below the 8 200 persons/km^2 average density of 22 Asian cities included in the study (Economist Intelligence Unit 2012). Because of this low density and urban sprawl, many Cape Town residents have poor access to economic opportunities and services, and commute long distances. While government is making large investments in improving public transport services, notably through the phased rollout of a bus rapid transit system, elements of the public transport system are not under local government control or within its mandate. Ownership of light passenger vehicles has doubled over the past 15 years in Cape Town (CCT 2015b), with 48 per cent of residents still relying on private vehicles (Transport for Cape Town 2015) and leading to growing congestion and vehicle emissions, as discussed later in this chapter (CCT 2015b).

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4 Other key service sectors contributing to Cape Town's local economy include real estate, business process outsourcing, auditing, architecture and engineering.

5 Cities included in the African Green City Index were: Accra, Ghana; Addis Ababa, Ethiopia; Alexandria, Egypt; Cairo, Egypt; Cape Town, South Africa; Casablanca, Morocco; Dar es Salaam, Tanzania; Durban, South Africa; Johannesburg, South Africa; Lagos, Nigeria; Luanda, Angola; Maputo, Mozambique; Nairobi, Kenya; Pretoria, South Africa; Tunis, Tunisia.

Natural systems

With over 300 km of coastline and a mix of mountain and lowland areas, Cape Town incorporates a range of natural and semi-natural open spaces and a diversity of terrestrial and aquatic ecosystems. Situated within the Cape Floristic Region, the smallest of the world's six floral kingdoms, Cape Town is a biodiversity hotspot of global significance. However, many endemic species are under threat of extinction (Holmes et al. 2012; Rebelo et al. 2011). The conservation of these species, and the ecosystems they form part of, is difficult owing to pressure on land for housing and commercial interests, driven by urban and economic growth. On the other hand, Cape Town's tourism industry is largely reliant on the health and attractiveness of these natural assets. In addition, natural systems such as wetlands, rivers and coastal dunes play an important role in buffering the city against extreme weather and climate events.

Service delivery

By South African and African city standards, Cape Town compares favourably when it comes to levels of public services provision. Census data from 2011 suggest that approximately 97 per cent of Cape Town's households have access to basic public services according to nationally stipulated minimum standards (CCT 2014a). However, unpacking the details reveals a significant number of households in Cape Town living in extremely poorly serviced conditions. In 2014/15 an estimated 30 000 households had no access to water within 200 m of their yard; 74 800 households only had access to a bucket toilet or no sanitation at all; 22 000 households used their own refuse dump and/or had no refuse disposal; and 36 316 households were without basic access to electricity (CCT 2014a).

Local government

The CCT local government has executive and legislative authority in the municipal area. In terms of the constitutional requirement for cooperative governance, the CCT must ensure that all its policies, strategies and plans align with national and Western Cape provincial legislation and policy. Since 1994, Cape Town's local government has been through numerous phases of integration and restructuring. Sixty-one local, racially segregated municipalities with different functions and levels of political authority were ultimately unified into one metropolitan municipality in December 2000, guided by the Local Government: Municipal Structures Act (No. 117 of 1998) and the Local Government: Municipal Systems Act (No. 32 of 2000) (Jaglin 2004). Through this restructuring there was a devolution of government functions from the national to the local level, and the service delivery approach shifted to focus on public-private partnerships, cost recovery and performance management systems (Swilling & De Wit 2010; Watson 2002).

The CCT currently consists of 231 politically elected City councillors, led by an Executive Mayor, who constitute the City Council; and nearly 30 000 City officials, headed by a City Manager, employed within the City administration. Since the local government elections of 3 August 2016, the Democratic Alliance, South Africa's main opposition political party at the national level, has a 66,6 per cent majority in the political leadership of the CCT. In the past few years, the CCT has worked to streamline policy development across public service domains and facilitate 'transversal management' to enable more effective service delivery and the realisation of priority agendas.

The climate context of Cape Town

Cape Town has a Mediterranean climate with warm, dry summers and cool, wet winters. This sets Cape Town apart from the other large cities in South Africa, all of which have sub-tropical, summer rainfall climates. The seasonal climate cycle experienced in Cape Town is largely driven by the presence of the South Atlantic high-pressure system during the summer and passing mid-latitude cyclones in the winter that bring cold fronts, rain and stormy seas (Tadross et al. 2012). Figure 3.2 shows the seasonal cycle based on historical data (1979–2000) collected at Cape Town International Airport. The narrow seasonal temperature range highlights the moderating effect of the ocean on Cape Town's climate.

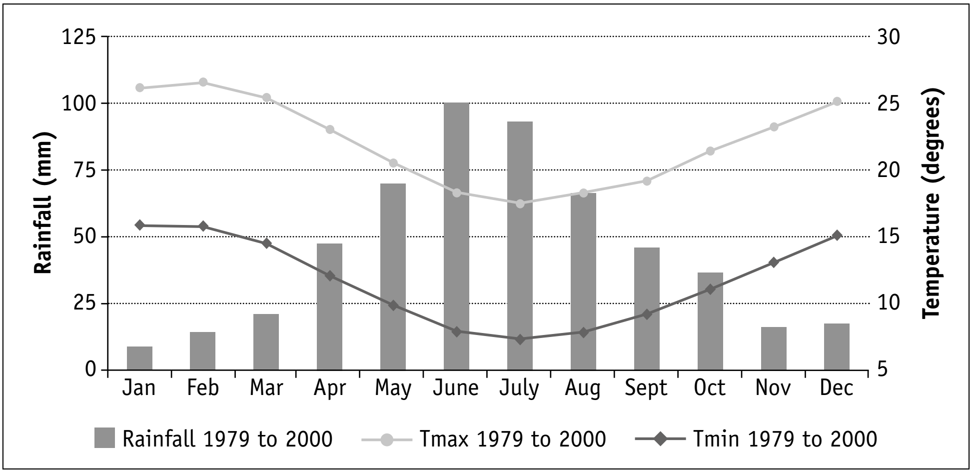

Figure 3.2: Monthly averages of total rainfall, maximum temperature and minimum temperature for 1979 to 2000 at the Cape Town International Airport weather station
Source: Climate Information Portal, http://cip.csag.uct.ac.za/, accessed 15 February 2016.

What the historical climate averages in Figure 3.3 do not show is the high variability of conditions between years and between different locations within the city. For example, the longer record at Cape Town International Airport (from 1841 to 2006) shows total annual rainfall ranging from 229 mm to 1 037 mm (Adelana et al. 2010). A comparison of data collected at the airport (inland) and at a coastal station at Cape Point shows considerable differences, for example a recorded average annual rainfall of 539,9 mm and 355,17 mm respectively.[6] It is in times and places of extreme rainfall and/or temperatures that adverse impacts are experienced. Climate impacts faced in Cape Town are discussed in a later section of this chapter. The severity, frequency and/or duration of such extreme events are changing due to increasing global concentrations of greenhouse gases (GHGs) in the atmosphere. The latest climate change projections undertaken for Cape Town recommend preparing in earnest for a drier, warmer future in the coming decades: 'the evidence for drying and warming is strong and planning that ignores this evidence is at significant risk of vulnerability to a changing climate. There is now sufficient science evidence to motivate for serious consideration of climate adaptation planning and implementation in the city' (CSAG 2016: 2). Understanding changes in the local climate requires looking at both trends in historical climate records and projections of the future climate (that is, both global models and downscaling analyses, as outlined in Chapter 1).

Past trends

A study of rainfall and temperature records for the period 1960 to 2010 at the South African Astronomical Observatory found that recent decades have, on average, been warmer than the preceding ones, and rainfall events have been less frequent but more intense than in the past (Tadross & Johnston 2012). A more recent study commissioned by the CCT, covering the broader Cape Town region using surrogate datasets (i.e. not station data), also shows a clear warming trend (CSAG 2016). The rainfall picture is mixed. The long-term trends in rainfall (1901 to the present) show an overall increase in rainfall in the northern part of the Cape Town region and a decline in the southern part. The mid-term (1979–2013) trends in annual rainfall show slight, although not statistically significant, drying (CSAG 2016). While changes in the local climate are thus already evident in the records, they are much clearer for temperature than for rainfall.

6 Data available through the Climate Information Portal, http://cip.csag.uct.ac.za/, accessed 15 February 2016.

Future projections from global models

Looking at temperature trends for the Cape Town region simulated by multiple GCMs[7] suggests that current temperatures (2010 to present) already exceed the range of historical climate variability simulated between 1986 and 2005 (CSAG 2016). In other words, we are likely already seeing temperatures occurring that are historically unprecedented. When run using a scenario of the future in which efforts to reduce global greenhouse gases have not been highly effective (i.e. RCP8.5)[8], the GCMs show a clear continued pattern of warming into the future, ranging from one to two degrees Celsius by the 2050s and two to five degrees by the end of the century (CSAG 2016; Tadross & Johnston 2012).

The rainfall picture across the GCMs shows a continuation of the same natural variability range as 1986–2005 until around 2030–2040, followed by a shift towards a drier future. The models vary in their projections of how much drier the future might be (based on modest global mitigation gains) ranging from small reductions through to as much as a 50 per cent reduction in rainfall (CSAG 2016). The strongest reduction in rainfall is projected for autumn and winter.

Downscaled future projections

The results obtained from statistically downscaling the projections made by Coupled Model Inter-comparison Project 5 (CMIP5) GCMs show similar patterns of projected warming across Cape Town, associated with increases in the number of extreme hot days and heat spell duration (CSAG 2016 and the Climate Information Portal).[9] The downscaled rainfall projections, however, differ from the GCM projections, showing an almost equal split between a wetter future and a drier future, ranging from a 20 per cent decrease to a 20 per cent increase by the 2050s. An initial analysis suggests that the downscaling approach used is potentially failing to capture drivers of rainfall variability and change. Consequently, along with clear warming trends, the potential of reduced rainfall in the future shown by GCM results should factor into planning, while acknowledging that the statistical downscaling continues to show a mixed picture (CSAG 2016).

Because Cape Town relies on resources drawn from across the wider Western Cape region, notably water and agricultural products, it is not only the climate

7 As simulated and projected by the fifth set of experiments run in the Coupled Model Inter-comparison Project (CMIP5).

8 RCP8.5 is the Representative Concentration Pathway depicting an increase in greenhouse gases resulting in an equivalent increase in solar radiation of 8,5 Watts per square metre at the top of the atmosphere by 2100; i.e. this is the worst-case scenario in terms of reducing global GHG emissions.

9 Statistical downscaling uses historical records of rainfall and temperature as well as histories of circulation patterns to calibrate a statistical model relating circulation patterns to local responses.

within the boundaries of the city but that of the wider region that impacts on the city's functioning. Climate data from across the Western Cape region also consistently show trends of warming in the historical record and in the future climate projections, with inland areas warming more than the coastal areas (CSAG 2014). The rainfall projections for the wider region are also varied. Projections point to possible aggregate drying in the region, but some models and locations show future wetting (CSAG 2014).

The overall climate picture

In sum, the available climate information shows clear evidence of increasing temperatures in the historical records, continuing to rise in the future projections across Cape Town and the broader Western Cape region, with inland areas warming more than coastal areas. This average temperature increase is associated with more extreme hot days, as well as less extreme cold temperatures, with notable impacts on health, agricultural production, water availability and energy demand. Rainfall patterns are more varied. There are signs in some station records of dry spells (i.e. number of days between rainfall events) increasing and rainfall events becoming more intense in recent decades. Projections of future rainfall from GCMs show annual totals remaining within the 1986–2005 natural variability range until the 2030–2040 period, followed by significant drying, especially in autumn and winter. The downscaled models show potential for either an increase or a decrease in rainfall. This remains a crucial area for further research. The challenge of developing detailed climate information at the city scale is not limited to Cape Town. It is an area of international scientific research, as described in Chapter 1 of this book, requiring increased investment in data collection and analysis.

As a coastal city, Cape Town is not only susceptible to and impacted by changes in the atmospheric climate conditions but is also impacted by changes in ocean conditions, particularly the mean sea level and the size and frequency of storm surges. An analysis of historical sea level records for the Cape Peninsula suggests an accelerating increase in local mean sea level that is consistent with global estimates of an average rate of increase of 1,8 (1,3–2,3) mm per year since 1961 and an increase of 3,1 (2,4–3,8) mm per year since 1993 (Brundrit 2008). As such, managing Cape Town's coastal areas for adaptation to an accelerating rise in sea levels and more intense storm surges will also prove critical to sustainable development.

Intersections between Cape Town's climate and development

The ways in which the city is growing and developing contribute to the impact that human activities have on the global climate. The development of the city also directly affects the extent to which and ways in which people and natural systems in the city can cope with and adapt to changes in climate conditions. The impacts of and resilience to climate change are the focus of this section.

Climate impacts and associated costs

The range of climate conditions currently experienced in Cape Town periodically leads to costly impacts. The evidence for continued warming and future drying is strong, and planning that ignores this evidence is ill-informed (CSAG 2016). Without significant and timeous adaptation action, direct climate impacts are likely to include:

- water stress in times of drought; fires in the dry, hot season;
- flooding triggered by heavy rainfall;
- coastal erosion and inundation caused by large winter storms and associated sea surges;
- damage to homes and public infrastructure from heavy winds and wind-blown sand;
- health threats from high temperatures and high concentrations of air pollution; and
- species loss that reduces local biodiversity and undermines the functioning of ecosystems (CCT 2006; Mukheibir & Ziervogel 2007).

Many of these impacts have been experienced in the past and may intensify unless preventative action is taken.

Climate impacts in turn create secondary impacts on the local economy and by extension the provincial economy. The Port of Cape Town and smaller harbours may be able to operate for fewer days of the year, and transport infrastructure may be blocked, damaged or destroyed. The quantity and quality of water, a critical resource underpinning the economy, is under increasing threat as the climate warms and gets drier and the city grows (Ziervogel et al. 2010). Agricultural productivity is compromised by changes in temperature and rainfall patterns, affecting the availability and cost of food, the export of agricultural products, and the profitability of Cape Town's agro-processing industry. Health impacts and disaster events are associated with reduced worker productivity, lower school attendance and an increased burden on the public health care service. Costly damages could lead to losses in the insurance sector, which in turn affect premiums and insurability. Deterioration of the city's ecosystems affects functions and services such as flood attenuation, water cleansing and recreational space, as well as compromising the scenic attractions that underpin the tourism industry. Repairing damages to physical infrastructure such as roads, railway lines, parking areas, pipes and electrical lines caused by high winds, flooding, wind-blown sand and extreme high temperatures is a drain on already stretched government budgets. Costly repairs to private properties have a disproportionate impact on the budgets and profitability of poor households and small businesses, also affecting the affordability of insurance. For example, a large flood event in November 2013 resulted in damages of R167,5 million across the CCT, Cape Winelands, Overberg and Eden municipalities (Pharoah et al. 2016). An assessment of sea level rise risk for Cape Town found that over the next 25 years the area seaward of the 2,5 m contour is highly vulnerable to flooding from storm surge events. In the event that the 2,5 m or 4,5 m contour is flooded, infrastructure to the value of R5,2 billion and R23,8 billion respectively would be exposed (Cartwright 2008).[10]

The full extent of climate risks to and impacts on Cape Town's economy (in a range of scenarios, for all affected sectors) has not been quantified. Methodologies for doing such city-scale economic impact assessments are an area of active research. Studies that have been undertaken, mostly in European and North American cities, show vast costs associated with climate impacts across the urban system (Hallegatte et al. 2011; Hunt & Watkiss 2011; Kirshen et al. 2008).

Vulnerability to impacts

The vulnerability of people and natural systems to climate impacts and associated damages and losses is not evenly distributed across Cape Town, either spatially or socio-economically. For example, heatwaves are known to have particularly severe effects on people with suppressed or underdeveloped immune systems, namely children, the elderly and those with pre-existing health conditions such as HIV/AIDS and tuberculosis. Furthermore, droughts creating water scarcity and food insecurity affect the city as a whole, but not everyone experiences these impacts equally. A spike in food prices hits the city's poorest households hardest, and it is individuals with fragile or compromised health who are worst affected by a decline in the nutritional value of their food intake. This points to the multiple and complex interlinkages between Cape Town's climate and development conditions.

A comprehensive city-scale climate vulnerability assessment has yet to be done for Cape Town. An assessment of this kind is an important step in the process of identifying how to tailor, target and sequence adaptation and risk management interventions within the city, especially in light of scarce and limited resources to do such work. Ideally, a vulnerability assessment should help to answer questions about where to target interventions, i.e. spatial focus; who to target, i.e. demographic or socio-economic focus; and what to target, i.e. what elements and

10 Wave run-up measured with a differential GPS from a storm surge on 31 August, 2008 indicated that both these scenarios have already taken place. These cost estimates are based on the theoretical assumption that the entire coastline would be inundated in both scenarios. Cape Town's coastline is not, however, homogenous and flooding events will take place on a discrete basis in 'pockets'. The nature and spatial extent of the flood event will also be influenced by the particular characteristics of storm surges, for example wind and swell direction, significant wave height and timing in relation to tidal fluctuations.

relations within the urban system are potentially important leverage points for intervention.

Declining biodiversity and ecosystem functioning

While many species have the ability to adapt and migrate in response to changing temperature, rainfall and wind patterns, their persistence is challenged by habitat loss and fragmentation caused by increasing urbanisation and the conversion of open land into built environment (Holmes et al. 2012; Rebelo et al. 2011). Cape Town's growth has resulted in habitat fragmentation and destruction, placing numerous species under considerable threat of population collapse and driving biodiversity loss. The loss of ecosystem functioning decreases the extent to which ecosystems can provide a buffer against the human impacts of climate change, for example flood attenuation and filtering of water.

Cape Town's emissions contributing to climate change

The extent to which climate impacts are experienced and climate adaptation is needed depends on the nature of Cape Town's development and on how much the global climate, and therefore the local climate, changes. The latter depends on the cumulative levels of GHGs emitted globally. Cape Town's development in relation to climate change therefore needs to focus not only on impacts and adaptation, but also on the city's contributions to GHG emissions, particularly in light of South Africa's nationally determined mitigation contributions under the United Nations Framework Convention on Climate Change (UNFCCC).

Cape Town's GHG emissions in 2012, including marine and aviation fuels, were 5,55 tCO_2e (tons of carbon dioxide equivalents) per capita (CCT 2015b). This positions Cape Town as a medium to high emitter when compared with other cities globally. For example, Cape Town's per capita emissions are higher than those of Stockholm, Sweden, at 3,6 tCO_2e per capita, but lower than those of Beijing, China, at 10,8 tCO_2e per capita (CCT 2015b).[11] In terms of national benchmarking, Cape Town's per capita emissions figure is similar to those of the other major South African metropolitan municipalities of Johannesburg, Tshwane and Ekurhuleni (CCT 2015b).

Cape Town's high carbon footprint is largely a result of the city's energy supply being primarily fossil fuel-based (i.e. coal and oil), the city's sprawling and poorly integrated urban layout that leads to considerable transport demands, and a poor public transport system. In terms of sectoral contributions, transport dominates, accounting for 33 per cent of the city's GHG emissions in 2012, followed by the commercial (26 per cent), residential (22 per cent) and industrial (11 per cent) sectors (CCT 2015b). Emissions generated by the operations of Cape Town's municipal government accounted for 2 per cent in 2012 (CCT 2015b). While the

11 Data for Stockholm and Beijing from 2005 and 2006 respectively.

city's emissions continue to grow year-on-year, the rate of growth has declined (CCT 2015b). Climate change mitigation efforts aimed at reducing the city's GHG emissions are focused on the following measures:

- improving energy efficiency across all sectors;
- investing in public transport;
- encouraging compact forms of urban growth and development to reduce sprawl; and
- increasing the amount of renewable energy within the national and local energy production mix (CCT 2015b).

Governing climate and development in Cape Town

The previous sections of this chapter have highlighted the interconnected development and climate challenges facing Cape Town. The shift towards a more sustainable and climate-resilient development trajectory is complex and takes time. Various efforts are already under way to explore and implement adaptation and mitigation interventions. To contextualise the following chapters in this book, which describe many such interventions in detail, this section provides an overview of who is doing what to address climate and development issues in Cape Town, with a primary focus on local government.

Key role-players in Cape Town

Concerns about tackling climate change surfaced in Cape Town in the late 1990s and early 2000s. Work on energy and carbon emissions in South African cities, including Cape Town, under the Sustainable Energy for Environment and Development (SEED) programme was an important contributor to the establishment of the climate change agenda locally (Borchers et al. 2008). So too was the work of ICLEI Local Governments for Sustainability, an international association of local governments and local government organisations committed to sustainability. The CCT's 2001 Integrated Metropolitan Environment Policy contained the first official mention by local government of climate change concerns for Cape Town. This led to the development of an Energy and Climate Change Strategy and Framework for Adaptation to Climate Change in the City of Cape Town (FAC4T). Both were finalised in 2006, supported by Sustainable Energy Africa (SEA), the Energy Research Group (ERC) at the University of Cape Town (UCT) and the Climate Systems Analysis Group (CSAG). From these flowed:

- the Energy and Climate Action Plan (ECAP) in 2009 (updated annually);
- Cape Town's Energy Futures Study in 2005 and an updated version in 2011;
- the State of Energy Report (in 2003, 2007, 2011 and 2015);
- the Energy 2040 Report in 2015;
- the development of sectoral Climate Adaptation Plans of Action (CAPAs); and

- the Global Sea Level Rise Risk Assessment for the City of Cape Town study (Brundrit 2008; Colenbrander et al. 2015; Taylor 2016).[12]

In 2009, the Cape Town Climate Change Think Tank was established to further advance climate change research, policy and practice in Cape Town. This was a multi-stakeholder forum for commissioning and reviewing key pieces of research on various local dimensions of climate change, led by the CCT and UCT's African Centre for Cities (ACC) (Cartwright et al. 2012). This gave rise to the Mistra Urban Futures partnership between the CCT and ACC, through which collaborative research and writing was undertaken on various aspects of urban sustainability, including climate change adaptation, energy governance and low-carbon, resilient economic growth (Patel et al. 2015). The present volume is a product of the Mistra Urban Futures partnership.

In parallel, significant work was under way in the disaster risk management sector in Cape Town, which also tackles questions relating to climate hazards and the changing nature of such hazards. The research and consultancy work of UCT's Disaster Mitigation Programme (DiMP), which became the Research Alliance for Disaster Risk Reduction (RADAR) based at Stellenbosch University, made an important contribution by highlighting the risks and vulnerabilities of people and places in Cape Town to climate-related hazards (DiMP 2005; Holloway et al. 2010; Holloway & Roomaney 2008).

Other research groups and NGOs have been important advocates of and contributors to strengthening the climate change agenda in Cape Town. International networks and agreements have also played a key role.[13] The CCT is a signatory to and member of the Cape Town — Aachen Partnership (2001), the Mexico City Pact (2010), the Durban Adaptation Charter (2011), the C40 Climate Leadership Group (2014), the Compact of Mayors (2015), the 50 Municipal Climate Partnerships Programme (2015), and the 100 Resilient Cities Network (2016).[14] Compared to many cities within South Africa and across the African continent, Cape Town has a relatively high concentration of organisations working on climate change issues and level of international exposure. Various efforts have been initiated to strengthen and coordinate the network of local actors, such as the

12 Most of these policy and planning documents can be accessed online via the CCT's Document Centre: http://www.capetown.gov.za/Document-centre, accessed 23 January 2019.

13 Among the research groups are the Sustainability Institute (SI) at Stellenbosch University, UCT's African Climate and Development Institute (ACDI), the South African National Biodiversity Initiative (SANBI) and the local branch of the Cambridge Institute for Sustainability Leadership (CISL). The NGOs include the Environmental Monitoring Group (EMG), the World Wide Fund for Nature (WWF), and SouthSouthNorth (SSN).

14 Dates in parentheses indicate when Cape Town joined each grouping.

Cape Town Climate Change Think Tank mentioned earlier, and the Cape Town Climate Change Coalition.[15] Despite this, a lack of well-resourced and continuous leadership and coordination has meant that much of the capacity to act on climate change in a way that changes the development trajectory of the city as a whole to be more sustainable, resilient and low-carbon has yet to be fully realised.

Climate adaptation led by local government

Various disaster risk assessments have been undertaken for Cape Town that point to climate change as a key hazard and a compounding factor in a large number of the risks facing the city. This mirrors a global assessment of risks undertaken by the World Economic Forum (WEF) in 2016, which ranks climate change as the number one risk with the greatest potential impact, and third-highest in likelihood of occurrence (WEF 2016). The CCT has established an agreement with the South African Weather Service to receive notification of developing extreme weather conditions, to enable early warnings to be issued and disaster preparedness to be put in place. The CCT runs an intensive public awareness programme, particularly among high-risk communities, on what hazards to look out for and how to protect against and prepare for the impacts of these hazards.

Work by the CCT to reduce climate risks has largely taken place under the banner of nine sectoral Climate Adaptation Plans of Action (CAPAs).[16] The CAPAs have not necessarily driven the work, but have been an attempt at coordinating adaptation activities across local government. Water-related projects with a climate adaptation benefit have included: detailed flood mapping of key catchments to include climate change projections; adjusting the stormwater planning and infrastructure design to accommodate an increase in rainfall intensity; mapping informal settlements at risk of flooding to target flood protection interventions; the inclusion of water-sensitive urban design principles in key policies; the implementation of a water conservation and water demand management programme; and feasibility studies for alternative water supplies, including the use of groundwater and desalination. On the biodiversity front, the Local

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15 The Cape Town Climate Change Coalition was launched in 2011 to support Cape Town's bid to host the 17th session of the Conference of the Parties to the UNFCCC (COP 17). It represents an alliance of Cape Town-based organisations, including private sector, governmental and non-governmental organisations, researchers and educators. The partners agreed to continue working together to build Cape Town citizens' understanding of and commitment to addressing climate change issues.

16 Sectoral CAPAs have been developed for: Catchment, River and Stormwater Management; Coastal Management; Disaster Risk Management; Health; Human Settlements; Planning; and Water and Sanitation. For details on the development of the CAPAs see Taylor (2016). Draft CAPAs have been developed for Biodiversity Management and for Transport and Roads.

Biodiversity Strategy and Action Plan (LBSAP) and Biodiversity Network (BioNet) have integrated climate change considerations and the CCT runs a very effective invasive species management unit, improving water flows, protecting biodiversity and reducing fire risks. To manage climate risks relating to infrastructure networks and urban growth, work has been done to:

- develop a framework of Resource Efficiency Criteria for Development in Cape Town;
- develop an Integrated Coastal Management Policy and Plan;
- define coastal setback lines to reduce the risks associated with sea level rise and storm surges; and
- map transport infrastructure and networks at risk.

While some work has started, there is still much to be done to develop a full picture of climate risks to infrastructure, and to design, construct and maintain key infrastructure to withstand increases in temperatures, rainfall intensity, coastal inundation and changes in wind patterns.

Climate change mitigation in Cape Town

The CCT's work to reduce GHG emissions has largely taken place under the banner of the ECAP. Key projects include:

- retrofitting municipal buildings, streetlights and traffic lights to improve energy efficiency;
- installing rooftop photovoltaics (PVs) on City buildings;
- reducing the emissions of the City's vehicle fleet;
- developing an internal energy management policy and protocol;
- retrofitting ceilings in low-cost housing;
- developing a low-income energy services strategy;
- running an electricity savings campaign;
- developing an accreditation programme for solar water heater service providers; and
- establishing a commercial energy efficiency forum.[17]

On the energy production and reticulation front, the CCT has worked with others to establish a feed-in tariff for small-scale renewable energy producers, undertake smart metering and develop smart grids, and secure the supply of liquefied natural gas to the Western Cape. In terms of waste management, the CCT has been working on landfill gas extraction and anaerobic treatment of sewage sludge and organic waste, and registering a Clean Development Mechanism Programme of Activities for landfill gas mitigation with the UNFCCC. The CCT helped to create the Atlantis Special Economic Zone to support the local establishment and growth

17 The CCT's Electricity Savings Campaign is a social marketing campaign encouraging residents to use less electricity and informing them about how to do so (see http://www.savingelectricity.org.za/, accessed 19 January 2019).

of green technology companies, and has undertaken a number of public transport and non-motorised transport projects that have emissions reduction co-benefits, alongside various mobility and economic benefits. These include a strategic shift toward Transit Oriented Development (i.e., promoting development along transport corridors) and active implementation of the CCT Densification Policy, in order to reduce travel distances and make public transport infrastructure more viable.

Developing CCT policy to address climate change

Building on the aforementioned activities and the growing recognition that climate change poses a significant risk to Cape Town's socio-economic success, the CCT adopted a Climate Change Policy in 2017. The policy focuses on: 1) preparing for changes in the regional and local climate by reducing risks and building adaptive capacity; and 2) contributing to national and global efforts to reduce GHG emissions while addressing energy poverty and building local energy security.

To mainstream climate change into all CCT work, the policy is designed to realise co-benefits between climate change-specific goals and sustainable urban development goals more broadly, such as improved resource security, reduced costs, improved air quality, improved quality of life, long-term fiscal efficiency and the protection of lives, livelihoods, the economy, ecosystems and investments. By clarifying the CCT's policy position and priorities, the policy provides a framework to encourage and enable departments within the CCT to work in more intersectoral and collaborative ways internally, as well as working more effectively in partnership with citizens, business, NGOs and others. The policy aims to use the key levers and mechanisms held by the CCT to actively drive, influence and enable change across the city as a whole. These levers include, among others: strategic planning; development approvals; pricing tariffs and rates; and by-law development and enforcement. The CCT aims to drive change through the following mechanisms:

- its own operations, infrastructure development and service delivery approaches;
- the way the CCT internal budgets are allocated and used;
- raising awareness;
- managing natural systems and resources;
- the design and development of human settlements; and
- the establishment and strengthening of key partnerships with other spheres of government, academia, private sector actors and non-governmental, civil society organisations.

The coordination and alignment of city-level climate policy with provincial and national legislation and policy is essential to furthering cooperative governance of the complex and multi-scalar set of challenges and opportunities that climate change presents.

The Energy and Climate Change Strategy of 2006, which was replaced by the Climate Change Policy, was a sub-component of the Integrated Metropolitan Environmental Policy (IMEP). This positioning under environmental policy did not facilitate a holistic approach to responding to climate change. The new Climate Change Policy therefore stands alongside the new Environmental Strategy, which replaces the IMEP. The Climate Change Policy will guide work being done to implement the Environment Strategy, the Economic Growth Strategy, the Social Development Strategy, and the CCT's Integrated Development Plan. The intention is for climate change to be treated not as a separate, additional issue, marginalised from the core development agenda, but rather as part of an integrated approach to urban sustainability and resilience.

Mainstreaming climate change activities

The Climate Change Policy is a strategic effort to mainstream climate change activities into the operations of local government and the wider governance network of state and non-state actors. However, a number of factors continue to inhibit the full integration of climate change concerns into all CCT line functions. A significant impediment is the financial management framework with which all local governments have to comply. Supply chain procedures limit the procurement of 'untested' technologies and application of innovative approaches, and do not adequately allow for higher upfront capital expenditure that gives rise to long-term reductions in operational expenditure (TAU & WCG 2013). Another impediment is that concepts and terminology used in the climate change field (such as adaptation, mitigation, vulnerability and uncertainty) are often unfamiliar to specialists in other fields and to political decision-makers. This challenges understanding and ownership of the issue, undermining mainstreaming efforts.

In early 2015, the CCT set up transversal management structures to promote the integration of policy development, implementation and service delivery across local government. One of these structures is the Green Economy, Energy and Climate Change Working Group, comprising representatives from 14 different line functions. This is a critical forum through which to mainstream climate change issues and pursue the adoption and implementation of the Climate Change Policy. In May 2016, the CCT became a member of the 100 Resilient Cities Network. The initial resilience risk assessment undertaken highlighted climate change as a key risk area. As a result, climate change will be an integral component of the resilience strategy, which is under development.

Conclusion

This chapter has shown that Cape Town faces a number of interrelated development and climate change challenges. While much work is under way to reduce climate risks, build adaptive capacity and reduce GHG emissions, there is still more to be done to make climate change a mainstream development issue within the planning, decision-making, design and management of Cape Town's urban system. There is growing acknowledgement that climate change poses significant risks to the socio-economic development of the city, with the poor being the most vulnerable, but this view is by no means universal.

The climate, history, socio-economic profile and governance network of Cape Town may be somewhat different to those of other cities in South Africa and beyond, but a number of lessons emerging from Cape Town's experience to date can potentially shed light on the challenges and opportunities for addressing climate and development challenges in cities elsewhere.

Firstly, understanding the spatial, social and ecological configuration of climate change hazards, vulnerabilities and risks is key to planning interventions and prioritising investments. Uncertainty in this regard must be accommodated to enable appropriate development and response action. Secondly, the climate change agenda cannot be framed simply as an environmental issue to be dealt with by the local government's environment department. Rather it needs to be elevated to a multi-sectoral, cross-cutting issue, requiring contributions from numerous line functions and specialist units and coordination across and between the strategic and operational levels of local government. Thirdly, collaborations, partnerships and networks at the city, national and international scales are critical to tackling the large, complex and interconnected challenges and opportunities posed by climate change and development. Developing more effective and sustained forms of engagement and collaboration between government, the private sector and civil society groups is essential for an inclusive and socially just approach to furthering city development while tackling climate change. As illustrated in the chapters that follow, initiating such work takes considerable time, creativity, foresight, energy, resources and social capital. This requires sustained investment, supportive policy, legislative and financial frameworks, and skilled individuals.

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CHAPTER 4

Responding to climate change and urban development through the co-production of knowledge

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The chapters in this book have been co-produced and written by municipal officials and academics to demonstrate the range of innovations that have occurred in mainstreaming climate change and development across a range of sectors in the City of Cape Town Municipality (CCT, also referred to as the City) in the face of an uncertain global future. This chapter addresses a second theme that is central to the book, namely, the co-production of knowledge by officials from the CCT and academics working across various departments. The chapter provides a history and understanding of knowledge co-production by the CCT and the University of Cape Town (UCT), and suggests the importance of this type of knowledge production for cities in their endeavour to create pathways to sustainable futures in the face of global environmental change and economic uncertainty. Commissioned by the CCT, the co-produced book aims to draw lessons from attempts by the City to institutionally address 'the challenges of dealing with the complex dynamics of social and ecological processes, and the high degrees of uncertainty in planning for sustainability in the current era' (Wise et al. 2014: 327).

The aim of the chapter is threefold: first, to provide a literature review of the concepts of co-production and of 'third space' as a virtual space where co-production can take place; second, to present a history and critical evaluation of the co-production processes that took place between UCT and the CCT Municipality in the period from 2012 to 2015; and third, to outline the structured process that was designed for authors as they entered into the process of co-writing that culminated in this book. The authors of this chapter have all been involved in the earlier rounds of co-production processes between UCT and the CCT

Municipality that informed the process of producing this book. These earlier rounds were compelling enough for the City to promote the replication of the same methodology in this book.

The concepts of co-production and third space

This section of the chapter provides a review of the concept of the co-production of knowledge, which has been used as the model of knowledge production in this book. It also discusses the co-production model of knowledge as part of the widespread shift from a Mode 1 to a Mode 2 transdisciplinary system of knowledge production (Klein 2014). This is followed by an overview of the concept of a 'third space' which was applied as part of the heuristic approach to problem-solving and learning used to facilitate knowledge co-production for this book, and also used to design a series of three structured workshops with the writing partners.[1] In this process, the third space was proposed as the virtual space into which authors would move as they worked collaboratively — ideally as equals — to co-produce their chapters. The section concludes by considering the importance of knowledge co-production in the transition to sustainability. Since the book is about the CCT, and cities are postulated as the 'most pressing and promising site for anticipating and addressing uncertain futures' (Wakefield & Braun 2014: 4), the focus in this chapter is on knowledge co-production for urban decision-making and urban sustainability transitions. With well over half of the world's population living in cities, 'city managers need knowledge and tools to transition to sustainability' (Munoz-Erickson 2014: 183).

It is now widely accepted that human impacts are greatly precipitating natural environmental change, and the current literature casts the Anthropocene as a 'social' rather than a natural problem, placing human agency as central in responses to climate change (Lövbrand et al. 2014).[2] Cities the world over are responding experimentally in different ways to the complex social, political and environmental threats of global environmental change, as they attempt to contribute to the creation of more resilient and sustainable cities. Furthermore, in order to create a 'democratic [and sustainable] knowledge-society' (Lane et al. 2011: 18) an alternative model of knowledge production needs to be adopted (Whatmore 2009) that is appropriate for urban governance in a developing society.

The literature proposes that co-production of knowledge is the most appropriate model of knowledge production for 'knowing and managing' problem-solving in the city in the face of increasing urban complexity and uncertainty

1 The three workshops were held at UCT on 17 March 2015, 21 April 2015 and 11 August 2015.

2 The Anthropocene is a proposed geological epoch or era that began when human activities started to have a significant global impact on Earth's geology and ecosystems.

(Callon 1999; Klein 2013; Polk 2015), particularly as a result of the 'double crisis' of global climate change and the 2008 economic recession (Hessels & Van Lente 2008; Lane et al. 2011). The model assumes that there are many sources of expertise other than the 'elitist scientific model' of knowledge (Bruckmeier & Tovey 2008; Gibbons et al. 1994). The co-production model proposes that producing knowledge is a social process built up through social institutions and social learning, as groups struggle to collaboratively promote their definitions of, and solutions to, problems (Hajer 1995).

The increasing support for the co-production of knowledge model shows the shift in 'science systems' towards more strategic societal goals (Hessels & Van Lente 2008). The most well-known characterisation of this shift is that it is a shift from what is termed Mode 1 knowledge production, that is, the conventional, discipline-based approach to producing knowledge which has existed since the 18th century, to Mode 2 knowledge production (Gibbons et al. 1994; Klein 2013; Nowotny et al. 2001). Mode 2 is the term used to describe an emerging socially embedded, transdisciplinary approach to knowledge production focused on problem-solving (Klein 2013).

The theoretical model of expert knowledge generation referred to as Mode 1 knowledge is being less and less accepted as an effective way of creating socially relevant knowledge, as the knowledge produced in this expert-driven way no longer holds a privileged position over other knowledges. On its own, Mode 1 knowledge is insufficient to enable an understanding of, and provision of solutions for, complex and uncertain environmental and social problems (Lane et al. 2011; Swilling 2014). One only has to look at the multitude of accredited discipline-based journals (from economics to political science to climate science and development), to find examples of Mode 1 knowledge in the form of journal articles. This model conventionally assumes that the one-way communication of scientific expert knowledge to society is necessary, as there is a 'public deficit' of knowledge. Similarly, it is assumed that policy-making needs to be based on knowledge which is transferred from expert scientists to policy-makers for use in 'evidence-based policy-making'.

The literature reveals that the shift over the past three decades to Mode 2 knowledge has challenged these assumptions. Mode 2 knowledge is argued to be more socially relevant and applied, requiring transdisciplinary collaborations to solve problems (Gibbons et al. 1994; Hessels & Van Lente 2008; Nowotny et al. 2001). Here, the policy knowledge produced by officials working in local government or local community knowledge, for example, is considered not only 'legitimate' but 'indispensable' for social problem-solving (Polk 2015). Polk maintains that such knowledge production processes can be termed 'transdisciplinary co-production'. Mode 2 knowledge is therefore transdisciplinary, which 'entails conducting interdisciplinary research *with*—rather than *for*—society in order to co-produce socially robust solutions to complex societal problems that can no longer be approached and solved by mono- or even interdisciplinary approaches' (Swilling 2014: 2). The conventional science-policy interface is thus being disrupted by the emergence of new actors, such as civil society organisations, that provide new knowledges, often engendering a growing distrust of science (Muñoz-Erickson 2014). Co-production of knowledge is therefore central to the production of Mode 2 knowledge.

The concept of the third space has been used in this book as a heuristic concept to envisage academics and practitioners moving from the comfort of their 'home spaces' into a virtual 'hybrid space' or 'in-between space'. It is proposed that it is here that they can collaborate in the co-construction of new hybrid meanings and interpretations of reality, and of appropriate solutions for problems (Figure 4.1). However, while engaging with each other in third space, the authors still belong to their 'home spaces' (the first and second spaces in Figure 4.1), which serve as 'a source of self-dignity and agency, a site of solidarity' (Routledge 1996: 410) where they position themselves and have disciplinary or professional status.

The concept of the third space was first used by cultural theorist Homi Bhabha (1994) as a means of thinking critically about identity and the perceived cultural boundaries between different cultural groups. It has since been used in many contexts as a means of exploring the breaking down of barriers between different domains to promote constructive and productive relationships. This concept helps to break down the conventional practice of conceiving of difference in terms of binaries or opposites. For example, the concept has been used to integrate Western and indigenous knowledge; the natural and social sciences; and more recently in the field of sustainability and science education (Glasson et al. 2010). In Figure 4.1, the two binaries of academic knowledge produced by UCT academics and practice-based knowledge produced by CCT officials involved are a product of the spaces in which they operate, namely, the first space of academia, and the second space of the CCT Municipality.

The third space creates a space where, in theory, no domain is dominant and the approach 'moves beyond' the first and second home spaces of academia and the CCT, promoting the development of new conceptual categories and thereby creating the potential for new hybrid meanings to emerge (Klein 2013; Wallace 2004).

Conventional Mode 1 binary thinking about knowledge production locates knowledge production in different 'sites', where the legitimacy and status of knowledge claims are based on the power relations between these sites. The conventionally dominant site is the site of scientific knowledge production in the first space (Figure 4.1). It is here that positivist enquiry remains the dominant form of knowledge production in the natural sciences and, decreasingly, the social sciences. Post-positivist (qualitative, interpretive and critical) enquiry in the social sciences is relegated to a second space — hence the natural science-social science binary (Lincoln et al. 2011). Similarly, the quest for theoretical knowledge produced by Mode 1 science is conventionally considered dominant over and separate from practice-based knowledge which is produced through 'practice' or 'social action'. The latter is seen to lie in the domain of 'communities other than researchers ... those of policy personnel, legislators, and civic and political officials', another second space (Lincoln et al. 2011: 118). The natural science-social science binary parallels the binary of quantitative versus qualitative methodology, the former conventionally judged to be more rigorous and 'objective' than the latter. Theoretically, these binaries lie at the heart of the first and second spaces of knowledge production and are the product of modernist Western thinking which supports Mode 1 knowledge production. However, Routledge (1996: 400) makes the point that no spaces are 'pure, authentic' spaces, as they are often 'interwoven' with other spaces, and people are increasingly moving between home spaces and a third space, as is the case with a number of the authors in this book. Furthermore, there are many challenges that arise when working in a third space as it can be a space of conflict and mistrust (Anderson et al. 2013).

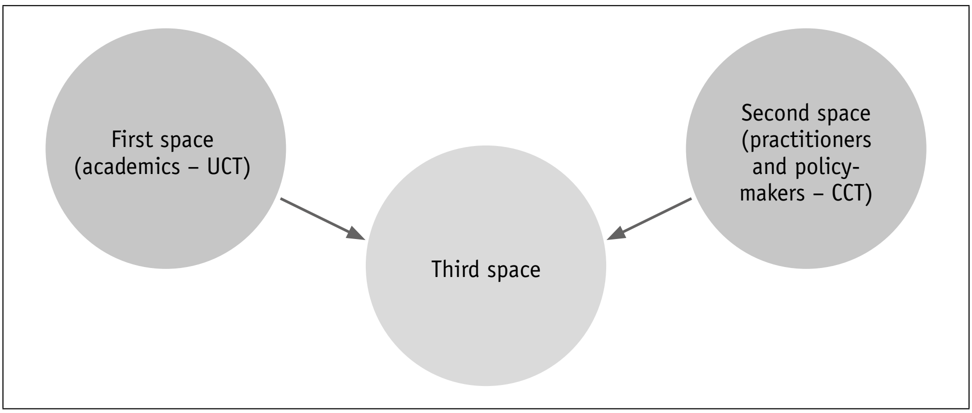

Figure 4.1: Schematic representation of the 'home spaces' of academics (first space), municipal officials (second space), and the third space where they co-produce knowledge
Source: Adapted from Routledge 1996: 410.

The academic is often criticised for writing about and reflecting on society from a 'privileged space', while the practitioner, such as a municipal official, is criticised for engaging directly with the world with little reflection on and abstraction from daily experiences. Academics frame their understandings of the world with theory, building on the ideas of others, but are criticised for not 'living it' (Routledge 1996). This position has, however, shifted with the increasing social responsiveness of academics and engaged scholarship, as documented by Swilling (2014) in his research at the science-policy interface. As sites for the production of knowledge, universities have many resources (facilities, training and access to information) and provide academic researchers with space and time to theorise and critically reflect on the natural and social realms (Chetty & Merrett 2014).

Practitioners, on the other hand, are considered to have limited freedom to observe, reflect and theorise, as they are constrained by policy, organisational processes and established practices, and operate experientially in a hierarchical space in which they are not mandated to exercise a critical voice. As such they are socially embedded, and contribute to practical interventions aimed at changing the material world. However, it is recognised that in producing practice-based knowledge, they do also operate in 'shadow spaces' outside hierarchical structures which can give rise to experimental and imaginative practices (Leck & Roberts 2015). Bulkeley and Castán Broto (2013) report the presence of increasing numbers of experimental governance practices in cities responding to climate change challenges.

The third space of engagement provides an opportunity for creating a space where no domain is dominant and 'new hybrid modes of enquiry, practice and learning' can emerge (Klein 2013: 197). It is therefore a 'hybrid' or 'in-between' space, a space of constant negotiation and flux which exists across various axes of difference between the first and second spaces, disrupting and unsettling these spaces (Klein 2013; Routledge 1996).

Operating in the third space as a location of knowledge co-production has the potential to foster the reconfiguring of different viewpoints (knowledge domains), to lead to innovations, broaden horizons and give rise to many possibilities (Klein 2013; Routledge 1996), and hence it holds the potential for socio-political transformation and transgression (Lotz-Sisitka et al. 2016). Stengers (2005a), cited in Whatmore and Landström (2011: 583), notes that working in the third space where conventional understandings of problems are disrupted, will create a 'different awareness of the problems and situations that mobilise us'.

The literature abounds with cautions that working in the third space is not easy and can also be a site of misunderstandings, contestation and conflict (Anderson et al. 2013; Polk 2015; Swilling 2014). In addition to overt misunderstandings and disagreements, there are also more subtle power differentiations, such as assumptions about valued forms of knowledge and their expression in written English. However, the more these challenges are understood, the more likely it is that they can be anticipated and effectively dealt with. It is proposed by the authors of this chapter that certain actions can be taken to nurture third space knowledge co-production. The reduction of power differentials between actors from first and second spaces; the sharing and interrogation of the underlying assumptions of different approaches to knowledge; the insistence on mutual respect for all knowledge types; the joint definition of research questions and the building of trust between partners may contribute to this process. Routledge (1996: 413) calls for the development of a 'third voice' which ideally involves a conceptual and operational shift among research partners, creating new identities as partners undergo a paradigm shift. However, it is not clear how this would translate into their institutional settings. Since third space knowledge production is socially embedded, mutual validation of knowledges and the development of new conceptions of what constitutes 'quality knowledge' are necessary (Ravenek & Rudman 2013). The metaphor of a third space has provided a valuable device for contributing to the incubation of transdisciplinary knowledge co-production for this book. While there is no one recipe for how to co-produce knowledge, the concept of the third space proposed here can act as a heuristic device to structure and shape co-production processes (Anderson et al. 2013; Butler-Kisber 2010; Patel et al. 2015).

Knowledge co-production in relation to climate change has been researched, specifically science policy co-production (Anderson, et al. 2013; Davison et al. 2015). The parties involved in knowledge production here include scientists and decision-makers from the public, non-governmental and private sectors (Lemos & Morehouse 2005: 61). The CCT and UCT have been collaborating in this way to grapple with issues of climate change and local governance (Cartwright et al. 2012).

In the rest of this chapter we look at aspects of the process of knowledge production that went into the making of this book. First, we describe the institutional history of the project that culminated in this book. This is followed by a glimpse into how participants experienced the earlier stages of the processes of co-production.

The history of co-production

The CCT Municipality and UCT have a long history of cooperation and collaboration. As one of the top research institutions in the Western Cape, and in close proximity to the seat of local government, UCT has been well placed to engage with the City. Historically, this has generally taken the form of a uni-directional flow of knowledge, in a traditional consultancy relationship which gained momentum during the post-apartheid period of policy reform. In this form, academic researchers were appointed by the City to provide a research or consultancy service for specific projects (see Anderson et al. 2013). This type of relationship, although of benefit to both parties, could not be considered to be co-production. Over time, the longstanding relationship between the CCT and UCT, specifically the African Centre for Cities (ACC) at UCT, shifted in nature towards more equal co-production of knowledge and shared learning — a change from the previous one-way flow of knowledge from academia to the City in the form of advisory, review, consultancy and think tank-based interventions.

During 2009, the Climate Change Think Tank (CCTT) was formed as a project jointly hosted by the CCT and the ACC. The CCTT aimed to 'inform, shape and drive the implementation of effective climate change policies, programmes and interventions at local level' (CCT 2009b) and included a Climate Change Research Reference group which was designed to 'facilitate on-going collaboration and dialogue between top academics, researchers, specialists and local government officials around this issue' (CCT 2009b). The CCTT was innovative in its approach, as it was the first initiative in which academics and local government officials were brought together to share knowledge and expertise and collaborate on shaping both climate change research and policy.

The CCTT recognised that co-production is a two-way, iterative relationship; through starting a dialogue between academics and government officials it aimed to create the opportunity for academics to engage with officials on matters of policy in a different way from the historical 'consultancy'-type relationship. Through the establishment of a CCTT forum that met on a regular basis, and at which critical issues of climate change policy and research were discussed and workshopped, significant progress was made towards realising these goals. City officials were keen to engage in research with academics, and work towards shaping research in order to answer specific questions of relevance to local government. Through the forum, specific key pieces of research of interest to both UCT and the City were commissioned, culminating in the production of a book (Cartwright et al. 2012). The CCTT, like the other ACC CityLabs, can however only be considered a partial success in terms of its achievement of co-production.[3] Although it opened up new dialogues and significantly increased knowledge-sharing and collaboration, the research outputs remained largely produced by academics, and policy outcomes remained the purview of City officials (Cartwright et al. 2012).

Having built credibility in the arena of knowledge co-production through the CityLabs and the CCTT, the ACC at UCT embarked on a partnership with Mistra Urban Futures in 2010 to jointly explore sustainability transitions at the city scale.[4] One of the new projects initiated as a result of this partnership was the Knowledge Transfer Programme (KTP) (Phase 1, 2012–2015). The KTP operated as a knowledge partnership between the CCT and the ACC. This knowledge co-production partnership foregrounded the inclusion of academic methods and research in the generation of knowledge, together with the practice-based knowledge typically informing policy processes.

The KTP had two linked programmes. The first was an embedded researcher programme in which four PhD students were embedded in City operations to carry

3 The CityLabs in the CCT were set up to stimulate interdisciplinary engagement between researchers and practitioners on policy-relevant research dealing with important issues in the city (Anderson et al. 2013).

4 Mistra Urban Futures is an international centre for sustainable urban development which is based in Gothenburg, and operates in three other cities around the world: Cape Town, Greater Manchester and Kisumu. One of the foci of Mistra Urban Futures is on co-production of knowledge for a sustainable urban future.

out policy research of interest to both themselves and the City. The second was a City Officials Exchange Programme in which selected City officials were given the opportunity to take a practitioner sabbatical at UCT, working with an academic to write up an aspect of their policy work in a journal article for publication in a peer-reviewed journal. Through the collaborative writing and publishing process, the work of the City became more legible and visible. There have been two rounds of this co-production process, and this book is the third round of exchange, as an extension of the original CCTT initiative. Given that the process followed in producing this book builds on the KTP process of co-production, the following section draws on evaluations of the first two rounds of officials' exchanges, indicating the value for participants of co-producing knowledge in the third space.

Evaluating the third space

The KTP was a groundbreaking initiative for both partners. It focused on making policy and practice legible to a wider audience, and has seen significant research outputs by City officials themselves, challenging the conventional notion that academia is the sole location and producer of peer-reviewed research. Similarly, the opportunity for academics at UCT to work with City officials provided new insights into the inner workings of local government, involved them in socially relevant research, and has brought the City's work into the academic realm. The reflections on the exchange experience below are organised thematically to critically reflect on the value of this particular example of creating and operating in a third space.[5]

Time away from City work to gain new perspective

Almost every official valued being able to take time off to get away from their day-to-day work, even if this rarely meant being fully detached from emails and City deliverables (M1, 2013). This 'dedicated and extended time away from the Council environment was essential to the success of the programme' (M2, 2015), particularly for the writing of the first draft of the paper. Getting up to two months of paid leave from the City to write an academic article was unprecedented, and

5 The individual opinions and quotations included in this section come from questionnaires sent to City officials following the completion of their writing sabbatical at UCT, where they were asked to reflect on their expectations of the programme, what they had learned through participating, the opportunities the programme had presented to them, as well as the challenges they had experienced. A similar questionnaire was sent to the officials' academic writing partners. To preserve anonymity as required by the ethics agreement for this process, respondents are not identified by name, but by their professional positions as municipal officials (M) or university academics (A).

allowed the officials to be able to 'focus attention for a meaningful period of time, without disruptions' (M3, 2013). A City official pointed out that being based at an academic institution 'allowed freedom to research, think and reflect' (M4, 2015). Being based at the university for some time meant that officials could 'step back from day-to-day operational urban planning and look at overall trends, issues and current difficulties related to this profession, from an academic point of view' (M2, 2015).

The everyday tasks of academia as perks of exchange

Officials enjoyed spending time immersing themselves in tasks typical of academic publishing. For example, officials noted that they enjoyed being able to 'develop a longer-term, more analytical perspective on the subject matter' (M4, 2015), and to 'explore the subject matter critically' (M5, 2015) through 'exposure to other thinking' (M4, 2015). In reading widely for their papers, the officials 'found it empowering to be up-to-date on the latest literature' (M1, 2013), something that is not always possible in their work environment. Access to the university's library resources was a valued resource for many of the officials, '[to] have access to fantastic information via the library, [to] focus on being able to read, evaluate and internalise knowledge and information [on] my topics of interest' (M4, 2015). In addition, support from UCT's Language Development Group helped the officials to write for an academic audience. An official noted that the writing workshops helped with 'panel beating [his] thinking and promoting new thinking approaches' (M5 2013).

In fact, the City Officials Exchange Programme was used by some officials as a prelude to continuing with further studies. One official noted that the exchange programme presented:

> *an opportunity [to] test the suitability of my thinking for progression into a PhD, an opportunity to use the published paper to form collaborations with research institutions both locally and abroad ... [and] an opportunity to use the published paper as leverage to enrol as a PhD candidate. (M5, 2015).*

An academic writing partner noted too that the official she was partnered with 'is to register for the MPhil ... this is a pleasing development, catalysed by the programme' (A1, 2015). Participating in the programme was also seen by officials to be beneficial to their careers, as it provided opportunities 'to develop scientific writing skills ... a career profile as a specialist in [the] field of interest, and personal growth' (M3, 2013). The programme allowed for the officials' 'work to be valued, and [it allowed them] to reflect on their work and approach their work at the City differently' (A2, 2013). Impact on the academic writing partners was also apparent, as one academic noted that the partnership had enabled a 'strengthen[ing] [of] an existing relationship ... I've worked with the City before, [but] I've never really thought of publishing with officials. I'm currently exploring other writing opportunities with City officials' (A3, 2015).

Through the exchange programme, both institutions are experimenting with moving away from sectoral, 'silo-based' research and policy-making to a more transdisciplinary approach, despite this not being explicitly part of the design of the programme. Officials noted that the exchange provided '[exposure] to academic [peers] and subsequent growth in knowledge on the topic of interest' (M3, 2013), and provided a space for officials 'to interact with experts in academia' and with their peers (M4, 2015). Another official noted that participating in the programme meant 'meeting new people, building a network with academics' and providing opportunities to learn new discourses (M5, 2013). Officials also learned more about their colleagues' work: 'Being subject to other fields of study has increased my understanding of the City's broader responsibilities' (M3, 2013). Similarly, university-based writing partners learned more about City processes, particularly the 'complexities in local government policy and decision-making' (A4, 2015) and 'the constraints and opportunities presented by local government practice' (A5, 2015) as well as the 'tacit knowledge' which surfaced (A2, 2015). This comment about tacit knowledge is particularly important as it is in this way that the different values that underlie knowledge-making practices in the two spaces can be experienced, identified and discussed.

In summary, the City Officials Exchange Programme, designed to have officials and academics operating in a third space, had as its primary intention increasing the legibility and defensibility of policy through publications. The credibility of producing a journal article or a book chapter is highly valued by City officials. The process of engaging with literature and conceptual debates validates the practice-based knowledge held by City officials and the importance of their work for urban sustainability.

The comments quoted above suggest, however, that officials tended to conform to the academic norms, rather than working with their writing partners to find a hybrid alternative. This raises questions about the extent to which the academic space is transformed, and how the transformation of spaces can happen in different ways in different contexts.

The next section of the chapter looks at how this power-sharing was supported in the third round of officials' exchange for this book through the design of a series of three workshops, each of which included activities that brought to the surface assumptions about the co-creation of written texts. This process also raised questions about writing, knowledge-making and power.

Bringing values to the surface through co-writing

A critical activity in the co-production of knowledge in the third space is co-writing. Phoenix et al. (2016) maintain that it is only at the point of co-writing by partners from different domains that they begin to understand the differences in their assumptions about how to know the research problem. The more embedded we become in one genre of writing — be it the academic article or the policy text — the more naturalised this form of writing becomes and the harder it is to appreciate the main genres in other spaces.[6] The differences between the genres of the journal article and the policy text are not neutral: they are amplified by the asymmetry between the academy and the City as historically constructed sites of knowledge production. In spite of the shift towards Mode 2 knowledge and the embrace of knowledge co-production as a generative process, as noted earlier, the academic journal article or book chapter still has more credibility than the policy document as a source of knowledge. The burden of accommodation lies with the City officials rather than with academic partners. Problematically, Polk (2015), in reviewing five transdisciplinary projects, found that it was usually the researchers who ended up writing up the research outputs although the knowledge had been co-produced.

So ideally, when co-writing in the third space neither of the co-writers' 'state of understanding is privileged' and 'neither one of two different languages are dominant' (Wallace 2004: 809). As negotiation happens along the continuum of meaning-making between co-writers, new hybrid meanings are constructed (Wallace 2004). Such negotiation is a slow process of engagement through which it is necessary to bring the underlying assumptions and values of the co-authors to the surface. Thus, the output of a transdisciplinary co-production process is both the process and the product — a problem for academics in institutions which do not value the former.

Ideally, with the shift to Mode 2 knowledge new publics or audiences will emerge to receive written texts presenting new forms of knowledge. Examples of these texts can be journal articles, opinion papers, technical reports, concept notes and blogs. The audience targeted by co-writers in a knowledge co-production project is wider than the audiences usually targeted by each writer in their home domain, and combines readers from academia, local government and the public. When writing in the third space, the authors themselves also become part of this audience, as all co-writers need to be comfortable with how a concept is articulated. When writing is aimed at an audience that is multi- or transdisciplinary, it becomes particularly important that attention is paid to the use of accessible language.

These new forms of writing and their audiences are often overlooked by academic journals, which may not be sympathetic to new voices and genres; these voices and genres in turn have to compromise their approaches to be acceptable

6 A genre of writing is a relatively stable category of writing based on its purpose and intended audience and as such is a 'conventional, culturally recognised grouping of texts based on properties other than lexical or grammatical ... features' (Lee 2001 in Ting et al. 2013: A26; see also Swales 1990).

to the journal writing conventions (Canagarajah & Lee 2013). Thus hybrid forms of writing are not always acceptable. It is the less powerful (novice authors, multilingual scholars, writers in the City) who have to make the compromises when working in the academic genre; in knowledge co-production processes it is not always immediately obvious who the less powerful are. While reviewers and readers may find 'certain breaks from convention to be refreshing and thus rhetorically effective, these ruptures generally still have to occur within particular parameters' (Tardy & Matsuda 2009: 45). Academic parameters are much harder to shift than those of other genres, as scientific journals build their readership and credentials through theoretically framed and peer-reviewed articles.

With these challenges in mind, three workshops were designed to take the partners through the co-writing process.[7] Figure 4.2 summarises the important moments in the knowledge co-production process, and the timing of the three workshops. Addressing the power relations between the City officials and academics was an important challenge, and therefore our process was designed to try to address this. Other challenges besides power also surfaced through the process, and these need to be acknowledged in future attempts to design co-production support processes; they will be reported on in the final chapter of this book. The objective of the workshops was to deal with the question of power only.

The Environmental Resource Management Department (ERMD) of the CCT put out a call across the municipal departments in November 2014 requesting applications from staff to engage in a process of co-production modelled on the KTP approach. The call invited all officials to work with a UCT academic to write up an aspect of their practice-based knowledge on mainstreaming climate change into policy and practice in their departments, as a chapter in an edited book. Applicants were required to demonstrate how their work had shifted their practice from 'business as usual'. It was stated in the call for applications that 'the ACC will provide academic induction, orientation and supervision to the selected City officials' (CCT 2014: 2) which served to frame the power relations between academics and officials.

The applications were reviewed and 10 officials were selected by the Steering Committee to participate in the co-production of knowledge process.[8] The applicants had to have been personally involved in actually mainstreaming climate

7 The workshops were designed by the workshop facilitators, Lucia Thesen and Mathilde van der Merwe from the UCT Centre for Higher Education Development (CHED) which helps students develop their academic writing skills, and Dianne Scott from the UCT ACC, with assistance from the other authors of this chapter.

8 This committee consisted of representatives from the CCT (ERMD) and UCT (the ACC), specifically the Mistra Urban Futures project, and the African Climate and Development Initiative (ACDI).

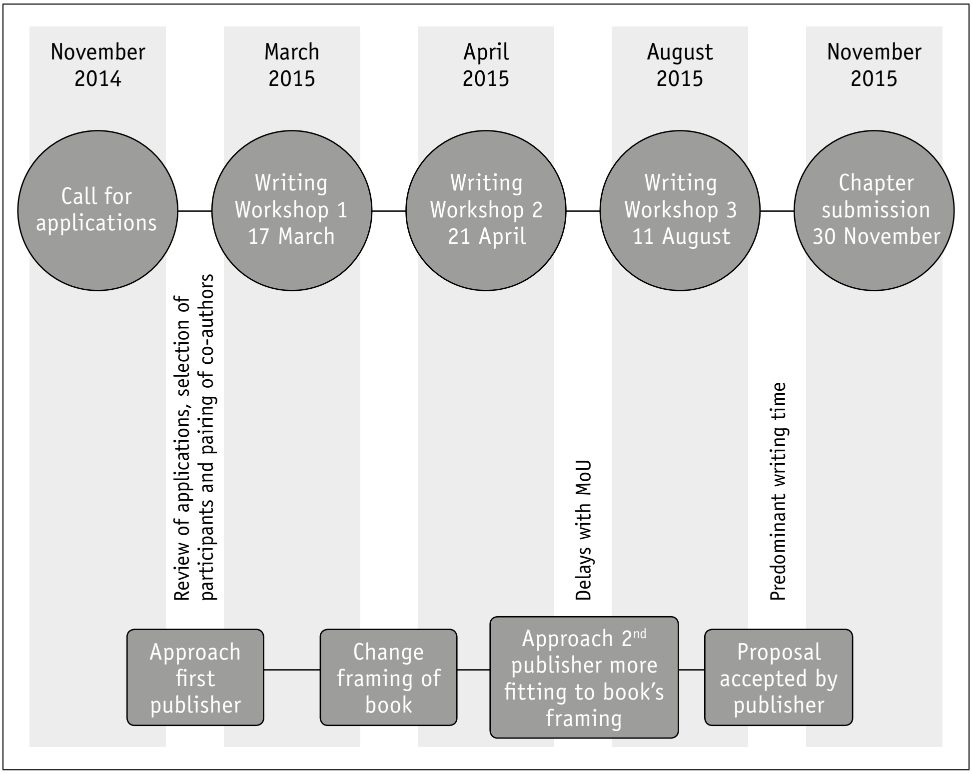

Figure 4.2: Process diagram of the 2014–2015 knowledge co-production cycle
Source: The authors

change, and have the permission of their managers to participate. The process was designed to co-produce a text conforming to the academic genre but at the same time written in a form that would be accessible to practitioners and policy-makers. The success of the journal article co-production in the earlier round of the KTP process, and the availability of funding from the CCTT, had led to a desire on the part of the City to produce an edited book addressing climate change in Cape Town, to follow on from the first book by Cartwright et al. (2012). Members of the editorial team for the book were subsequently drawn from the CCT and UCT, signalling the co-production of the book at the editorial level. Furthermore, since it was the ERMD's specific request that the book be an 'academic publication' rather than another type of knowledge output, it was initially assumed by this department that the officials would need some support to write in the required academic style. However, the use of the metaphor of the third space in the workshops contradicted this assumption, as it introduced the idea that practitioners were not seen as needing writing 'development', but rather that both academics and practitioners would need to engage with new forms of writing together. This contradiction was therefore inherent in the project from the outset. Three writing workshops were scheduled between March and August 2015 to provide support for officials (Figure 4.2).[9]

The concept of a third space was introduced in Workshop 1 (17 March 2015) as a framing concept to allow both officials and academics to position themselves in the space of co-production and co-writing in relation to their partners, and in some cases meet each other for the first time. Based on the initial statement by the CCT that the practitioners would be 'supported' to write academically, the workshop was designed primarily with the officials in mind. After an introductory session the academic authors left the workshop, while the officials were introduced to the academic 'writing process' by the three facilitators and critically discussed an example of the difference between the writing process of an academic and that of a City official. The idea behind this activity was to see how the academic approach to writing would resonate with the City officials' experience. This exercise allowed the officials to express what they valued and what they experienced as constraints in the writing process.

It emerged in the workshop that when writing for the municipality, brevity is valued over elaboration. City officials work to tight deadlines, which sometimes preclude the opportunity for revision. Other constraints include being bound by templates for writing, being instructed from the top on how and what should be written, and doing research while already knowing what the desired outcome is. City officials' biggest critics are the councillors, who serve as political intermediaries between the municipality and the citizens. Their concern is to understand the reports to such an extent that they can relay them to all citizens. It furthermore became clear that authority in the municipality is expressed in a different way than in academia. The hierarchical structures often dictate that it is not necessarily up to the author to implement suggested changes in their writing, since they do not always 'own' their work and it can be revised by others. There is also a feeling among City officials that academic authority (power) sometimes overrules reason in the co-production process when co-authors do not reach consensus. This points to challenges associated with writing in the third space, a space that requires working with and ultimately unifying or harmonising writing practices and writing styles from different contexts.

The workshop ended with City officials writing an abstract for their chapters in narrative form, as a story. To bring about a sharp break with conventional academic writing, the story began with a statement ('Once upon a time researchers/policy-makers believed that ...'), after which officials inserted their research question ('But then I thought that maybe ...'), followed by their method ('So what I will do is ...'); their anticipated results (And I expect that I might find ...), and what the impact of these findings could be ('Which could change the way that we ...'). On reflection, the second part of the workshop, with the focus on writing, should have included

9 Academic authors attended the introductory sessions of Workshops 1 and 3.

the academics so that they too could have done this exercise. This would have made it clear that support for writing involved both parties, in different ways.

From April to August 2015 there were delays as the Memorandum of Understanding (MoU) between UCT and the CCT was not signed and officials were therefore not allowed to take leave to work on their chapters (Figure 4.2). This led to a loss of momentum and interest in the book, somewhat undermining the integrity of the third space. The second workshop was nevertheless held in late April of that year, with the focus on working with theory. This was seen as a necessary discussion as it had emerged in the previous workshop that some officials were daunted by the demands of 'theory'. We looked at an example of co-writing and the application of theory in the article by Leck and Roberts (2015), 'What lies beneath: understanding the invisible aspects of municipal climate change governance', an interesting behind-the-scenes account of policy negotiations in the eThekwini Municipality. Again, only officials attended the workshop, further reinforcing the dominance of the academic genre.[10] The veiled assumption here was that academics already know what theory is and how to apply it, thus undermining the confidence of the officials and positioning their knowledge as secondary to academic knowledge.

It was only in August 2015 that the third workshop was held, and it served to re-ignite the commitment of the authors and get the process back on track. All authors, both officials and academics, attended this workshop. The introductory presentations sketched the context of climate change in Cape Town and the climate change policy developments that had taken place in the City, as well as the history of co-production efforts between the CCT and UCT. After much reflection, the inclusion of both officials and academics was designed as an explicit attempt to level the playing field by presuming that the officials and the academics both needed support in understanding the different values underlying academic and practice-based knowledge.

Both parties continued with an exercise on comparing the writing styles of an academic article and a policy document. The example focused on two kinds of text on the same topic — the Integrated Metropolitan Environmental Policy (IMEP) adopted by the CCT in 2001. The first text was an extract from the revised policy of 2009 (CCT 2009a) and the second — a critical reflection on the process of the IMEP review which draws attention to the need to understand power imbalances in policy learning — was extracted from a journal article from a previous round of City/university exchange (Davison et al. 2015). Participants compared the two, identifying the values in both texts. They noted for instance that different forms of evidence were used in each document (policy texts cited previous policy

10 The genre of academic writing is a category of writing based on a style which is conventionally expected to be precise and objective, and includes many sub-genres such as the description, explanation and argument sub-genres (Ting et al. 2013).

documents, as well as lived experience, while journal articles cited previous studies and data), and that the language used in the two texts differed (the policy text expressed a greater degree of certainty — even impatience — whereas the journal article could slowly build an argument). Noting these features enabled participants to engage with questions about what was at stake in both kinds of writing: for example, what would one have to give up to 'cross over' into journal publication, and vice versa? Discussion was enriched by the presence of the authors of both texts in the room. The authors of the journal article shared their struggles over how to settle tricky questions about which material should stay in the article. This was a vivid instance of the challenges of co-writing: whose knowledge will prevail, and in what form?

After the three workshops the co-writers of each chapter set up meetings to plan and write their chapters together in their version of the third space. The writers then had three months to submit their chapters for the internal review.

Conclusion

This chapter has presented the concepts, contextual history and support programme underpinning the methodology used to co-produce the chapters in this book. Theoretically, it is proposed that the innovative 'co-production' methodology has the potential to present a different way of learning about the municipality, by providing a more authentic, yet reflective 'insider' view of sustainable urban development and climate change governance through the lens of theory.

It has been emphasised that the history of engagement between the CCT and UCT provided a supportive context within which the book could be written. The KTP approach to co-production has shown that success is dependent on a number of soft factors, including an alignment of academic and official interests, commitment to outcome and process, willingness of both parties in the partnership to experiment, and getting the right fit between research focus and policy priorities. The model is therefore 'no model' (Soal 2014) as the factors influencing questions of credibility, salience and legitimacy (Cash et al. 2002) have to be navigated on a chapter-by-chapter basis. When assessing the effectiveness of the third space for knowledge co-production, configuration, history and context matter. The history of building relationships between the ACC and the CCT pre-dating the Mistra Urban Futures programme certainly contributed to the partnership. Furthermore, the careful selection of researchers and City officials committed to similar outcomes proved significant in most cases. Given the lengthy duration of the relationship-building process and realisation of its impact, the long-term nature of the funding supporting the programme must be given credit for providing the space to both achieve objectives (effectiveness) and to allow for equal power-sharing in producing policy and scholarly responses (legitimacy). This book constitutes a continuation of this process of building relationships between the CCT and UCT. However, there remain questions about the identity shifts and accommodations that academics made in the process.

The chapter offers some reflection on the success of this methodology. Since the book was required by the CCT to be an 'academic' publication demonstrating the City's progress in embedding climate change across its various sectors, it was expected that the officials would need support; and they themselves requested this. The metaphor of the third space was used as a heuristic tool to challenge the binary between theoretical academic knowledge and the practice-based knowledge of the CCT, and contributed to the call for the recognition of diverse but equally important forms of expertise. However, the challenge remained, despite the attempts in the workshops to provide support for this process and reduce the power differentials between the officials and the academics. This was partly due to the original framing of the process in the CCT call as one wherein officials would need 'support'. It is also acknowledged here that the power differential was not only expressed in the mandate to write for an academic genre, which the workshops aimed to address. Power is multifaceted; it is exerted not only through the values assigned to different sorts of knowledge, but also through practical issues such as MoUs, access to journals, time available for writing, and the intellectual property rights assumed by the two institutions. The production of a book with the aim of understanding the embedding of climate change in urban development policy-making in cities created further challenges, in that the authors had to write to a given topic and structure, as opposed to writing a journal article on any urban topic they chose with an open agenda as had previously been the case.

It has been argued in this chapter that the process of transdisciplinary knowledge co-production represents the new knowledge frontier for transitioning to a more resilient and sustainable urban future; this argument is supported by a growing body of literature in this field (Klein 2013, 2014; Markard et al. 2012; Polk, 2015). It is therefore proposed that other cities can learn lessons from Cape Town's experience of undertaking theoretically framed analyses of urban climate change governance innovations in the municipal context (practice-based knowledge), and building a knowledge base for climate change, and then reflecting on the process of knowledge co-production that was applied to provide this. Thus co-production has shaped the research agenda to build climate change knowledge which will ultimately feed into the policy agenda of climate-compatible development through the involvement of the officials in the mutual learning process.

An assessment of the success of the co-production process undertaken in this book and its challenges is presented in the final chapter of the book, to determine to what extent the process did indeed provide co-learning for both academics and officials. Co-production is a very difficult process with many tensions and ambiguities, which the authors will reveal in their reflections after the writing process. It will also be interesting to see how the City takes this process of engaged scholarship and co-production forward.

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CHAPTER 5

Building energy efficiency in City of Cape Town operations: the role of the energy intermediary

Sumaya Mahomed, Louise Tait and Wikus Kruger

Energy efficiency is a crucial component of the climate change agenda. A low-carbon economy requires not only interventions in the energy supply sector, but also fundamental changes in patterns of energy consumption. In South Africa municipalities are seen to have a key role to play in the adoption of more energy-efficient modes of operation, particularly against a backdrop of climate change, electricity supply constraints and rising electricity prices. The City of Cape Town Municipality (CCT, also referred to as the City) has been one of the first movers among South African municipalities to reduce electricity consumption in its internal operations (SEA 2015b). To date, the City has saved 15 per cent of its electricity consumption (off a 2007 baseline), amounting to over 65 GWh of electricity, and has had financial savings of R110 million against approximately R160 million invested (CCT 2015).

Much of the implementation of energy efficiency measures to date has been project-based. The real challenge for longer-term sustainability, however, is less about the implementation of specific retrofit projects than about how to integrate energy efficiency as a deeply embedded operational mode within the City, such that it becomes the new 'business as usual'. Much more than just the introduction of new technologies, energy efficiency also requires changes in institutional processes such as procurement systems and policy frameworks (Janda & Parag 2013). Processes of change and innovation in South African municipalities are, however, still poorly understood. Cape Town's achievements in building energy efficiency are interesting to understand, not because of what has been implemented, but rather *how* this has been done. By seeking a deeper understanding of the incentives, mechanisms and processes of this change, this study aims to contribute to the knowledge base on how South African municipalities can better respond to climate change.

Much of the City's energy efficiency work has been led by the Environmental Resource Management Department (ERMD). Acting as institutional champions, officials in this department have been responsible for developing and coordinating projects on behalf of, and with, other departments. In this chapter we examine their role in the innovation process through the theoretical frame of an 'energy intermediary' (Hodson et al. 2013). Intermediaries play an important linking role in innovation processes, configuring users, contexts and technologies to bring about change (Stewart & Hyyaslo 2008). They can play specific and useful roles in implementing cross-cutting organisational initiatives that challenge traditional municipal governance structures.

This chapter explores the role of a strategic innovation unit like the ERMD in driving energy efficiency in a municipality. We first discuss how electricity is currently used and governed in the City, and follow this with an exploration of the modes and tactics the ERMD has employed as an intermediary to promote energy efficiency within municipal facilities and operations. The chapter then explores the challenges that exist in this space and discusses the way in which this work could move forward.

Understanding energy use and governance in CCT operations

The context for energy use in the CCT

South Africa has a very energy-intensive economy (Aye et al. 2015). This is driven partly by the prevalence of energy-intensive industries, but also by inefficient electricity usage across the economy. This pattern of inefficient consumption has been facilitated by low electricity prices; before the supply crisis of 2008, these prices were among the lowest in the world (Newbery & Eberhard 2008). Local governments are no different from industry in having an inefficient usage profile. Many of their infrastructural systems were developed in a time of cheap and abundant resources. Government buildings in Cape Town, for example, which account for 32 per cent of the City's electricity consumption, are often highly energy-inefficient. The choice of building materials, historically common practices of over-specifying equipment designs, as well as inefficient behaviours like leaving equipment switched on when not in use, contribute to their poor energy performance.

The CCT is a large and diverse organisation, undertaking a huge number of activities in the fulfilment of its service delivery mandates. Many of these activities have energy implications. The City employs nearly 30 000 people and owns more than 5 000 buildings. Electricity accounts for three-quarters of the organisation's energy use; in 2018 electricity cost the City R150.5 million (CCT 2018). City buildings, wastewater treatment plants and street lighting are the biggest consumers of electricity in City operations (see Figure 5.1).

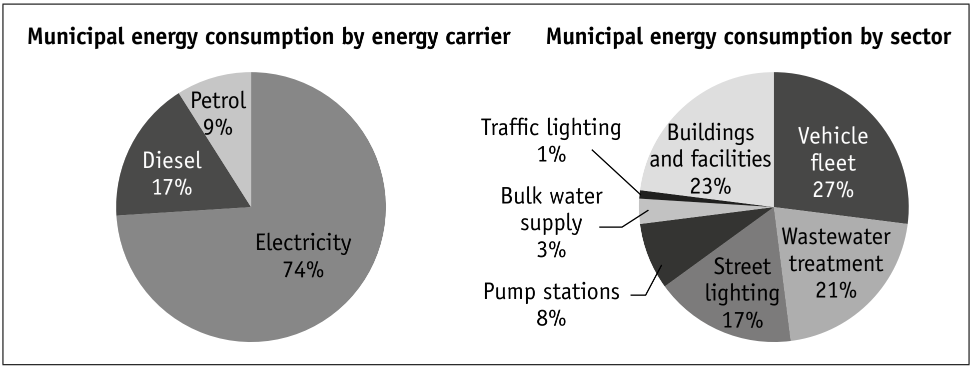

Figure 5.1: Energy use in CCT municipal operations, 2012
Source: CCT 2015: 70

South Africa's electricity sector has undergone immense changes in the past few years. Electricity supply nationally is now characterised by rapidly rising prices and generation shortages that have led to periodic load shedding; as a result, issues like energy efficiency have been driven up the national agenda. Although electricity prices are still relatively low by international standards (NUS 2014), the pace of price increases has been an economic shock for many sectors. Figure 5.2 illustrates the annual electricity price increases in Cape Town for the period 2006–2015. The impact of these price rises is already evident; since 2008, Cape Town has experienced an absolute decline in electricity consumption, despite economic growth, as shown in Figure 5.3. Although the focus of this chapter is on the energy transition within the municipality's own operations, it is relevant to understand the background of crisis and mounting economic pressures against which this transition is taking place.

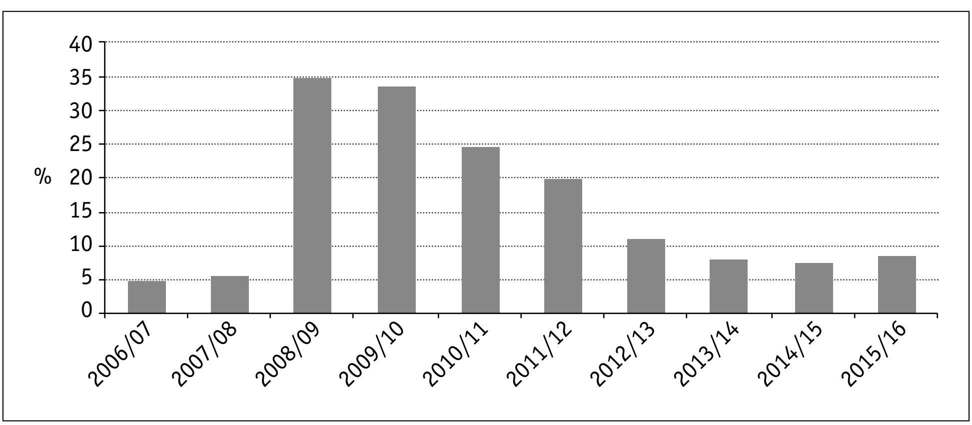

Figure 5.2: Average electricity price percentage increases in Cape Town, 2006–2015
Source: CCT 2015: 56

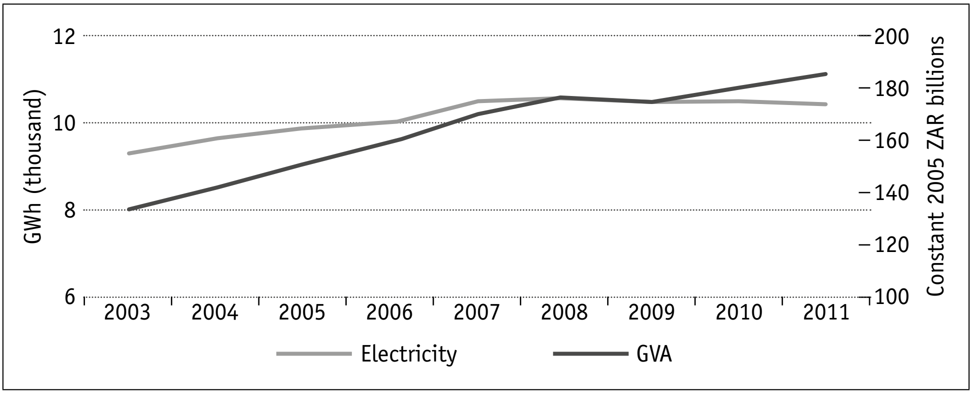

Figure 5.3: Changes in electricity sales relative to economic performance in Cape Town
Source: CCT 2015: 62
Note: Gross value added (GVA) is the measure of the value of goods and services produced in an area, industry or sector of an economy.

Traditional modes of governance of electricity in the CCT

Electricity — a ubiquitous yet invisible input

Despite the important role that electricity plays as an input into municipal operations, it has for a long time lacked 'visibility'. Its day-to-day use and management in buildings, for example, is spread over a huge number of facilities, each managed at a departmental level by different facilities managers. There is no centralised control, monitoring or management of this resource. The cost of electricity to departments is obscured in budgets through centralised accounting and managerial systems.

Although this picture is slowly changing as bottom-up monitoring and data collection processes improve, historically most departments have not had easy access to information about consumption and costs, nor where inefficiencies may lie. Previously electricity has been measurable only through centralised sales data with no metering and data collection systems at a more disaggregated level. This, added to the fact that electricity has historically been very cheap, has fostered a culture of inefficiency, and has meant that electricity does not receive much focus as an operational input.

Thus electricity, although necessary for the organisation to fulfil its primary service delivery obligations, has become a background service, not explicitly acknowledged or managed. In infrastructural studies, this is described as stabilisation of an infrastructural system. Embedded in a broader system, electricity becomes part of the backdrop, where the focus is on the activities it enables, rather than on the infrastructural or technological form itself (Bijker 1992). Once a socio-technical system has stabilised around a certain configuration, it is argued, it develops a resistance to change (Unruh 2000). Skills, politics and associated technologies or infrastructure are all based on the existing types of technologies utilised (Geels & Schot 2007). These become part of established organisational routines from which it is often difficult to deviate. Understanding the institutional processes and dynamics of change in municipalities, therefore, becomes central to understanding how to achieve technology transitions.

Energy as a cross-cutting policy issue

Electricity is a cross-cutting organisational issue. No one department could on its own fulfil an organisational target to reduce electricity use. Consumption 'infrastructure' is distributed across thousands of different end-use technologies from air conditioners to streetlights to water pumps, involving a diverse range of users and managers. Despite the City having set a 10 per cent reduction policy target for energy efficiency in its own operations, implementation has largely been left to individual departments. A review of City departmental performance plans reveals that this target has neither been systematised within departmental performance requirements nor in asset management procedures and protocols (CCT 2015).

For individual departments, the incentives to proactively take on energy efficiency are not always clear. Developing the necessary systems can be time-consuming and administratively burdensome. How electricity management aligns with departments' core operational mandates not only impacts on their willingness to proactively take on this task, but also raises the question of whether competencies to do so exist. To illustrate, we give the example of two different departments in the City. The first, Specialised Technical Services, is responsible for managing the City's 90 administrative buildings. Its core mandate and performance outcomes, related to building management and cost-effective operation, are unambiguously aligned with energy efficiency. With facilities managers and dedicated staff with appropriate skills, this department has had a good basis from which to incorporate energy management into existing staff roles and make necessary changes. Unsurprisingly, it has been one of the early implementers in the City.

By contrast, the Health Department's mandate is the delivery of health services. Clinics, as a building typology, account for 20 per cent of electricity consumption in City buildings and have significant potential for efficiency gains. The management of clinic facilities, however, is often undertaken by health professionals rather than building professionals. For professionals who may have no prior experience or competence in energy management, overseeing an energy audit, identifying appropriate technologies and undertaking monitoring and verification (M&V) of energy savings requires substantial investment in new skills and competencies. At a managerial level, this investment of departmental resources may not be regarded as contributing to key performance indicators and delivery of its core health mandate.

Innovation in bureaucratised institutions: the role of an intermediary

Like many of the policy responses needed to address climate change problems, energy efficiency requires an integrated and coordinated response by various actors across an organisation (Aylett 2013). It requires both innovation and collaboration. While departments can independently develop and execute interventions, this is unlikely to achieve more systemic change in the long run — and it is at the systemic level that the greatest resources and scale can be achieved (Hodson et al. 2013). However, system change requires a coordinated and integrated response. It requires multiple interventions at different scales, some technical, but also tasks like advocacy, fundraising, policy development and capacity-building. Many of these more strategic tasks will fall outside of the interests of individual departments.

Research into the adoption of climate change innovations in South African municipalities (for example Aylett 2013; Froestad et al. 2014; Roux 2014) reveals that there is often little motivation at a departmental level for individuals to take on responsibilities outside of perceived operational mandates — even if there are higher-level strategic policy goals to do so. In this way policy objectives such as energy efficiency often find themselves in grey zones in terms of implementation — falling into the gaps between any specific institutional actors. The particular institutional dynamics of bureaucracies hinder both collaboration and innovation (Aylett 2013; Froestad et al. 2014). Compliance with departmental mandates has come to achieve primacy in a highly systematised and bureaucratised environment where operational efficiency is, in and of itself, often seen as an end goal (Aylett 2013; Froestad et al. 2014). With severe penalties for non-compliance, but little organisational rewards for innovation, municipalities have been characterised by a 'culture of compliance' that hinders innovation and change (De Visser 2011). In addition, protectiveness of the boundaries of departmental mandates makes collaboration and partnerships challenging (Aylett 2013; Froestad et al. 2014).

Against this background, interest in the role of intermediaries in driving organisational change has been growing. Various studies have examined the role of intermediaries in motivating and initiating projects, mediating between different role players and offering advice and capacity-building (Hodson et al. 2013; Janda & Parag 2013; Stewart & Hyysalo 2008). They may add value through building relationships, providing platforms for learning and experimentation, and developing visions and strategies (Van Lente et al. 2003). Engaging at both the systemic level and the individual project implementation level, they act as networkers, facilitators and motivators of change (Hodson et al. 2013). They often fulfil very specific functions that no other actor would be likely to take on, particularly in driving a more strategic and system-building response (Hodson et al. 2013).

In the case of Cape Town, there have been various actors, both internal and external to the municipality, who have played an important role in driving energy efficiency. The focus of this chapter is on the role of an internal actor, the ERMD, and how it has facilitated change in a particular organisational environment. In the following section we present the energy efficiency initiatives and results in the City to date, before examining the mechanisms and tactics that the ERMD has used to drive these initiatives.

An overview of energy efficiency initiatives and their results to date

Energy efficiency initiatives in the City have developed over a period of some 12 years. Starting with donor-funded energy audit and building retrofit demonstration projects driven by the ERMD, there are now multiple implementing departments. Energy efficiency is now located in policy and strategy frameworks, and the City makes budgetary contributions towards its implementation. To date, the City has reduced its electricity use by 15 per cent against its 'business as usual' growth trajectory (Mahomed 2016), exceeding its self-set policy target of a 10 per cent reduction laid out in the Energy and Climate Change Action Plan (CCT 2011).

The City is not unique in pursuing a more energy-efficient mode of operation. This is a growing trend in many South African municipalities. An important catalyst has been national government's energy efficiency grant programme, the Energy Efficiency Demand Side Management Programme (EEDSM). The programme targets energy efficiency in local government by providing grants to retrofit technologies in lighting and buildings. Since 2009, 54 of South Africa's 294 municipalities have participated, with total grant disbursements to municipalities ranging between R130 million and R280 million annually (Kruger & Tait 2015).

Most of Cape Town's energy savings to date have come from retrofitting buildings, streetlights and traffic lights. All traffic lights and high-wattage streetlights (approximately 17 per cent of all streetlights) in the municipality have been retrofitted with energy-efficient bulbs. Fifty-three City-owned buildings have solar water heaters installed. Thirty-two buildings have been retrofitted with smart meter technologies, energy-efficient light bulbs, solar water heaters and heating, ventilation and air conditioning (HVAC) systems. Energy use in these buildings has declined by approximately 18 per cent. Although the number of buildings retrofitted remains a small percentage of the City's 5 000 buildings, they include some of the most significant energy consumers — for example those operated by the Specialised Technical Services Department. Figure 5.4 shows the significance of the energy consumption in these buildings.

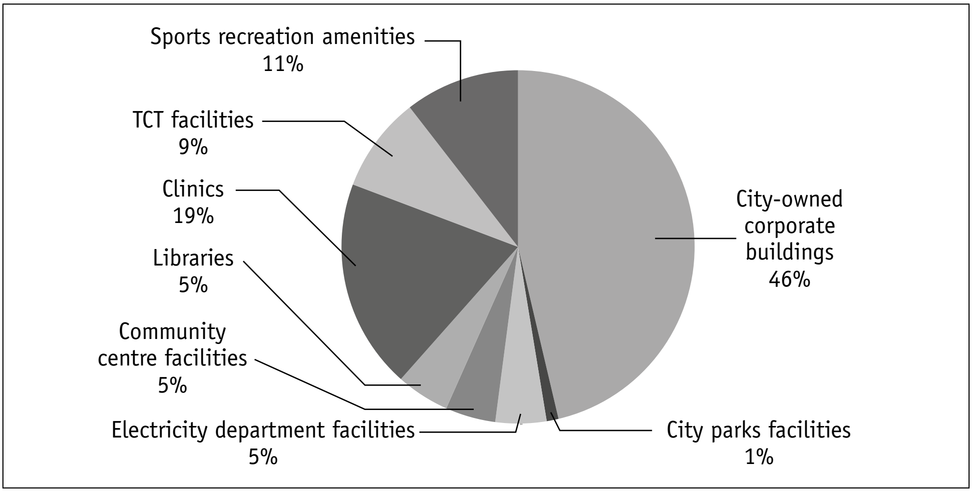

Figure 5.4: Percentage of total energy consumption in CCT buildings and other facilities
Source: CCT 2015: 70

Despite the longer-term financial gains, energy efficiency requires significant capital outlays. Payback periods across a range of interventions in the City are between three and nine years (CCT 2015). The financial investment of interventions undertaken from 2009 to 2014 amounts to approximately R155 million and has saved the City just over R100 million (CCT 2015).

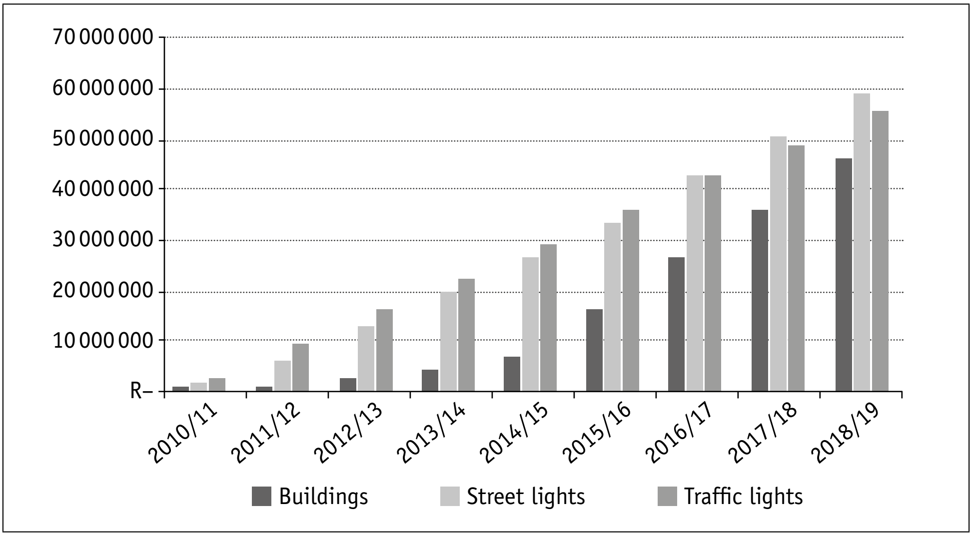

Figure 5.5: Cumulative savings from energy efficiency interventions
Source: Mahomed 2015: 14

The role of the ERMD as energy intermediary

The ERMD's role as innovator is interesting precisely because it emerged within the constraints of a bureaucratised environment, as described in Chapter 3 of this book. The nature of its innovation activities contrasts strongly with the compliance-driven culture typical of municipal departments. This can be better understood by exploring the influence of departmental mandates on departmental cultures.

The ERMD, established in 2000, is tasked with driving the City's environmental sustainability objectives. Its mandate is primarily strategic, being to introduce the necessary changes into the organisation to achieve environmental protection. The department's staff view their function, therefore, as one of innovation. As one ERMD employee described it, they do not see themselves as being limited by their mandate, but instead are encouraged at a managerial level to push the boundaries thereof. This is in marked contrast to operational departments tasked with delivery of a specific service, where routinised efficiency in complying with specifically stated job specifications is required. Without this 'burden' of mandate compliance, ERMD staff do not experience the same institutional pressures that can hinder the required innovation described above.

The ERMD's role can best be characterised as one of 'municipal voluntarism' (Hodson et al. 2013) or 'institutional entrepreneurship' (Leca et al. 2008). Establishing itself as an intermediary, however, has not been an easy or automatic process. Legitimising itself as a home for energy efficiency has been an important and ongoing process, requiring partnership-building and innovative ways of adding value. We explore this process below, before examining the broader scope of the department's activities.

Legitimation and building partnerships

Legitimacy is a key variable in the success or failure of innovations (Binz et al. 2016). ERMD staff have had to demonstrate the value not only of energy efficiency, but also of themselves as intermediaries. Much of their early work was episodic and opportunistic, in order to start building a profile and track record. Their early work consisted of fundraising, demonstration projects, data collection and strategy development. These preparatory activities initiated a process of awareness-raising and problematising inefficient energy use in the organisation. Demonstration retrofitting projects funded with donor grants illustrated that energy efficiency was workable in municipal operations, and provided financial paybacks. These early projects were central to building the necessary evidence base for the value of energy efficiency to the municipality that could be presented to the higher-level municipal executive. In 2012, on the basis of demonstrated financial savings from previous interventions, ERMD officials were able to motivate for the City to start contributing its own internal revenue sources towards energy efficiency.

The ERMD does not manage or control infrastructural systems itself, but instead facilitates action by those that do. This requires partnerships. Thus in addition to the strategic value that the ERMD offers at the system level, it must also bring value to individual partnerships. Its value-add varies across different projects, and is often opportunistically identified. We characterise three key ways in which it brings value to partnerships: firstly by providing technical advice and support; secondly by reducing the risk of innovation for other departments; and thirdly by directly contributing to fulfilling departmental mandates.

Adding value through technical advice and support takes a range of forms, including support in writing business plans, developing tenders, setting up M&V processes and other project-specific advice and support. The second way in which the department adds value is by reducing the risk of innovation for others. Risk management can be an effective stimulus for innovation. For a department, potential risks might relate to various institutional hurdles that could jeopardise project implementation or raise costs, or to the liability of project failure. In addition, departments face risks in diverting resources away from other mandated activities which may invoke penalties, if they fail to deliver on these mandates.

The ERMD reduces the risk by taking on burdensome administrative tasks, setting up new systems, and in some cases taking on the role of project lead, thereby taking on the risk of failure. For example, the Electricity Services Department (ESD) was unable to manage the onerous reporting requirements that accompanied the national EEDSM grant and was facing impending penalties for non-compliance imposed by national government. The ERMD proposed that it take on the reporting and administrative responsibilities of the project, as well as that it become the project lead. This not only freed up ESD capacity to focus on project implementation, but also shifted the risk of project failure from the ESD to the ERMD. Another manner in which ERMD reduces risk is by 'clearing the path' for other departments to undertake a new project. ERMD staff will undertake much of the work involved in fundraising, overcoming institutional hurdles, training staff and setting up new systems for M&V. A collaborating department therefore becomes more of a 'recipient' of an innovation, rather than being the active agent.

The third way in which the ERMD adds value to partnerships is by contributing to a collaborating department's performance objectives. Different municipal departments are pursuing different, and sometimes even competing, objectives. While energy efficiency is motivated by deeper core values held by ERMD employees, other departments may not share these values. Finding motivations that talk more directly to departmental goals is, therefore, essential. For example, the ESD was initially unable to justify devoting departmental resources and expertise to a project to install smart meters in City-owned buildings. For the ERMD, though, this was part of a bigger strategy to develop an energy management system that would assist in data collection for M&V. The

ERMD therefore re-strategised and reframed the project so that it could contribute more directly to the ESD's objectives relating to revenue protection, a key performance area for the department. The City's asset monitoring systems are still poorly developed and, as a result, many City-owned buildings escape electricity billing, creating a significant challenge for the ESD. The energy efficiency measure of installing smart meters was reframed as a project to introduce smart meters in City buildings in order to improve monitoring and billing procedures and help the ESD to reduce loss and theft.

Energy efficient system-building activities

Perhaps the greatest value an intermediary can play is in building systemic change and undertaking those activities that fall outside of the interests of individual departments. The ERMD's various strategic and operational activities are all bound up in a broader system-building process (Binz et al. 2016), realigning the institution towards a low-carbon mode of operation. We have characterised three broad areas of systemic work that the ERMD engages in as an intermediary, as shown in Table 5.1. The first area is focused on reshaping institutional systems and processes to enable both innovations as well as longer-term institutionalisation of energy efficiency. The second area involves reshaping user interactions with technologies, and the third relates to networking, advocacy and mediation activities.

Table 5.1: Overview of the intermediary's system-building activities

System-building activity	Examples
Reshaping institutional processes	• Knowledge creation and diffusion • Developing energy management and data collection systems • Developing necessary changes to procurement processes • Institutionalising energy efficiency within standard municipal operating procedures
Reshaping user interactions with technologies	• Capacity-building • New technologies that mediate usage of technologies • Building the profile of energy efficiency
Networking, advocacy and mediation	• Political work to build strategic support • Networking and advocacy with both internal and external stakeholders • Mediating between project funders and City departments

Source: The authors

Reshaping institutional processes

The process of turning individual retrofitting projects into a more fundamental change in asset management procedures is by no means automatic. Institutional alignment in many cases needs to be actively constructed. In this section we describe three key areas of the ERMD's work in this regard: strategy development, adapting procurement systems and internalising energy efficiency within city operations.

Building an evidence base for strategy development

The 'urban energy problem' is largely an abstract one, previously not particularly high on departmental or political agendas. It has required work to clearly articulate the issues in order to mobilise the necessary support and resources for action to deal with this problem. Much of the ERMD's work involves presentations to various internal and external stakeholder groups, producing reports, briefs and other visual or data outputs to build the identity of the City's energy use, and the issues associated with it. This knowledge creation feeds into and supports networking and advocacy work. A significant contribution from the ERMD has been the production of an evidence base in its State of Energy reports. Three Cape Town State of Energy reports have been produced in 2003, 2007 and 2015 (CCT 2003, 2007, 2015) as well as an Energy Futures report (SEA 2015a). These studies have attempted to collect data on the municipal urban energy system in order to build a comprehensive quantitative picture of energy supply and demand across all sectors projected into the future. They have established an important and necessary evidence base to feed into policy and strategy development. No systemic change can happen in a municipal environment without the appropriate policy framework, and the evidence base these reports have developed has been extremely influential. Figure 5.6 shows the development of the energy-related policy landscape in the City. The supporting policy framework has created an enabling environment and set out concrete objectives relating to energy conservation in internal city operations.

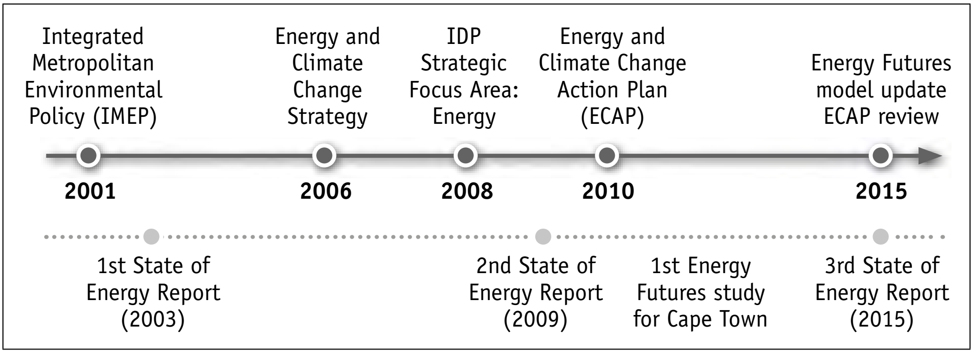

Figure 5.6: Policy and reporting timeline for energy and climate change-related initiatives
Source: Mahomed 2015: 2

Procurement systems

Although a policy framework creates the potential for action, it does not ensure that institutional processes are necessarily in place to facilitate this. Tendering and procurement, for example, has taken time to adapt to the specificities of energy performance contracting (EPC). There are two distinct stages to an energy retrofit project. The first involves an energy audit and business plan detailing the costs, projected energy savings and payback periods of the intervention. This is followed by the second stage which consists of implementation and performance guarantee. These two stages could not be covered in a single municipal tendering process because the full costs of the implementation stage cannot be determined until after an energy audit has been undertaken. This means that service providers cannot provide the necessary details to satisfy tendering requirements. But the two stages also could not take place in two separate competitive tendering processes, as they cannot be undertaken by different service providers. Service providers are unwilling to commit to performance guarantees based on an energy audit they have not personally undertaken (Mackenzie & Diederichs Mander 2014).

The way in which an EPC is normally structured in other sectors does not comply with many of the specifications of local government procurement legislation (Mackenzie & Diederichs Mander 2014). EPC refers to the contracting mechanisms by means of which service providers guarantee the energy savings of their interventions for the duration of that intervention's payback period. In this way service providers provide assurance that their interventions will deliver on the savings they have promised, and take on the risk of non-performance. However, these contract types are problematic in several ways for municipalities. Municipalities cannot, for example, ring-fence the financial savings out of which to pay service providers, and the process of engaging in long-term contracting for municipalities is onerous. Developing the appropriate two-stage tendering process has been a long and iterative exercise, taking place over several years in collaboration with Supply Chain Management (SCM), the department responsible for procurement. Both the ERMD and SCM have had to develop the appropriate skill set to review the technical aspects of tenders.

Reshaping user interactions with technologies

Users can be as important in shaping outcomes as the technologies themselves. The ERMD engages with three levels of municipal actors that influence the energy system. The first is at managerial level. Their buy-in is an essential starting point for initiating and supporting departmental energy efficiency interventions lower down the hierarchy. The second level focuses on providing training for building facilities managers and maintenance staff. The ERMD has developed a detailed practical energy management course to introduce officials to energy concepts, and to methods for efficiently managing energy technologies and their usage in their day-to-day roles. The third level of engagement is with tenants and occupants of buildings, or the end-users. Behaviour change workshops and interactive displays on energy efficiency are held at all retrofitted buildings. To date, the ERMD has undertaken 45 facilities managers' courses as well as 35 behaviour change workshops with more than 700 participants. As well as these engagement and training activities, the ERMD is pioneering the introduction of new technological interfaces to improve awareness of and engagement with sustainable energy use. All of these activities aim to enrol users more directly and consciously in the use and management of energy, and to make visible the 'black-boxed' element of operational activities (Furlong 2011).

Networking, advocacy and mediation

Networking, advocacy and mediation activities enable opportunities to be leveraged from diverse sources, and are instrumental in creating the necessary conditions for further innovative activity to unfold. Having a proactive and dedicated actor able to invest the necessary time and capacity in these strategic activities is important. The concept of 'opportunistic incrementalism' is a useful one to characterise the ERMD's work over time. It describes a process of seizing opportunities as they arise — 'finding ideas and projects that at specific moments have traction with specific politicians or departments and facilitating their implementation' (Aylett 2013: 1399).

Making use of networks and personal ties is an important feature of the way that change and innovation happen in cities. The ERMD participates in both national and international networks, which not only enables cross-learning and diffusion of new ideas, but also builds political support locally for its work. Networks with other municipalities, for example, provide support in business plan development for EEDSM applications, which are technically and administratively difficult to complete. Internationally, these networks include a partnering scheme with the City of Munich on climate change, and involvement in the Global Compact of Mayors, a cooperative agreement among city mayors around the world to reduce emissions, track progress, and prepare for the impacts of climate change.[1]

Energy efficiency is not automatically on local government political agendas (Kruger & Tait 2015). Engagement with politicians and strategic leverage of international networks can be important tools to build the necessary political support. Internally, the ERMD also undertakes a lot of advocacy work. This includes reporting to the Chief Financial Officer to motivate for City funding, and engaging with the Facilities Optimisation Working Group, an interdepartmental working group that aims to optimise facilities management and improve lifecycle management of City infrastructure. The ERMD uses this platform to report on energy efficiency work to date, as well as to leverage interest and support for future work.

1 See https://www.globalcovenantofmayors.org/, accessed 28 January 2019.

Challenges and issues going forward

The innovation process has not been without its challenges. It has been a long and slow one, and what has been achieved to date remains a small part of the overall scale of implementation required. One of the ERMD's key ongoing challenges has been securing funding. EEDSM grant funding has been an important source over the years. But this programme only allocates funding on an annual basis, and funds must be spent within the financial year for which they are allocated. Each year new business plans must be submitted in order to apply for more funding. This has proved challenging in two regards: firstly in that it offers no long-term certainty beyond that year's allocation; and secondly in that it limits the scale and scope of projects to those that can be implemented within one year. However, as the ERMD's implementation record has developed, it has been able to build a compelling evidence base for the financial savings it has achieved. This has been used to secure internal City revenues to fund a portion of its activities. This is significant, firstly in demonstrating City support and endorsement of energy efficiency, but also in that it enables the ERMD to shift from project-based interventions to a more programmatic approach. To date, approximately 56 per cent of its total funding has come from external grant sources, and 44 per cent from internal revenue sources within the City.

Going forward, the ERMD's major focus is on institutionalising energy efficiency in City operations. To date interventions have followed a bottom-up approach, with action limited to those departments which are interested in proactively taking on this objective. Longer-term sustainability will require a top-down approach centred on internalising energy efficiency within departmental performance objectives and asset management protocols. Much of the ERMD's more recent institutional work has, therefore, been focused on developing and advocating for an Internal Energy Management Protocol (IEMP) to feed into existing asset management policy. This proposes to introduce mandatory energy targets into departments, specifying a measurable key performance area. It also outlines specific operating procedures to implement the energy efficiency principles set out in policy. These include step-by-step procedures to follow, such as conducting an energy audit and identifying departmental resource requirements in terms of staff and budget to implement energy efficiency. At the time of writing, this provided the basis for setting departmental energy targets and for developing a five-year implementation and business plan. Two pilot departments were identified to develop and test the IEMP.

Conclusion

The ERMD's experience with building energy efficiency in the City can offer useful reflections on and insights into the complex task of institutionalising climate change-related innovations within municipalities. These types of policy challenges often fall through the gaps between specific mandates and are difficult to implement in departmentalised organisational environments which inhibit both collaboration and innovation. This chapter has demonstrated how introducing energy efficiency has required reshaping the wider socio-technical system in which technologies are embedded.

An intermediary department, unconstrained by operational mandates, can be a critical mechanism to navigate through the various institutional challenges. Working at both strategic and operational levels, intermediaries may have greater flexibility to undertake a diverse range of activities. The ERMD's scope of work to build energy efficiency in the City has included project-specific technical support, adapting institutional systems through redeveloping strategy and developing new tendering processes, capacity-building, as well as networking and advocacy work both within the City and externally. There remains much more to be done, and the ERMD's central focus at the system level going forward will be on embedding energy efficiency within asset management processes and departmental performance criteria, such that it becomes a core component of operational practices.

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CHAPTER 6

Water demand management in Cape Town: managing water security in a changing climate

Ken Sinclair-Smith and Kevin Winter

Cape Town is a large and rapidly growing city located in a water-scarce region where future options for increasing water supply to the city are constrained. In addition to continued rapid urban growth, climate change-related risks threaten regional water security. The aim of this chapter is to show how the growth in water demand has been managed in Cape Town since the introduction of a comprehensive programme of water demand management (WDM) in 2001, and covers the important role this programme has played in managing water resources in the period 2001 to 2015. The chapter also outlines water saving measures implemented 2016 to 2018 during the Cape Town drought and describes how many elements of this long-term programme were scaled-up and adapted as part of the City's emergency drought response.

Cape Town's water insecurity

As South Africa's second-largest metropole, Cape Town supplies water to approximately 4 million people via 650 000 formal water connections and 6 500 communal taps in informal settlements. As shown in Figure 6.1, formal residential use (houses, flats and housing complexes) accounts for most water used in the city (66 per cent in 2014/15 prior to drought and the introduction of water restrictions but dropping to 60 per cent in 2017/18), whereas informal settlements use 5 per cent and industry only 4 per cent as the city's economy is largely service-based (CCT 2018a).

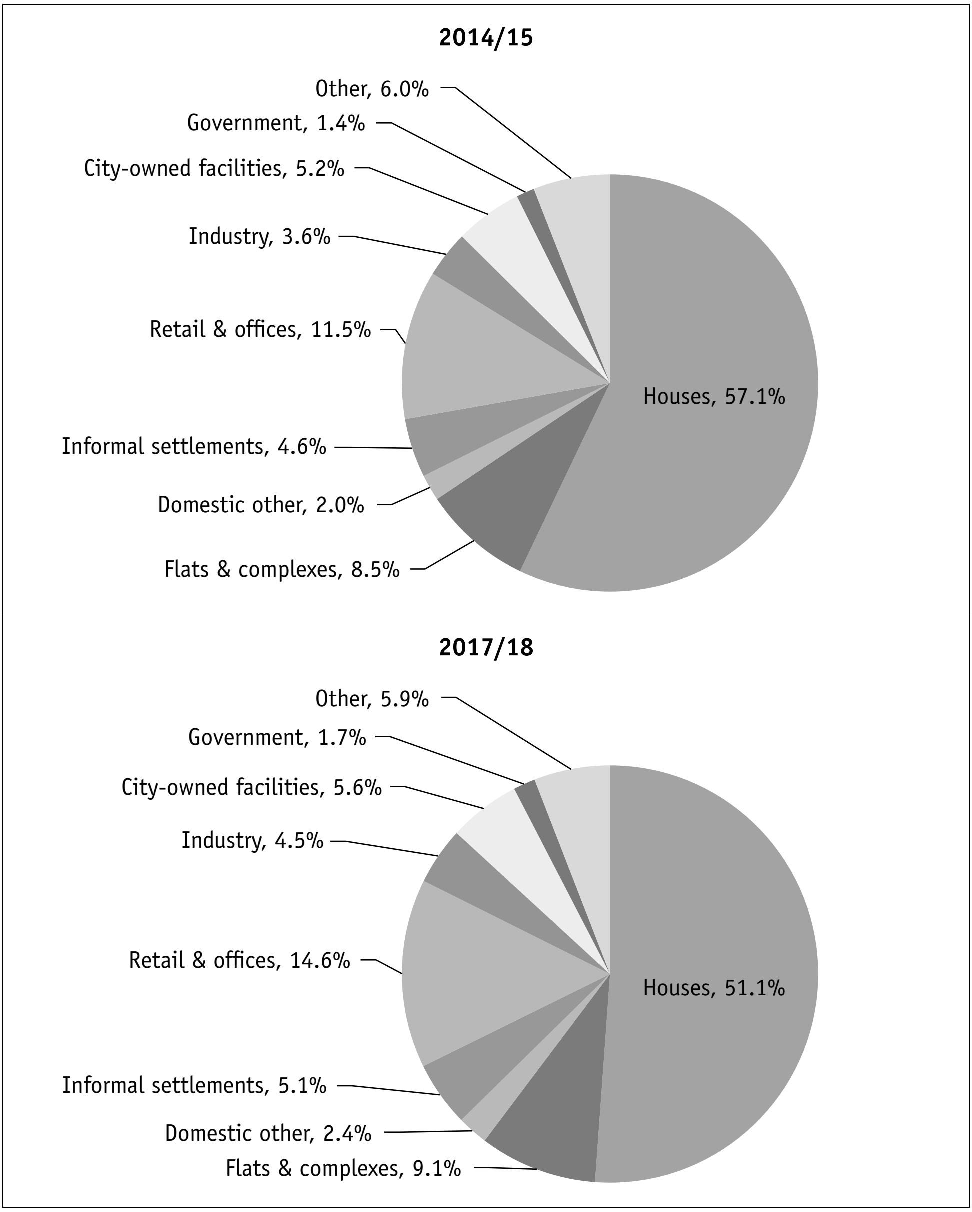

Figure 6.1: Percentage of water used in Cape Town by sector in 2014/15 and 2017/18
Source: CCT 2018a

Water demand is expected to increase due to the continuing rapid growth of the city and national urbanisation trends that have seen substantial population relocation to urban areas of the Western Cape and Gauteng provinces. The number of formal dwellings in the city increased by 194 965 between 2011 and 2016 (WCG 2017) and approximately 7 000 new formal households are connected to

Table 6.1: Estimated water use for different housing types prior to the introduction of water restrictions from 2016

Type of housing	Daily water use	Source
South African dwellings serviced by communal tap	25 litres per person	CSIR 2000
South African dwellings serviced by yard connection (tap on the property)	55 litres per person	CSIR 2000
Cape Town informal dwellings (communal tap)	41 litres per household	Viljoen 2015
Government subsidy housing in Cape Town*	310 litres per household	CCT 2018a
Cape Town residential property 200–300 m^2*	455 litres per household	CCT 2018a
Cape Town residential property 300–600 m^2*	583 litres per household	CCT 2018a

Note: * Median values with use averaged over 12 months (2013/14).

the water system every year (CCT 2018a). In addition, service delivery, improved access to water, economic growth and improved standards of living associated with urbanisation are expected to contribute to increases in water use. Furthermore, economic growth is expected to lead to an increase in water demand in businesses and industry as well as an increase in domestic use as a result of increased household income. Table 6.1 indicates how water demand typically increases with improved housing and living conditions.

Cape Town is situated within the Berg Water Management Area which was recognised as early as 2004 by the Department of Water Affairs and Forestry (DWAF), now the Department of Water and Sanitation (DWS), as the most water-stressed major urban region in the country (DWAF 2004). Unlike most of South Africa, Cape Town has a Mediterranean climate with winter rainfall and hot dry summers. This contributes to increased demand for domestic and agricultural irrigation, especially in the hot dry summer months, and requires greater water storage capacity. While Cape Town is the largest urban water consumer in the region, regional water resources need to be shared with a number of smaller towns in the region and with the agricultural sector, which forms an important part of the regional economy and has strong economic links to other sectors including tourism and the agro-processing sectors.

Furthermore, it is important that sufficient water remains in river systems in order to maintain the ecological health of the river — this is referred to as the

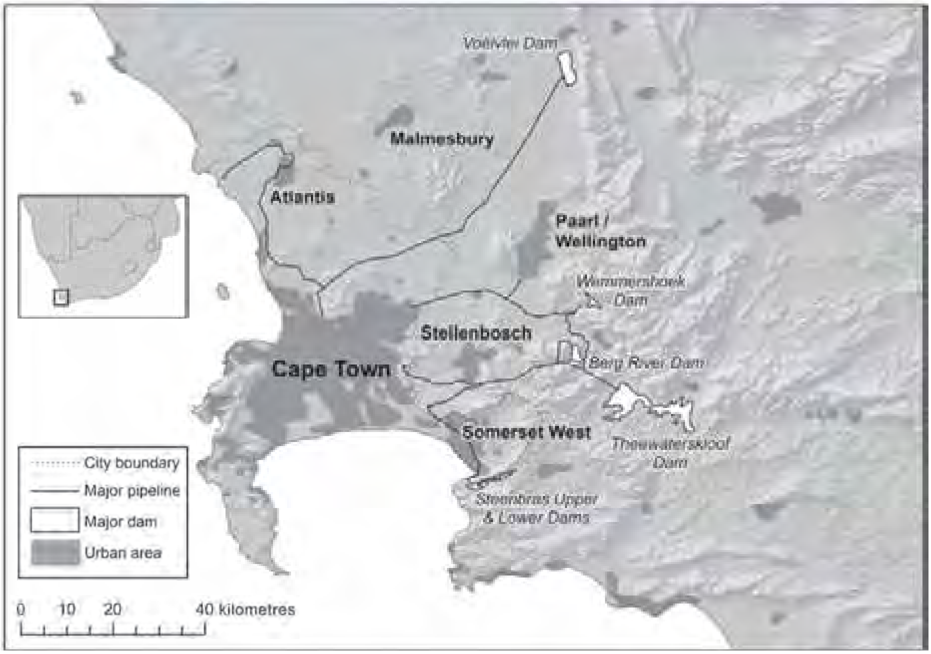

Figure 6.2: CCT municipal area and major Cape Town water sources
Source: The authors

ecological reserve. Nowadays ecological reserve requirements are factored into the planning and management of all new dams and water supply schemes, as required by the National Water Act (NWA, No. 36 of 1998). This approach was followed for the ecologically sensitive Berg River Dam, completed in 2007, but not for the earlier dams; ideally, additional water should be returned to the rivers downstream of the dam in order to maintain their ecological reserve in compliance with the NWA (DWAF 2007).

Future unreliability of water supply is one of the greatest risks of climate change (Solomon et al. 2007). Southern Africa is considered to be one of the most vulnerable regions of the world, and the south-western Cape in particular is deemed to be at greatest risk due to the likelihood of a decrease in precipitation compared to other parts of South Africa (Solomon et al. 2007). Cape Town's water insecurity is therefore compounded by climate change risks, as medium-term predictions for the region include reduced average rainfall, higher temperatures, increased south-easterly winds, higher evapotranspiration rates and an increased likelihood of drought (Midgley et al. 2005; Mukheibir & Ziervogel 2006; Tadross et al. 2012). This creates the combined risk of increased water demand and reduced water supply.

Traditional approaches: increasing water supply

Traditional approaches to managing water insecurity emphasise supply augmentation (such as building new dams and other water supply schemes) and short-term water restrictions, enforced in times of drought. This contrasts with more integrated approaches to water planning which highlight the importance of ongoing, long-term-oriented WDM programmes (CCT 2007; Frame & Killick 2007). Cape Town has a history of water demand exceeding available supply, and periodic water shortages have prompted expenditure on new water supply schemes. The Disa River, which flows off Table Mountain to Hout Bay, was diverted in 1891 to increase supply to the Molteno Reservoir in central Cape Town following water shortages experienced from the early 1880s. However, water from Table Mountain rivers and springs soon proved to be insufficient in the summer months, resulting in the construction of five dams on Table Mountain between 1892 and 1910. Due to city growth, water demand again exceeded supply and severe water shortages were experienced from as early as 1912. This led to the construction of the first Steenbras Dam and accompanying 64 km pipeline completed in 1921 and, later, the construction of the Wemmershoek Dam, completed in 1957.[1]

Today Cape Town is supplied by 14 dams with a collective capacity of nearly 900 million m^3, most of which is provided by six large dams: the Theewaterskloof, Voëlvlei, Berg River, Wemmershoek and Steenbras Upper and Lower dams. Cape Town's water is largely sourced from surface water. The balance is mostly groundwater from the Atlantis Aquifer and the Albion Spring in Newlands while smaller contributions are received from other springs and temporary desalination plants. Cape Town's water supply forms part of the Western Cape Water Supply System (WCWSS), which is an integrated and collectively managed system of the City of Cape Town (CCT, also referred to as the City) Municipality and DWS-owned dams, pump stations, pipelines and tunnels, and which supplies raw water to urban areas and agricultural users in the region. The integrated system helps to optimise water storage in the region by preventing spillage from individual dams; it also allows for the transfer of water between the Berg and Breede River catchment areas which reduces the City's dependence on any one catchment area. The highly integrated nature of the WCWSS, as well as its drought-operating rules and other innovations in its management, contribute considerably to the resilience of the regional water supply.

Planning for the development of additional water supply schemes and the timing thereof is undertaken collectively by the CCT, DWS and other regional stakeholders through a planning process known as the WCWSS Reconciliation Strategy (DWS 2014). However, increasing water supply is more difficult than in the past as most surface water resources in the region are already fully utilised.

1 A. Singels, personal communication, 2015.

In some areas, the ecological health of rivers is threatened by the removal of an unsustainable amount of water, compromising downstream aquatic ecosystems, water quality and biodiversity (Midgley et al. 2005).

The Berg River Dam added an additional 81 million m^3 of annual yield to the WCWSS and was the last major surface scheme available in the region. Future options for supply augmentation are generally less attractive due to their higher energy requirements and higher financial and environmental costs. At the time of writing, the following schemes were either under consideration or under way: the Berg River-Voëlvlei Augmentation Scheme that involves pumping surplus winter flows from the Berg River to Voëlvlei Dam for storage; ground water from the Cape Flats and Table Mountain Group aquifers; increasing the yield from the Atlantis and Silwerstroom Aquifers; clearing of alien vegetation from water catchments, water reuse schemes; and desalination (CCT 2018c).

Water demand management

Over the past two decades WDM has become widely accepted as an essential component of water resource planning (Gleick 2000; Sharma & Vairavamoorthy 2009) and, more recently, its potential benefit as a climate change adaptation measure has been highlighted (see for example Cullis et al. 2011 and Lopez et al. 2009). WDM has successfully reduced demand and improved efficiencies in many countries; however implementation has been more difficult in environments where technical skills are less available and infrastructure and management systems less developed (Sharma & Vairavamoorthy 2009). Political preferences for more traditional supply-side measures may also have hindered the implementation of WDM programmes in some cases (Gumbo & Van der Zaag 2002). While WDM initiatives in developed countries are generally oriented towards improving efficiency, WDM projects in resource-limited settings have focused more on reducing extremely high water leakage rates in order to extend limited water resources to inadequately served and rapidly growing populations (Sharma & Vairavamoorthy 2009). In comparison, Cape Town has a relatively well-managed water distribution system and its WDM programme includes a comprehensive range of technical and non-technical measures. However, this programme has been implemented in an environment of rapid population growth, limited resources and high poverty levels.

The CCT water conservation and water demand management programme 2001 to 2015

WDM at the CCT is implemented by a dedicated WDM section established within the City's Water and Sanitation Department and is guided by the Water

Conservation and Water Demand Management (WCWDM) policy, first published in 2007 and updated from time to time (CCT 2007). The policy aims to reduce water demand by minimising water wastage and increasing water use efficiency in order to ensure the long-term balance between water demand and supply, and to limit or postpone expensive capital infrastructure projects for water supply augmentation. The focus of the programme differs from water restrictions, which are short-term measures implemented in periods of below-average rainfall. WDM and water supply augmentation are both considered essential components of integrated water planning as it is unlikely that water security can be achieved by demand-side or supply-side measures alone due to continuing population growth and development.

The concept of WDM became increasingly prominent in Cape Town from the mid-1990s amid growing concern over the city's rapidly increasing water demand. Key milestones from this early period include the establishment of a WDM section within the former Cape Metropolitan Council (CMC), the adoption of a CMC WDM policy in 1998, and the initiation of WDM projects, including the Khayelitsha Pressure Management Project, implemented in 2001 (CCT 2007; Frame & Killick 2007). The 2001 Integrated Water Resource Planning study concluded that WDM initiatives could achieve substantial water savings and were preferable to water supply augmentation options in terms of cost, implementation times, and environmental and social acceptability. Findings from this study informed the 2001 CCT WDM Policy and Strategy adopted by the then newly formed Cape Town 'Unicity' (CCT 2007; Frame & Killick 2007).

A key objective of the 2001 WDM Strategy was a 20 per cent reduction in water demand (relative to past growth rates) by 2010. This was achieved ahead of time in 2004. However, despite early successes, the implementation of the strategy was not sustained and funding for WDM projects was reduced between 2003 and 2006. Nevertheless, a number of events at the time refocused attention on WDM, including the 2003 agreement to proceed with the Berg River Scheme, lobbying from the DWAF for the intensification of WDM, and the drought of 2004/5 which resulted in severe water restrictions. Significantly, the implementation of WDM was included as a condition of the 2003 raw water supply agreement between the City and DWAF. These events led to the adoption of the ten-point Water Conservation Plan in 2005 and the more comprehensive WCWDM Policy and associated 10-year implementation plan, which were both approved in 2007 (CCT 2007). From 2016, WDM initiatives were rapidly expanded and reorientated towards maximising water savings as part of the City's emergency drought response measures as discussed later in this chapter.

WDM initiatives have generally been implemented earlier in Cape Town than in other South African cities because of an awareness of water scarcity in the region. Many WDM projects implemented in Cape Town were groundbreaking at the time and have since been mainstreamed and incorporated into national guidelines and policies. The WCWDM programme has received numerous national awards and in 2015 received the C40 Cities Award for best climate change adaptation implementation project at the Paris COP21 climate negotiations (C40 Cities 2015).[2]

An important feature of the programme is its multi-pronged approach, which focuses on both technical and behavioural aspects of saving water. Many of the projects have been innovative and have explored new ways of dealing with water loss in low-income urban environments with sensitivity to poverty and social needs. The programme consists of a diverse range of initiatives which are outlined below.

1. Managing water pressure

Lowering water pressure can dramatically reduce the amount of water lost from leaking water mains and plumbing fittings (for example dripping taps or leaking toilet cisterns). Other benefits include extending the lifespans of water mains and plumbing fittings, and a reduction in pipe bursts and resulting water losses. Water pressure is reduced by installing pressure-reducing valves in the water supply to discrete water supply zones that are isolated from the rest of system. The valves are usually linked to an electronic controller that allows for substantial pressure reductions in off-peak (night-time) periods when pressure is normally highest due to lower water use.

Pressure management has been particularly effective in Cape Town, especially on the Cape Flats where the majority of the city's low-income suburbs have relatively higher water pressures because water is supplied from reservoirs that are located 110 m above mean sea level. High pressure causes damage to plumbing fittings over time and contributes to the high leakage rates (McKenzie et al. 2004). This is particularly problematic in low-income residential areas where households struggle to afford high-quality plumbing fittings and repairs. Water supply is unaffected as sufficient pressure is maintained during periods of peak demand.

Cape Town's first pressure management scheme was implemented in Khayelitsha in 2001. It was one of the first large-scale advanced pressure management projects in the world, and the project won numerous awards and was highly influential locally and internationally. Water savings from the scheme greatly exceeded expectations, resulting in a 40 per cent reduction in water supplied to the area and a saving of 9 million m^3 per year (McKenzie et al. 2004) — the equivalent of two Olympic-size swimming pools every five hours. A second scheme was implemented in Mitchells Plain in 2008. Pressure management has since been extended to a further 25 areas. It is now a well-established component of the WCWDM programme with an annual capital budget of R22 million (CCT 2015b).

2 See http://www.c40.org/awards/2015-awards/profiles, accessed 12 June 2016.

2. Minimising water leaks from the municipal network

Water leaks from the municipal water system are addressed through ongoing network maintenance programmes, responding to reported leaks, detection and repair of underground leaks, and by ensuring rapid response times to burst water mains. A dedicated leak detection and repair programme has been established as most leaks occur underground and are difficult to detect. Leak detection teams are dispatched to water zones with high leakage rates. These teams use 'listening devices' in combination with geographic information systems (GIS), mapping and aerial photography to locate underground leaks. Estimated water savings from leak detection and repair programmes are in the order of two million m^3 per year (in addition to water savings realised from routine repair and maintenance) (CCT 2018a).

Although total leakage from the municipal water network is difficult to measure, it is estimated to be approximately 30 million m^3 per year (CCT 2018a). While this figure may seem high, the size and scale of Cape Town's water distribution network is considerable, spanning a distance of nearly 11 000 km long with over 650 000 connection points. This level of losses compares relatively favourably to industry benchmarks for physical water loss and suggests that water leakage in Cape Town is well within acceptable limits. Percentage non-revenue water (a broader measure of losses that includes physical losses as well as unbilled-for water) is approximately 25 per cent (CCT 2018a), against the South African average of 41 per cent (DWS 2018) and the global average of 36 per cent (McKenzie et al. 2012). It is also important to note that due to the nature of water networks it is not possible to repair all leaks; nor is it economically desirable to reduce leakage below a certain rate due to the high cost of leak detection and repair relative to the cost of water (McKenzie & Seago 2005).

3. Pipe replacement programme

The CCT replaces approximately 40 km of old pipeline every year as part of an ongoing programme to maintain and rehabilitate the city's water reticulation system, which in many areas is more than 40 years old and reaching the end of its useful life. The City's objective is to prioritise the repair and maintenance of existing infrastructure, which has previously been under-invested in due to limited resources (CCT 2015b). Pipe replacement is important for preventing water losses as old pipes tend to leak more and are also more likely to burst. As shown in Figure 6.3, the incidence of pipe bursts per year has steadily declined from over 6 000 in 2010/11 to around 2 500 in 2017/18. The pipe replacement and pressure management programmes are seen as the most likely reasons for this reduction.

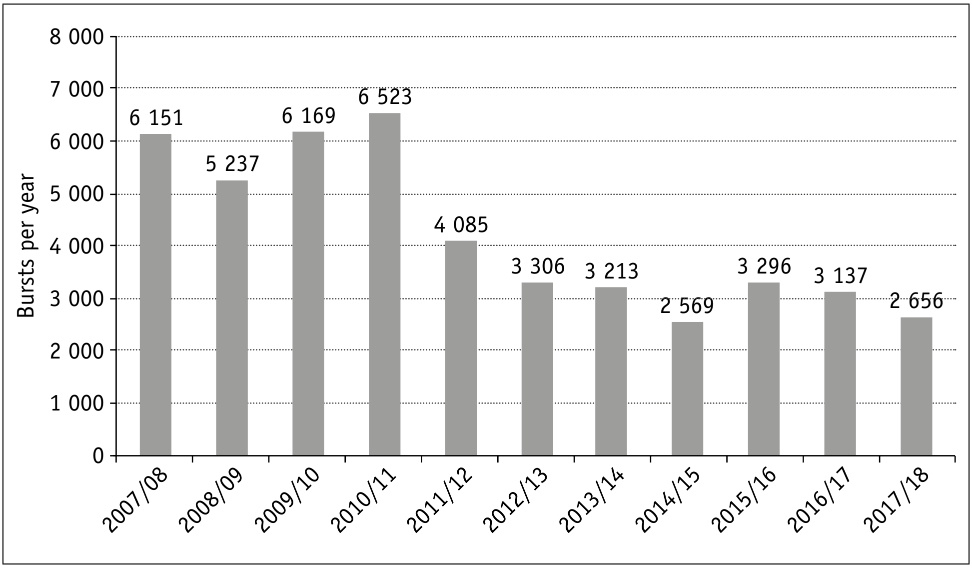

Figure 6.3: Pipe bursts in Cape Town per year
Source: CCT 2018a

4. Substituting potable water with non-potable sources

Over 20 million m³ of recycled water (also referred to as treated effluent or treated sewage water) is supplied annually via dedicated pipelines. This water is generally used for industrial purposes, for agriculture, and by sports clubs, schools, golf courses and the CCT for irrigation. More than 10 per cent of all potable water supplied within the city is recycled in this manner (CCT 2018a). The City actively promotes the use of recycled water and is expanding the reticulation network on an ongoing basis to accommodate additional customers. For instance, R20 million was budgeted for extending and upgrading this system in the 2018/19 financial year (CCT 2018b).

In addition, spring water is used to irrigate the Green Point Urban Park and surrounding sports fields, and a 2015 investigation has located and evaluated more than 60 springs for potential use.

5. Improving water metering

Accurate water metering and billing is critical for ensuring responsible and efficient use of water. The City aims to meter all water use (as far as practically possible) and to read all meters on a monthly basis. Through various programmes, approximately 30 000 defective, ageing or inaccessible water meters are replaced or relocated each year. In addition, meter audits are regularly conducted for large consumers and in industrial areas.

6. Water tariffs

The City introduced a 'rising block' tariff for residential consumers from 1997 and substantially increased tariffs in 2001 to encourage water efficiency (Frame & Killick 2007). As shown in Table 6.2, the kilolitre price of water increases as more water is used. This results in high-demand users being charged substantially more than low-demand users. The effectiveness and suitability of this mechanism is supported by Jansen and Schulz (2006), who found that high-income groups in Cape Town are price-sensitive and reduce water use in response to price increases. Another benefit of the rising block tariff is that it allows for the cross-subsidisation of low water demand users. The first 10 500 litres of water per month are provided free of charge to indigent households.

Variable tariffs are used in conjunction with water restrictions to manage short-term demand during periods of drought. Every year the City pre-approves tariffs to allow for different levels of water restriction and sets significantly higher prices for the upper tariff blocks in order to effect additional water savings, particularly for high water demand users (Table 6.2).

Table 6.2: CCT residential water tariffs for 2018/19*

Tariff blocks	Level 1 tariff	Level 2 tariff	Level 3 tariff	Level 4 tariff	Level 5 tariff	Level 6 tariff
Step 1 ** (0 ≤ 6 kl)	R14.78	R15.25	R15.73	R16.25	R24.37	R33.24
Step 2 ** (> 6 kl ≤ 10,5 kl)	R19.70	R20.95	R22.38	R25.90	R39.59	R52.90
Step 3 (> 10,5 kl ≤ 35 kl)	R26.20	R28.47	R31.77	R39.16	R60.25	R138.31
Step 4 (> 35 kl)	R45.30	R52.54	R69.76	R97.39	R345.00	R1,150.00

Source: http://www.capetown.gov.za/Work%20and%20business/Meet-the-city/The-City-budget/the-citys-budget-2018-2019, accessed 31 December 2018.

Notes: * Monthly tariff blocks for domestic full and domestic cluster tariff categories. Prices in Rands inclusive of VAT per kilolitre (1 kilolitre = 1 m^3 = 1 000 litres).

** free for indigent households

7. Information, monitoring and research

An important component of the WCWDM programme is the ongoing improvement of information and monitoring systems. An extensive set of measurements, including the amount of water lost from the water network, water recycled and unbilled water, are tracked to monitor the effectiveness of the WCWDM programme. These are published monthly by the City's Water and Sanitation Department to ensure awareness and informed decision-making. In addition, indicators monitoring the effectiveness of the WCWDM programme feature prominently in the City's performance management system and receive close scrutiny from political leadership, the public and national departments such as the Auditor General and National Treasury. Examples include: 'metres of water mains replaced annually', 'percentage water recycled' and 'percentage water not billed'. An annual research budget improves understanding of the water system, monitor effectiveness and inform policy and decision-making. The department collaborates with research bodies and other partners, including the DWS, the Water Research Commission and the Municipal Benchmarking Initiative, to develop relevant water loss indicators and industry benchmarks.[3]

8. By-laws and enforcement

The City has progressively tightened water regulations to promote water use efficiency, allow for more effective enforcement and allow for and regulate the use of alternative water sources. Many water use efficiency regulations, previously only applicable during periods when water restrictions, are now permanently in force.

Revised legislation includes the promulgation of the 2006 Water By-Law, the 2010 Water By-Law and its amendment in 2018 as well as the 2010 Treated Effluent By-Law and its amendment in 2015. These by-laws introduced a number of permanent water saving measures including restrictions on garden watering times and hosepipe use, compulsory water audits for large users and a plumbing compliance certificate required for the transfer of a property to take place to ensure that there are no water leaks on the property and that the water meter installed there is working correctly. The 2018 Water By-Law amendment specifies higher water efficiency standards for taps, showerheads and toilet cisterns; requires sub-metering for all new developments comprising multiple dwelling units or commercial units; requires all swimming pools to be covered when not in use; makes provision and regulates the use of alternative water sources such as grey water, rainwater, ground water, surface water and sea water; and allows for improved oversight of plumbers.

9. Addressing water leaks in low-income households

As much as seven per cent of domestic water supplied is estimated to be lost due to household leaks (CCT 2014). This contributes significantly to the city's water demand and much of this leakage occurs in households that are not paying for services. Household leaks typically occur in low-income households with poor quality or poorly maintained plumbing and fittings. The occupants may have little

3 The Water Research Commission is a statutory research organisation that coordinates research and innovation in the South African water sector. The Municipal Benchmarking Initiative is an initiative aimed at facilitating benchmarking and information-sharing within the South African municipal water sector.

awareness of a leak or the extent of the leakage if it is underground, or coming from the toilet cistern that drains directly to the sewer network. Households frequently cannot afford to repair the plumbing or pay high water bills resulting from leaks. As a result many stop paying for services and account arrears build up. The vicious cycle continues once the household stops paying for water, as there is little incentive to use water efficiently in this scenario.

The City has adopted an integrated approach to managing debt and water leakage in households qualifying for indigent status. In such cases the City will, on a one-off basis, write off the arrears, repair all plumbing leaks and replace defective plumbing fittings free of charge. The household qualifies for 10 500 litres of free water per month (approximately 350 litres per day) in terms of the indigent household water allocation discussed above. A water management device is installed to allocate the 10 500 litres of free water (or a higher volume as per agreement) in daily allocations over the course of the month. This policy, which is fully operational and reaches over 30 000 households per year, plays a critical role in managing water demand (CCT 2018a).

However, the installation of water management devices has not been problem-free. While the device allows for a high level of service, it is relatively complex and is more difficult to install and manage than a standard water connection. There has also been resistance to the installation of these devices; this is compounded by a lack of understanding of how the device works, especially in households where recurring leaks result in the device shutting off water supply once the daily allocation has flowed through it. In addition, a number of devices malfunction, although this has been found to be relatively infrequent. In response to these challenges, the City has increased community engagement programmes as detailed below.

10. Education and awareness

The City's longstanding 'Keep Saving Water' programme played an important role in maintaining awareness and influencing citizen behaviour during the period of relatively good rainfall experienced from 2005 to 2014, even though WCWSS dams frequently achieved 100 percent capacity during this period. The programme was marketed through a variety of media including press statements, radio, newspaper advertisements, the CCT website, billboards and signage on municipal vehicles. In addition, education and awareness messages were disseminated through a diverse range of public engagements including school drama festivals, face-to-face customer surveys, an education display at the Two Oceans Aquarium, the celebration of Water Week, and water audits conducted at businesses and institutions with high use.

More than 2 000 Expanded Public Works Programme employment opportunities were created through water education and awareness programmes, including door-to-door awareness campaigns, engagements with informal car wash businesses, workshops, meetings and other public engagements at community centres, schools, churches, clinics and shopping malls. Nevertheless, education and awareness initiatives were stepped up considerably from 2015 as dam levels began to drop during the recent drought, as discussed later.

11. Innovative approaches in low-income communities
A number of innovative programmes have combined water conservation with skills development and job creation. For example, the Integrated Water Leak Repair Project combined free-of-charge plumbing repairs for low-income households with education and awareness and the training of 'community plumbers'. This programme was implemented in over 4 500 households and more than 200 previously unemployed individuals from disadvantaged communities were given an opportunity to develop marketable skills and experience. A further example is the Schools Project in which education and awareness events were conducted with learners and teachers at school halls, while a technical team repaired leaking plumbing at the schools and provided training to school caretakers in plumbing repairs.

Climate change risks to water security

In order to evaluate the role the CCT WCWDM programme plays in reducing climate change-related risks, it is necessary to first assess how climate change increases the risk of water insecurity and is an additional challenge in planning and management.

1. Climate change expectations for the region
Climate change predictions for the Western Cape region that are most relevant to water security include increased temperature, increased probability of drought, and a possible reduction in year-round rainfall accompanied by complex and uncertain changes in rainfall patterns. These are summarised as follows:

- Increased likelihood of multi-seasonal drought (Hewitson 2015) and severe drought events (Otto et al. 2018).
- Temperature increases of between 1 °C and 3 °C, with greater increases expected inland than on the coast (Midgley et al. 2005; Tadross et al. 2012).
- Decreased year round rainfall (Tadross et al. 2012).
- Increased evaporation due to higher temperatures, contributing to an overall reduction in 'effective rainfall' (rainfall minus evaporation) (Tadross et al. 2012).
- Shifting seasonality of rainfall, including less early and late winter rainfall but more late summer rainfall (Midgley et al. 2005; Tadross et al. 2012).

- Increased rainfall in mountainous areas and eastern regions but decreased rainfall in lowland areas and in the south-west (Midgley et al. 2005; Mukheibir & Ziervogel 2006).
- Less frequent and more irregular rainfall, with more intense rainfall events particularly in mountainous areas and in the east in mid to late summer (Midgley et al. 2005; Mukheibir & Ziervogel 2006; Tadross & Johnston 2012).
- Increased frequency of hot, dry 'berg wind' events from October to December (Midgley et al. 2005).
- A median increase of around six per cent in the demand for water from irrigation in the Berg Water Management Area (Cullis et al. 2015).

2. Increased risk to water security

The above-mentioned changes could affect water security in a number of ways. Firstly, the combined effects of expected temperature increases, higher evapotranspiration rates and an expected overall reduction in effective rainfall are likely to lead to increases in agricultural irrigation. Agricultural irrigation accounts for approximately 34 per cent of water use in the WCWSS (DWS 2014), and any increases may lead to increased competition for regional raw water resources.

In addition, the same factors increase domestic outdoor water use (garden irrigation and the topping up of swimming pools). Prior to the introduction of water restrictions from 2016, domestic outdoor water use was a sizable component of Cape Town's water demand, especially for large high-income properties (Jacobs et al. 2007). The influence of outdoor water use is evident in the seasonality of Cape Town's water demand before the introduction of water restrictions (see 2014 water demand shown in Figure 6.4) and which closely follows annual weather patterns (as shown in Figure 6.5). In contrast, water demand for 2018 is much reduced and displays little seasonal variation (see Figure 6.4). This suggests that very little water was used outdoors in 2018 due to the restrictions on outdoor use and changes in water use behaviour, however, this may change once the restrictions are lifted.

While there is still uncertainty about future climate change impacts on precipitation, there is a relatively high level of confidence in the prediction for increased temperature. This is supported by a range of climatic models as well as observed trends (Midgley et al. 2005; Tadross et al. 2012; Tadross & Johnston 2012). Furthermore, increased evapotranspiration resulting from increased temperature alone has been shown to be sufficient to cause a decline in effective rainfall — even if rainfall remains unchanged (Tadross & Johnston 2012). Water demand increases may be compounded by a range of predicted changes including increased duration of dry periods, shortening of the winter rainfall season, less frequent but more intense rain events, increased duration and strength of south-easterly summer winds and increased frequency of hot, dry 'berg wind' events.

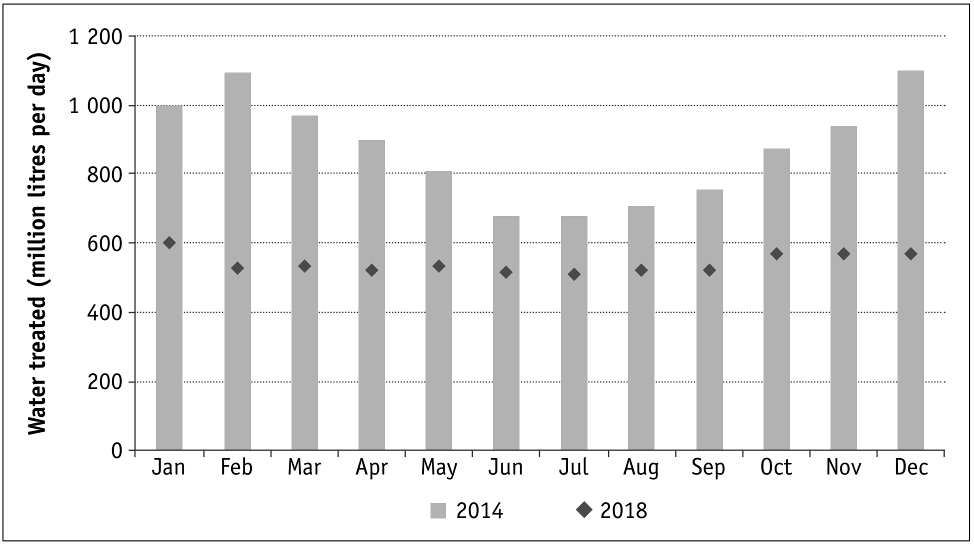

Figure 6.4: Average daily volume of water treated by CCT by month before and after the introduction of water restrictions.
Source: CCT 2018a

Secondly, a significant risk to water supply is the possible decrease in rainfall in the winter rainfall period. Additional risks to supply include increased evapotranspiration and possible decreases in runoff from catchment areas from increased water usage by invasive alien plants (Cullis et al. 2007), and increased evaporation from dams. Increased evaporation from water distribution reservoirs is, however, unlikely to be significant as most reservoirs are covered. Expected decreases in precipitation in south-western areas may result in reduced yield from the Atlantis Aquifer, potentially leading to localised water supply risks in the Atlantis area.

Lastly, increased inter-seasonal variability in rainfall and increased likelihood of multi-seasonal drought affect both water demand and supply, and present significant risk to water security. While the collective bulk water storage capacity and integrated nature of the WCWSS mitigates the impacts of drought, water security may be threatened after successive years of below-average rainfall. This was evident in the 2015 to 2018 drought which saw large decreases in water supply as well as increased demand for urban and agricultural water in the early stages of the drought (see Figure 6.10). In addition, Cape Town relies predominantly on surface water resources that are more sensitive to drought than groundwater sources, although plans are in place to diversify the supply of water.

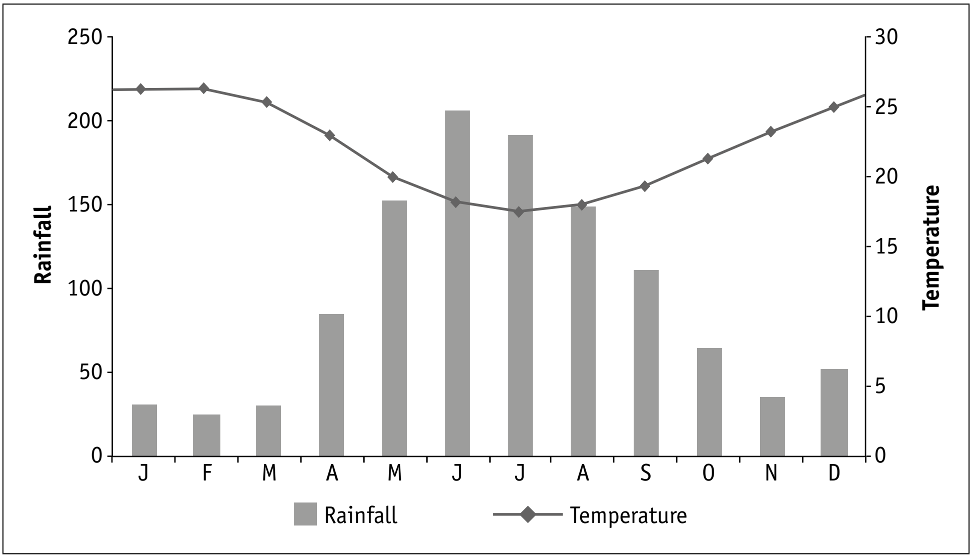

Figure 6.5: Seasonal cycle of rainfall (mm/month) and temperature (°C) at Groote Schuur, 1980–2000
Source: Tadross et al. 2012: 11

3. *Increased uncertainty*

Climate change leads to increased uncertainty of future water supply and demand. Both are highly sensitive to changes in temperature, evaporation and rainfall patterns which, according to climatic models, have the potential to change significantly from current weather patterns (Midgley et al. 2005; Mukheibir & Ziervogel 2006; Tadross et al. 2012). Moreover, the probability of experiencing a severe drought event is understood to increase with climate change (Otto et al. 2018) although a drought in the order of the 2015 to 2018 drought is still considered to be an extremely rare event (Otto et al. 2018; Wolski 2017; Wolski et al. 2017). Rainfall predictions are difficult to interpret due to their spatial and seasonal complexity, and there is significant variation in the results obtained from different climatic models. Actual rainfall trends are similarly complex and difficult to analyse, and there is little clear correlation between predicted and observed rainfall (Midgley et al. 2005; Tadross et al. 2012). Similarly, predicted and observed evaporation diverges (Tadross et al. 2012).

Furthermore, the effects of expected climate change on the Cape Town water system are complex and are not well understood. Predictions for an overall reduction in effective rainfall in the region suggest that climate change may result in decreased water security. Other predictions, however, suggest that water supply may actually increase. For example, climatic models and observed rainfall trends suggest that rainfall within Cape Town's mountainous catchment areas is increasing (Midgley et al. 2005; Mukheibir & Ziervogel 2006; Tadross et al. 2012). Increased intensity of rainfall events expected in mountainous areas may contribute to greater stream runoff and more efficient inflows into dams. New (2002) demonstrates that stream flows in Western Cape catchment areas are highly sensitive to changes in precipitation. In addition, increased late summer rainfall may help to reduce water demand, which is highest in late summer.

Current climatic models, even when 'downscaled' to provide greater accuracy for smaller regions, remain too spatially coarse to provide rainfall predictions useful for water planning. This is particularly true for the Western Cape, where rainfall is significantly influenced by topography, with precipitation ranging from 100 to 3 600 mm per year over relatively short distances (New 2002; Midgley et al. 2005; Tadross & Johnston 2012). Limited availability of monitoring data from mountainous areas further contributes to the uncertainty. As most of Cape Town's water supply is derived from dams fed by surface runoff from mountainous water catchment areas, it follows that the city's water supply is largely dependent on rainfall within these relatively small catchment areas, while average regional rainfall has little influence on water supply. Similarly, residential water demand is spatially sensitive and strongly influenced by rainfall received within affluent suburban areas. Figure 6.6 shows that water demand for Rondebosch, a high-income suburban area, is strongly seasonal while, demand for Langa, a low-income area with limited outdoor water use, remains constant throughout the year.

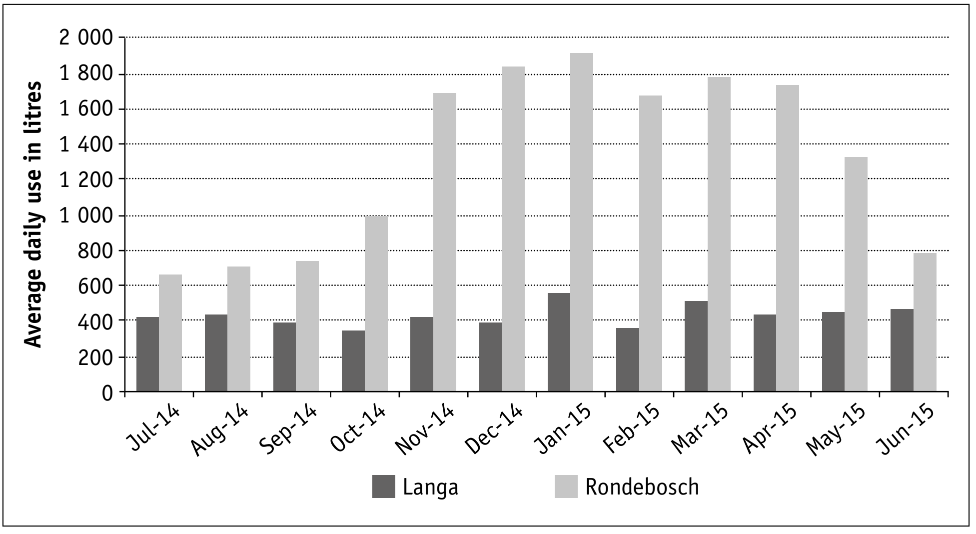

Figure 6.6: Comparison of average daily use per household for the period July 2014–June 2015: Langa and Rondebosch
Source: CCT 2018a

The WCWDM programme: an adaptation to climate change

The WCWDM programme helps the City to make optimal use of the existing high-quality, cost-efficient surface water resources available in the region and reduces water requirements from more expensive and energy-intensive water sources. In addition, the successful implementation of the programme reduces the risk of water insecurity and improves resilience to droughts by slowing water demand growth which helps maintain a buffer between water demand and available water supply. This reduces the risk of extended periods of water restrictions, the implementation of larger than necessary additional water augmentation schemes and other costly water infrastructure, and, in a worst-case scenario, interruptions to water supply. These events could result in a range of social, environmental, economic and financial costs, including the following:

- environmental costs resulting from increased water extraction from rivers and groundwater;
- additional energy use required for pumping and treating increased volumes of water and wastewater, and associated increases in CO_2 production;
- capital costs of implementing larger than necessary water augmentation schemes;
- capital costs of additional water treatment and reticulation capacity and wastewater treatment capacity required to meet increased water demand;
- diversion of capital expenditure from maintenance towards infrastructure expansion;
- increased cost of water to consumers as a result of water restriction pricing and increased financial and operating costs of expanded water infrastructure;
- economic impacts due to increased costs to businesses and industry (especially water-intensive industries), reduced household disposable income and local economic demand, and potential loss of production due to water supply disruptions; and
- less water available in the region for agriculture.

Water savings achieved 2001 to 2015

Prior to the establishment of the WCWDM programme in 2001, water demand was growing at an unsustainable rate. Average annual growth before 2001 was an alarming 4 per cent (CCT 2007), significantly faster than population growth, which was 2,5 per cent between 1996 and 2001 (Statistics South Africa, n.d.). However, this rapid growth trend was arrested in 2001 and much slower growth in demand (of less than 1 per cent per annum) was experienced in the period 2001 to 2015, as shown by the relatively level section of the solid thick line in Figure 6.7. This was achieved even though city population increased by nearly 30 per cent between 2001 and 2011 (Statistics South Africa 2012). This decline can be attributed to a combination of WDM initiatives implemented from 2001, the substantial upscaling of the WDM programme from 2007, the introduction of the rising block tariffs in 1997, subsequent tariff increases in 2001, and water restrictions implemented in 2001 and 2004. The subsequent sharp decline in demand growth from 2016 is due to water restrictions and emergency measures implemented in response to the extreme 2015 to 2018 drought as discussed later in this chapter.

By 2015 average annual water demand was approximately 43 per cent (or 980 million litres per day) and much lower than water demand predictions based on historic growth before 2001. This is shown as the dotted 4 per cent growth line in Figure 6.7, which indicates a hypothetically possible water demand had WDM not been implemented. While the extent of the savings achieved through the WCWDM programme depends on assumptions used to generate growth predictions, it is widely accepted that a dramatic reduction in demand has been achieved.[4]

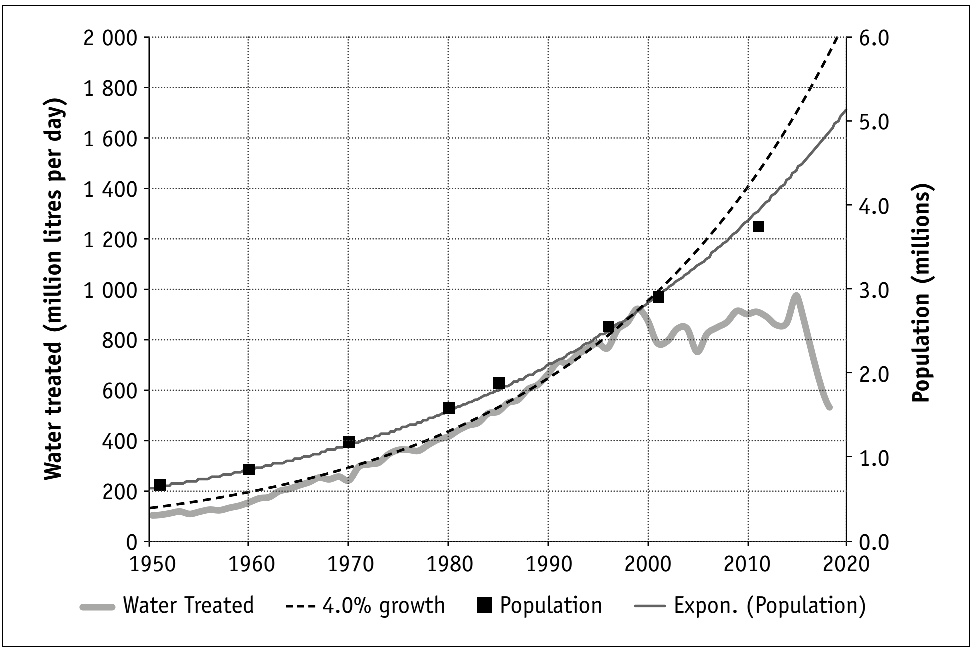

Figure 6.7: Population growth and average daily volume of water treated by CCT by calendar year 1950 to 2018

Sources: Adapted from CCT 2018a; Singels n.d.; Statistics South Africa n.d.

4 Estimates for water demand growth prior to 2001 range from 3,0 per cent to 4,75 per cent (CCT 2007; CCT 2014). In 2000, the CCT developed the 'unconstrained water demand' projection, sometimes referred to as the 'do nothing scenario', based on 3 per cent growth. In 2015, actual water demand was approximately 34 per cent lower than this projection (CCT 2018a).

In 2002 the CCT adopted a 'low water demand' projection for planning purposes which predicted that, except for during extreme drought events, demand would exceed supply by around 2012 (see Figure 6.8) without the implementation of further WDM measures (CCT 2007). Similarly, the *WCWSS Reconciliation Strategy Study* (DWAF 2007) concluded that the next water supply scheme (to follow the 2008 Berg River Scheme) would be required by as early as 2011, unless additional WDM measures were successfully implemented. However, demand was tightly managed in this period and remained well within available supply limits. Also shown in Figure 6.8 is the 'do nothing scenario' demand curve which indicates the consequence if no WDM measures had been implemented. In this scenario, water demand would have exceeded the Berg River Dam water allocation before the dam was even constructed.

Substantial capital investment in water and sewer reticulation and treatment capacities has been postponed or avoided. This includes planned bulk infrastructure upgrades, estimated at more than R1,5 billion, to help convey additional water to the rapidly growing northern areas of the city. Increased water demand also directly impacts on wastewater reticulation and treatment costs, as approximately 70 per cent of all potable water supplied to users ultimately enters the wastewater system. To help provide perspective on the implications of the large percentage reduction in demand achieved through the WCWDM programme, it is worth considering that the current CCT water and sanitation system is valued

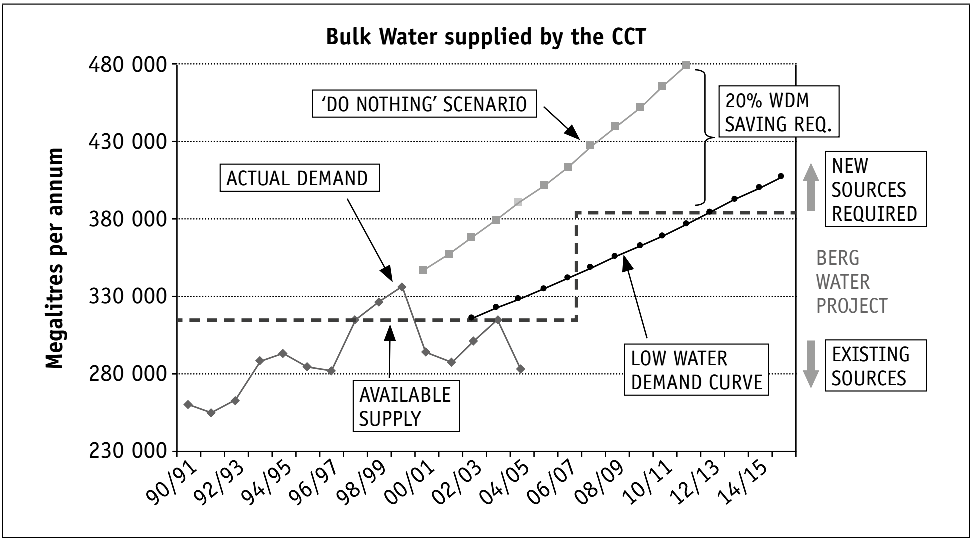

Figure 6.8: Early water demand projections established at the outset of the WDM programme, showing the 2001 strategy objective of a 20 per cent reduction by 2010. This target was actually achieved as early as 2004.
Source: CCT 2007

at R58 billion, with pre-drought operating and capital costs of approximately R6,5 billion and R1,5 billion respectively. WDM contributes significantly to financial sustainability through the postponement or avoidance of capital costs and the reduction in water lost or used without generating income. This is critical for maintaining affordable water tariffs and the generation of sufficient revenue for the effective maintenance and expansion of water and sanitation infrastructure.

Water demand contributes directly to energy requirements for pumping and treatment of potable water and wastewater; in 2012 this amounted to 681 239 GJ per year as detailed in Table 6.3 (CCT 2015a). In addition, future energy efficiency may decrease if more energy-intensive water schemes, desalination and water re-use in particular, are required.

Table 6.3: Annual water and sanitation energy consumption, 2012

Component	Energy consumption (GJ)	CO_2 equivalent (tons)
Wastewater treatment works	452 761	129 540
Pump stations (raw, potable & wastewater)	159 935	45 759
Bulk supply	68 543	19 611
Total	681 239	194 910

Source: Based on CCT 2015a.

Challenges to water demand management

WDM is a long-term programme and its success is dependent on ongoing implementation over many years. However, it is difficult to sustain commitment to long-term goals, especially in years with above-average rainfall, when funding and resources can easily be diverted to other immediate concerns. Simultaneously revenue is usually lower in these years due to lower water sales.

A further challenge is that WDM initiatives can introduce technical complexity into the water system, requiring higher-level skills for operation and maintenance. Examples include pressure-managed water networks, which are more complex and require greater monitoring; recycled water networks which introduce the risk of cross-contamination with potable water; and WDM devices which need specific settings in order to operate correctly. In addition, WDM requires planning and the proactive implementation of projects, which can be challenging with insufficient skilled staff or in times of crisis management.

A third challenge is community resistance to the installation of WDM devices, as detailed earlier.

These problems have been reduced with the establishment of a dedicated WDM section with its own budget, staff and management structure which has helped sustain the programme's implementation since its initiation in 2007. In addition, WDM indicators feature prominently in the City's performance management system, which has increased awareness, helped to maintain commitment to WDM objectives, and facilitated cooperation between different sections within the department. Community engagement in education and awareness programmes for water conservation and for the payment of services has played an important role in improving the City's relationship with citizens.

Water demand management 2016 to 2018

Following several years of above-average rainfall, which resulted in WCWSS dams overflowing in 2012, 2013 and 2014 (see Figure 6.9), the region experienced a period of severe drought after three consecutive years of considerably reduced rainfall. In 2017, inflows into WCWSS dams were less than 40 per cent relative to the long-term average (CCT, 2018c). The severity of the drought has been estimated by climatologists to be in the order of a one in a thousand-year event, and it occurred with little warning (Wolski 2017; Wolski et al. 2017). In comparison the WCWSS is only designed to provide assurance of supply for 98 out of 100 years (DWA 2013).

The City's response to the drought comprised three elements: 1) WDM, 2) the rollout of emergency water augmentation schemes including desalination, groundwater and recycling projects, and 3) the development of a disaster management plan to be implemented should dams drop below certain threshold levels. However, water restrictions and WDM initiatives were undoubtedly the City's primary drought response and water saving played a key role in preventing the city from running out of water. Emergency augmentation schemes provided little additional water during the critical drought period due to the longer timeframes required for their implementation. During the drought period, WDM projects were upscaled and reoriented towards achieving immediate reductions in water use. Key WDM initiatives undertaken are outlined below:

1. *Water use restrictions and enforcement*

- Water use restrictions were progressively tightened (see Table 6.4) together with tariff increases, city media releases and water conservation messaging to increase their effectiveness. Three restriction levels existed prior to the 2015 to 2018 drought, with level 1 permanently in place since the previous drought. However, the City introduced more restrictive levels (4 to 6B) from 2017 onwards as the severity of the drought increased. Level 2 restrictions were implemented from 1 January 2016 following the City Council's approval of the restrictions in early December 2015. Level 6B, the highest level implemented, included an individual limit of 50 litres per person per day and an overall household limit of 10 500 litres per month for households with four or fewer occupants, a ban on irrigation, washing cars and topping up of swimming pools.

- The City increased the number of water inspectors and obtained the assistance of city law enforcement officers to provide additional capacity for the enforcement of water restrictions and by-laws. In addition, the City requested members of the public to report non-compliance.
- 'Enforcement blitzes' were conducted in areas with high levels of non-compliance. The City helped to publicise such enforcement operations by issuing media releases and photographs and by inviting members of the press to attend enforcement operations to help deter non-compliance.
- The City attempted to streamline the enforcement of water restriction limits through the automatic issuing of admission-of-guilt fines through the City's billing system. However, this was not supported by the Magistrate's Commission.[5]

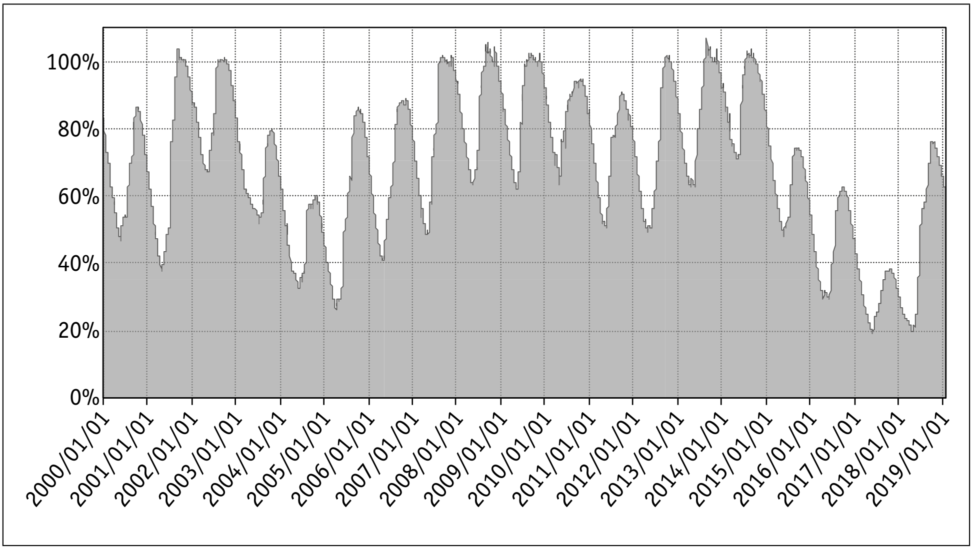

Figure 6.9: Total water stored in WCWSS major dams
Source: CCT 2018a

5 The national Magistrate's Commission is a statutory body (see http://www.justice.gov.za/contact/cnt_mcomm.html, accessed 28 February 2019). The local committee of this body needs to approve any new fines that the CCT wants to impose.

Table 6.4: Water restrictions and tariffs

Level	Implementation date	Key additional restriction measures implemented per level
Level 1	November 2005	• No irrigation between 10:00 and 17:00 • Compulsory spray nozzles for hosepipes • No hosing down of hard surfaces • No dampening of building sand • Level 1 tariffs
Level 2	January 2016	• Irrigation for maximum of one hour on Tuesdays, Thursdays and Saturdays • Level 2 tariffs from January 2016
Level 3	November 2016	• Irrigation with buckets only • Compulsory pool covers • Level 3 tariffs from December 2016
Level 3B	February 2017	• No private car washing • Level 3 tariffs remain in place
Level 4	June 2017	• 100 litres per person per day water use limit • No irrigation • No topping up of private pools • Level 3 tariffs remain in place
Level 4B	July 2017	• 87 litres per person per day water use limit • No topping up of public pools • Level 4 tariffs from July 2017
Level 5	September 2017	• The installation of WDM devices and fines for residential properties using more than 20 000 litres per month • Commercial properties to reduce consumption by 20 per cent relative to consumption one year ago • Level 4 tariffs remain in place
Level 6	January 2018	• The installation of WDM devices and fines for residential properties using more than 10 500 litres per month • Non-residential properties to reduce consumption by 45 per cent relative to 2015 consumption • Level 4 tariffs remain in place
Level 6B	February 2018	• 50 litres per person per day water use limit • Level 6 tariffs from February 2018

Source: The authors

- Nonetheless, effective enforcement of the water restrictions remained a challenge due to the size of Cape Town relative to enforcement capacity, and because non-compliance often occurs behind closed doors or garden walls. Processes for securing convictions or ensuring payment of admission-of-guilt fines were administratively inefficient and difficult to implement at scale. For these reasons, the City also sought to achieve water saving through education and awareness, water pricing, behaviour change initiatives and the installation of water management devices as discussed below.

2. Water management devices

From October 2017, the WMD programme, which previously focused solely on leak reduction and debt management for indigent households, was upscaled and reoriented towards the enforcement of water restriction consumption limits for all domestic properties, including paid-up non-indigent properties. High water users were first served with a warning notice and monitored for an additional month for further non-compliance. A WMD device was then installed, at the owner's cost, if water use continued to exceed restriction limits. The programme was rapidly up-scaled to over 6 000 installations per month using existing contractual agreements. Households with the highest consumption were prioritised for installation. In total, over 150 000 warning letters were issued and more than 17 000 WMD were installed at non-compliant non-indigent domestic properties.

3. Water tariffs

Every year, the City normally establishes and ultimately pre-approves three sets of water tariffs linked to water restriction levels. However, as the drought progressed, the pricing of the upper tariff steps was too low to deter many users from demanding excessive amounts of water. Level 4 tariffs were established and approved in time for the start of the city financial year in July 2017. Later that year it became evident that even higher tariffs were required to deter excessive demand. After obtaining special permission from the Minister of Finance to be exempted from legislated procedures for establishing tariffs, the City was able shortcut approval processes and implement Level 6 tariffs from February 2018. These included punitively high tariffs for all domestic water use in excess of 20 000 litres per month.

4. Communication, information and water conservation messaging

- Water conservation awareness, transparency and the empowerment of citizens by providing information and advice was an important component of City's drought response.
- Water-related communication was boosted significantly. This was managed by the CCT Communications Department and supported by external consultants. It included a wide range of media and activities including print media, radio,

video, website, social media, billboards, posters and electronic displays, exhibitions, information tables and face-to-face engagement.

- Dashboards showing information on dam levels and water consumption relative to water saving targets were created to keep the public informed and provide easily understandable information. These were progressively improved and adapted to meet changing needs.
- The 'Water Outlook Report' was published in 2018 and regularly updated. The aim of this document is to provide informative and creditable information to stakeholders to build trust and counter misinformation (CCT 2018b, 2018c).
- A large body of printed media and website content was developed for the provision of information and advice on topics such as how to save water, detect and fix leaks, comply with water restriction and how to make use of alternative water sources.

5. *Behaviour change initiatives*

- The City established and publicised water saving targets for overall city water use as well as individual targets such as the '87 and 50 litres per day per person' targets. Online dashboards were used extensively to track overall city water use against these targets as well as dam levels and the possible timing of 'Day Zero', the day that most city taps would be turned off.
- The Cape Town Water Map, published from January 2018, used an online map and water billing information for individual houses to encourage water saving. The map and related media campaign publicly acknowledged households that achieved water-saving targets. Water-saving households were 'rewarded' with green dot symbols displayed on their properties in order to incentivise and normalise water-saving behaviour. Light green dots were used to indicate properties using less than 10 500 litres per month while dark green dots were used for properties using less than 6 000 litres per month (Sinclair-Smith et al. 2018).
- More than 150 000 warning letters were sent to residential properties where water consumption exceeded water restriction limits. While this was a necessary step for the installation of a WMD, the letters are likely also to have played an important role in changing the water use behaviour of high water consumers.
- Water saving messages were included within municipal bills for approximately 400 000 properties. As part of a research programme, different messages were used to help determine the effectiveness of different message types (Brick et al. 2017).
- An online water use calculator was developed to help citizens manage their water use within restriction limits and to encourage water saving.

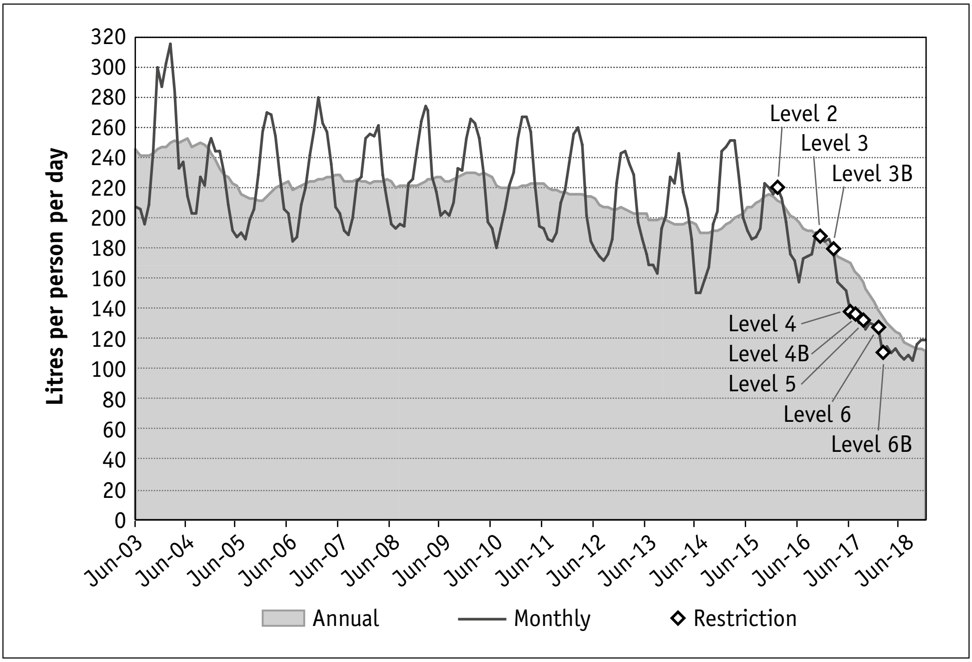

Figure 6.10: Gross City of Cape Town per person water use (inclusive of water losses and water used for industry and other non-domestic purposes)
Source: CCT 2018a

6. *Engagement with key sectors*

The City engaged with large corporations and high water use sectors including construction, nurseries and the horticulture industry, commercial and informal car washes, the swimming pool industry and tourism to encourage water saving technologies and assist with water saving and access to alternative water sources. The City engaged directly with companies as well as through facilitation organisations such as Wesgro and Green Cape.

7. *Engagement with large water users*

- Geographical Information System information of building outlines and building heights was combined with water consumption data to identify properties with high water use relative to built floor area. The top 1 000 properties, mostly industrial properties, were inspected by Water Pollution Control officers redeployed to assist water saving during the drought. In each case a responsible contact person was established, the property was inspected to determine the cause of the high water use, water-saving technology was discussed and, where necessary, water by-law contravention notices were issued. In many cases an inefficient industrial process was the cause of the high water use and the company was required to reduce water use and submit a water audit to the City.

- Water-flow loggers were installed to monitor real-time water use for the City's 1 000 highest water users.
- The City engaged extensively with large property owners such as the Department of Public Works and the provincial government, which is responsible for school properties.

8. *Reduction of water losses*

- Additional staff were employed to attend to water leaks and reduce time taken to repair pipe bursts.
- Pressure management zones were optimised to reduce leakage pipe bursts and reduce water use. This was done by establishing new pressure management zones and reducing water pressures in the water distribution network to extremely low pressures. Water pressure was also decreased in areas not equipped with pressure management technology, by 'water throttling' (the manual semi-closing of water valves). It is estimated that 70 million litres per day was saved from additional pressure management (CCT 2018c).
- Indigent houses with high water use were identified and a programme was established to fix leaks on private indigent properties.
- Water-efficient water fittings were installed on council properties.

9. *Promotion of alternative water sources*

- Promotional material, guidelines and policy for the safe use of water from alternative sources such as grey water, rainwater, ground water and treated effluent (recycled water) were rapidly developed.
- The use of borehole water was initially encouraged in order to offset potable water consumption. However, the use of groundwater for irrigation and the filling of swimming pools was later discouraged in order to protect groundwater resources.
- The City engaged with the construction industry to encourage the use of treated effluent water instead of potable water. To increase its accessibility, treated effluent was made available for sale at several wastewater treatment works, as well as at 32 'draw-off' points established throughout the city where building contractors can collect treated effluent water directly from the network.
- The City installed a new spring water infrastructure in Newlands to make spring water more easily available.

Water savings during the 2015 to 2018 drought

Average daily city water demand by calendar year declined nearly 50% from 980 million litres per day in 2015 to 537 million litres per day in 2018 (Figure 6.7), reaching annual water demand levels not seen since 1985 (CCT 2018a). However, summertime water use which normally peaks in February, dropped more than 50% from a monthly average of 1 154 million litres per day before the drought in February 2015 to 526 million litres per day for the same period in 2018 at the peak of the drought crisis (CCT 2018a). The City received an award from the International Water Association in May 2018 for achieving this remarkable reduction in water demand without resorting to intermittent supply.

Figure 6.10 shows that gross water use per capita (inclusive of water used for industry and other non-residential purposes) reduced from over 250 litres per person per day in February 2015 to 110 litres per person per day in February 2018 (CCT 2018a). The shaded area of the graph indicates consumption averaged over a 12-month period in order to show the long-term trend and remove seasonal variation. Implementation dates of progressively more restrictive water restriction are also indicated.

As expected, most savings came from high-income residential properties that previously used large amounts of drinking water for non-essential outdoor purposes such as watering gardens and topping up swimming pools. Significantly, the number of single residential properties using more than 20 000 litres per month decreased from nearly 120 000 in December 2016 to less than 10 000 properties by April 2018 (CCT 2018a).

The existence of strong WDM systems, institutional structures and infrastructure within the CCT thus played an important role in reducing the impacts of the extreme drought and allowed for the upscaling and extension of existing WDM programmes to achieve large water use reductions within a short timeframe.

Conclusion

The CCT WCWDM programme played a key role in curbing water demand growth to under one percent per annum between 2001 and 2015 — markedly lower than the four percent growth rate experienced before the establishment of the programme — even though city population increased by approximately a third over this period. The success of WDM programmes can be attributed to the early introduction of large-scale WDM initiatives as far back as 2001, the implementation of a comprehensive policy from 2007, sufficient institutional support and the establishment of a dedicated WDM section in the City with its own budget, staff and management structure.

From 2016 to 2018 during the drought crisis, many WDM initiatives were scaled up to effect immediate water savings. The pre-existence of established programmes and WDM capabilities within the City facilitated the large water savings achieved over the drought period, resulting in city-wide water demand dropping to half that of pre-drought levels.

Looking forward, further reductions in water demand are likely to be more difficult to achieve, as population numbers and water usage per household for low-income households are expected to increase. In addition, water loss from the distribution system is relatively low and further sizable improvements are unlikely without substantial increases in capital expenditure. In the short term, water demand is likely to increase from the very low levels achieved during the drought if there is relatively normal rainfall. Water demand was highly seasonal prior to the introduction of water restrictions from 2016, suggesting that much water was used inefficiently for outdoor purposes, such as garden irrigation and the topping up of swimming pools. This use is likely increase with relaxation of water restrictions and will again be an important area for water conservation efforts.

Sensitising Cape Town's users to the availability and use of water, reducing excessive and wasteful water usage, and increasing water re-use are core to sustainability and climate resilience in a semi-arid region. WDM thus remains a critical tool within a long-term climate adaptation strategy. However, it must be accompanied by a number of other policies and programmes, including the diversification of water supply and the ecologically sensitive rehabilitation and management of the city's waterways and catchments. The CCT has engaged with a wide range of stakeholders to develop a Water Resilience Plan that takes a long-term systemic perspective.

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CHAPTER 7

Overcoming urban sprawl: exploring the potential and challenges of implementing social housing in Cape Town

Nicola Sasman and Liza Cirolia

Undeniably, addressing the changing climate requires changing cities and the institutions which work to develop them. This chapter focuses on the challenges of implementing change — of moving from good ideas to better practice. The City of Cape Town Municipality (referred to as the CCT or the City) recognises (some of) the challenges posed by climate change, and a number of departments within the City actively support the need to develop social housing to combat sprawl (for the sake of both the environment and the urban poor). However, as we will show, moving from innovation to implementation is not a linear process. This chapter explores the challenges faced in implementing social housing in Cape Town.

We seek to document the challenges faced in implementing innovations (such as social housing); our intention is to combat an isolationist narrative on innovation, and to show the need not only for innovations, but for systemic and institutional support for change. In addition, we seek to show the interconnected nature of many urban issues: how innovations which could be conceived with the intention of addressing one issue can work to simultaneously address others. Looking for climate-related innovations, therefore, should not be confined to the conventional domain of environmental planning; nor can these innovations be seen outside their implementation contexts.

This chapter specifically explores social housing. In the South African context, 'social housing' refers to partially subsidised, well-located, medium- to high-density rental housing aimed at low- to moderate-income households, and administered by a non-state entity. Housing of this type can respond to the mounting demand for well-located housing among the poor, while ensuring that there is a minimal burden on the state. South Africa's national social housing programme was designed to fulfil these functions. In this chapter we argue that social housing generally, and the national social housing programme specifically, have the potential to create more compact cities. Compact cities, in turn, can create more sustainable cities.

A critical aspect of work towards sustainability is addressing issues of environmental sustainability and climate change. The chapter thus argues for social housing to be taken more seriously by decision-makers in the housing delivery sector, as this form of housing has the co-benefits of being a tool for both restructuring the apartheid city and increasing densities in well-serviced locations, in order to create a more sustainable, compact city form and hence contribute to addressing the challenges of climate change.[1] In keeping with the desire to unpack both the innovation itself (social housing) and the systemic processes of incorporation, the chapter also explains the constraints and opportunities which this change agenda faces.

The chapter is organised into three sections. The first section offers a brief review of literature on sustainable cities and affordable rental housing. This literature points to the possibilities of using higher-density rental housing to address urban restructuring, for the purposes of both environmental sustainability and social justice.

The second section sets out the CCT's understanding of social housing, and analyses how this type of housing is marginalised in practice (especially in comparison to other subsidised housing typologies).[2] The section includes a description of the types of social housing used in South Africa, an exploration of social housing policies, and a discussion of the disjuncture between policy and practice. The drivers behind this disjuncture — specifically NIMBYism (opposition by residents to a development in their local area), competing imperatives and technical challenges — are then described in detail.

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1 Responses to climate change can be categorised under climate change mitigation, adaptation, and resilience. While other chapters in this book address these three responses specifically, this chapter addresses climate change more generally in terms of broader thinking about sustainability. The sustainability thinking in quarters relevant to South African cities proposes selective densification in core areas (Ewing & Mammon 2010; Rubin 2011). Parnell (2015) advocates for the closer alignment of the poverty and climate agendas, recognising the link between climate change and sustainable development. The United Nations Sustainable Development Goals adopted in 2015 recognise the link between poverty alleviation, environmental protection and prosperity for all (see http://www.un.org/sustainabledevelopment/sustainable-development-goals/, accessed 15 April 2016).

2 To understand social housing in Cape Town and its co-benefits for development and increasing climate change resilience, four interviews were held with officials from two CCT departments during the period March to November 2015. To preserve anonymity these interviewees are numbered from A to D. The authors also draw on their knowledge gained over the years working for and with local government.

In the concluding section, the chapter argues that despite these many challenges to institutionalising this social housing agenda, there is an important policy moment on the horizon. This moment has been brought about by the financial unsustainability of the City's Bus Rapid Transit (BRT) system. While it would be preferable for a shift to be driven by a social or environmental impetus, in fact this policy moment can be used as a catalyst to inspire a rapid upscaling of social housing — and by extension more sustainable urban development — in Cape Town.

Sustainable city: densification and affordable rental

Over the past 20 years, urban areas have received increasing recognition as having a contribution to make to international climate change governance responses (Bulkeley & Tuts 2013). Bulkeley and Tuts (2013: 655) write: '[If] cities are to take adaptation to climate change seriously, a fundamental rethink of urban planning as a tool to support adaptation and promote sustainable development is required.' As urban areas respond differently to the challenge of climate change, depending on their experience of the intensity of its current felt impacts, it is helpful to situate the climate challenges in relation to the broader thinking on sustainability. In particular, how cities are both planned and how they ultimately develop has come to be seen as a critical component of the sustainability and climate change debates (see for example ICLEI, and UN-Habitat's Cities and Climate Change Initiative).[3] In many circles, cities have moved from being seen as the source of 'sustainability problems' to being viewed as essential contributors to more sustainable development patterns (Satterthwaite 1999).

In literature on sustainable development spanning the past five decades, the understanding of what sustainable development means has evolved beyond Brundtland's 1987 definition of it as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Swilling 2004: 220). The concept of sustainable development now recognises the reality of unequal access to natural resources, using the metaphor of the ecological footprint (Girardet 1999); and it challenges current linear systems thinking, replacing it with a concept of cyclical 'urban metabolism' (Satterthwaite 1999). Pieterse (2010) extends this understanding to cover multiple dimensions of sustainability, including political sustainability and bioregional ecological capacity.

While there are many theories about what makes a sustainable city in practice, one of the common discourses has to do with spatial form (Petrić 2004;

3 See old.iclei.org/about/who-is-iclei.html, accessed 23 January 2019; https://unhabitat.org/urban-initiatives/initiatives-programmes/cities-and-climate-change-initiative/, accessed 23 January 2019.

Rubin 2011). Compact cities, within the urban literature, are said to be more climate-resilient and sustainable, for a host of reasons including land preservation, infrastructure maximisation, reduced travel distances for people and goods, and a more fine-grained and interconnected development fabric (Ewing & Mammon 2010; Petrić 2004).

In Europe, most cities were developed according to a compact city structure. However, in the USA, where urbanisation took place simultaneously with modernisation, suburban sprawl has dominated city-building (Giuliano & Narayan 2003; Gordon & Richardson 1997). This has led to a fervent debate among Western scholars as to the merits of compaction and the methods for achieving increased urban densification and intensification. These debates, while centred in the West, have had reverberating effects in the developing world (Ewing & Mammon 2010; Jenks & Burgess 2000). For example, Jenks and Burgess examine extensively whether urban form and compact cities have relevance to the sustainability of cities in developing countries, which are experiencing rapid urbanisation (often without concomitant economic growth). They conclude that while increasing inequality is an inhibitor of greater sustainability, the same principles do apply, and argue that regions of the global South should be taking the lead in the thinking around sustainability and urban form.

Evolving out of the compact cities debates in the global South, various authors point to the need to weave the discourses on sustainable cities and climate change into those on poverty reduction and the building of 'just cities' (Swilling & Annecke 2012). Parnell (2015: 363) argues that climate mitigation and urban poverty strategies need to be 'twinned development goals', closely aligned and balanced. She points out that the mitigation/adaptation split, institutionalised by the Intergovernmental Panel on Climate Change (IPCC), reinforces the global North-mitigation/South-adaptation split, and that the United Nations (UN) Sustainable Development Goals could become a mechanism for aligning the poverty (and by implication adaptation) and climate mitigation agendas.

More practically, urban densification and compaction processes are of central interest to those interested in both the climate and social issues within cities. Densification is a particular challenge in places like South Africa, where the existing urban fabric is fragmented, often informal and sprawling. South African cities have some of the lowest densities in the world, comparable to the US models (Jenks & Burgess 2000). Cape Town, moreover, has an 'inverted density gradient' — it is a rare case where density increases with distance from the urban centre (Bertaud & Malpezzi 2003; Wainer 2015). Unlike many developing cities, where medium- to high-density rental housing is the norm, South Africa has few examples of effective densification. In fact, the most common drivers of densification tend to be informal (that is, informal settlements, backyard shacks, informal subdivision and extension, overcrowding, 'hijacked buildings' and so on), with implications for governance, infrastructure provision, and long-term sustainability (McGaffin et al. 2015; Turok & Borel-Saladin 2015).

Given that the overwhelming demand for space in developing cities is for housing, and that most of those who are demanding housing are living on low incomes, the need for higher-density, well-located and affordable housing solutions comes to the fore in compact city debates in the global South. However, higher-density models require more complex management relations than single-storey alternatives (which can use a conventional lease or freehold model).

For ownership, sectional title (also known as condominium) or communal ownership would be required. Since the 1970s, private ownership has been heavily promoted by the development community as a mechanism for 'asset creation' and the enlivening of so-called 'dead capital' (De Soto 1990; Turner 1972). Rental is another option which allows for high-density designs. If well-located rental housing is to be affordable, state involvement is often necessary. State-owned rental housing, for example, has the benefit of protection from downward raiding and does not require significant body corporate governance or involve the financing challenges (such as accessing mortgages or development finance) faced by low-income households (DAG 2008; Huchzermeyer 2014).[4]

Scholars of developing cities have studied the role of rental housing as a mechanism for housing the poor. Rakodi (1995), Huchzermeyer (2007), Watson and McCarthy (1998), Gilbert (2003) and the Development Action Group (DAG 2008) argue that rental housing has the potential to provide scaled dense, affordable and well-located opportunities — in particular when public and private sector players work together. However, these authors acknowledge some of the persistent challenges posed by rental housing in contexts of high demand and low regulation, such as market-led evictions or deteriorating conditions. Despite these challenges, there is growing consensus within both South African and international literature that public and private rental housing should be promoted, and that this housing must be affordable to the poor and the lower-middle class. It is on the back of this optimism that we will explore how social housing has been conceptualised and implemented in South African cities.

4 'Downward raiding' refers to the large-scale practice of private sector interests buying up low-income housing stock in well-located areas, leading to gentrification and displacement of the original intended beneficiaries.

Social housing in South Africa and in Cape Town

Since 1994, the state has provided more than three million subsidised housing units for poor households.[5] Funding for this delivery comes from the national government as part of a broad-based welfare and developmental agenda. The National Department of Human Settlements (previously the Department of Housing) provides a conditional grant to provinces called the Human Settlements Development Grant (HSDG). Provinces can decide how to spend their HSDG, within the confines of the National Housing Code (National Department of Human Settlements 2009). The CCT, as a metropolitan government, has some additional control over its human settlements and infrastructure budgets, but must also work within the framework of the Housing Code when delivering subsidised housing.

The National Housing Code spells out the options for spending this budget. Included in the Code are a range of housing programmes including fully subsidised new-build housing, known colloquially as Reconstruction and Development Programme (RDP) or Breaking New Ground (BNG) housing; informal settlements upgrading under the Upgrading of Informal Settlements Programme; emergency assistance provided under the Emergency Housing Programme; a subsidised mortgage programme, the Finance-Linked Individual Subsidy Programme; and rental housing options, most notably Social Housing and the Community Residential Units Programme.

Despite the broad range of housing delivery programmes spelled out in the National Housing Code, the vast majority of state-led housing delivery has been driven by RDP or BNG housing, that is, fully subsidised housing aimed at individual ownership. Even with the 2004 policy shift to integrated housing and informal settlements upgrading (National Department of Human Settlements 2004), the persistent obsession with creating 'suburban' living and eradicating informality has perpetuated the conventional delivery approach. This housing has tended to take the form of uniform, peripheral, greenfield development, an approach favoured both because it is low-cost (based on cheap land, economies of scale and so on) and because of its political appeal.

The critiques of this programme are well documented. Low-income households, while owning their land and house, remain marginalised in the urban system, having received an asset worth very little. Urban areas remain low-density and sprawling, placing heavy social and financial burdens on the local government and low-income households alike (Palmer et al. 2011). Wolpe and Reddy (2015)

5 This is the official figure quoted by the National Department of Human Settlements; see http://www.gov.za/speeches/minister-lindiwe-sisulu-human-settlements-dept-budget-vote-201718-18-may-2017-0000, accessed 19 January 2019. However, this is a contested figure because of the potential for 'double counting' of top structures and sites over various financial years.

identify the sprawling nature of South African cities as having a direct impact on their ability to mitigate against climate change.

Social housing is a huge departure from this conventional delivery approach. Constructing social housing, or other affordable rental products, at scale would represent a marked change from the current model of housing and city-building. It would provide one of the very few options available for the poor to live in multi-storey complexes in well-located areas.

According to an official in the CCT's Human Settlements Directorate responsible for its social housing programme (Interviewee A, 19 March 2015), social housing is a mechanism for providing good quality, well-located, affordable housing to low-income households through developing medium- to high-density, multi-storey residential complexes in areas well-served by public transport, and accessible to a range of services and amenities.[6] Social housing in South Africa is a unique adaptation of a European/American model of subsidised housing provision. It was formalised in 2008 with the passing of the Social Housing Act (No. 16 of 2008), which enabled it to be funded as one of the government's subsidised housing delivery mechanisms using an institutional subsidy (that is, a subsidy granted not to projects or households but to organised institutions).

Social housing is delivered through social housing institutions (SHIs), which are non-profit organisations that design, develop and tightly manage rental complexes on the land they are leasing at below-market rates. At the same time, SHIs are meant to provide the necessary support systems to ensure social development, community cohesion and safety, and even contribute to urban renewal in their neighbourhood (National Department of Human Settlements, 2005). There are currently three active SHIs partnered with the CCT. These are Communicare, Madulammoho Housing Association and Sohco Property Investments. The City gives the SHIs rights to its land at a discounted rate, using a long-term lease arrangement (Interviewee A, 19 March 2015).

SHIs are accredited by the Social Housing Regulatory Authority (SHRA), which has the following functions: it regulates the social housing sector; it provides a link to the National Department of Human Settlements; and it administers an additional Restructuring Capital Grant. This grant is awarded for projects in defined Restructuring Zones, that is, the geographic areas which have been deemed suitable for social housing (National Department of Human Settlements 2005).

6 Social housing uses the institutional subsidy granted to accredited Social Housing Institutions (SHIs) to make subsidised rental accommodation available to targeted beneficiaries. Selected social housing beneficiaries must meet the following criteria: they must qualify for the national housing subsidy scheme; earn between R1 500 and R7 500 per month household income; be permanently employed; and pass rigorous screenings in terms of their suitability for rental accommodation (Interviewee A).

Restructuring Zones are a particularly important tool as they spatially designate, based on good planning, where social housing should be provided.

The potential benefits of social housing have not gone unnoticed in policy discourses. At the national level, the Presidency's National Development Plan (National Planning Commission 2011), the Department of Cooperative Governance and Traditional Affairs' Integrated Urban Development Framework (Department of Cooperative Governance and Traditional Affairs 2014) and the National Department of Human Settlements' Breaking New Ground (National Department of Human Settlements 2004) all stress the need for programmes and policies which build more compact cities and situate the urban poor on well-located land. These policy documents recognise the flaws of the RDP/BNG housing model, and the need to provide housing in a very different way, for the sake of both people and cities.

In the Western Cape, the Provincial Spatial Development Framework (Western Cape Government 2013) and the Cape Town Spatial Development Framework (CTSDF) (CCT 2012) consolidate this perspective. The CTSDF articulates a set of spatial planning principles, which include the need to 'offer maximum access to the city's opportunities, resources and amenities, and redress spatial imbalances in this regard as far as possible' (CCT 2012: 9).

The following are the reasons presented in the City's 2015 Integrated Development Plan (IDP) Review (CCT 2015) why targeted densification is imperative to proactively address this legacy and create a more compact and sustainable city:

- Cape Town's population grew by 4,8 per cent between 2011 and 2014, and is expected to reach 4,42 million by 2030 (p.18). The economy is not able to sustain this population growth, with unemployment levels at 25 per cent, and 9 per cent of employment opportunities being provided by the informal sector (p.20 of the IDP document).
- There was a 40 per cent increase in developed land between 1985 and 2005, and the city is growing at 1 232 hectares per annum (p.22).
- Due to the housing shortage, and the lack of affordability, 14 per cent of households lived in informal settlements and 7 per cent in backyard shacks in poor neighbourhoods in 2011 (p.21).
- The spatial form of the city should be guided: the 'building block' for the movement system should be a multi-directional accessibility grid which would facilitate more convenient access and multi-directional movement (p.14).

In Cape Town, the many benefits of targeted densification are further reinforced in the transport and densification policies. For example, Transport for Cape Town (TCT), the CCT's transport authority, notes that a minimum density of 75 dwelling units/hectare along major transport corridors is needed to sustain the services. Both of these policies note that densification is desired 'at specific locations with good public transport accessibility, at concentrations of employment, commercial development and/or social amenities and in areas of high amenity' and that '[the] City will encourage densification in priority zones — [these] include activity routes; activity streets; around rail and IRT [integrated rapid transit] stations' (TCT 2013: 7).

These characteristics of Cape Town indicate that affordable housing is of particular consequence to densification. The demand for space in the city is predominantly driven by the increasing needs within the lower- and lower-middle-income bands. Simultaneously, lower- and lower-middle-income households have limited effective demand (that is, ability to pay), thus making state subsidisation critically important.

Figure 7.1 lists all the social housing projects which are planned, under construction, or completed in Cape Town. Figure 7.1 also indicates the locations of these social housing projects in relation to areas of access and opportunity in Cape Town. The map shows the structure of Cape Town, which has a strong historical core in the west of the city, with transport routes radiating from this core to the north, east and south. These historical routes are the areas of greatest accessibility and amenity provision. The planning philosophy has been to 'grow' secondary centres (nodes) connected by access routes in Claremont/Wynberg, Bellville (extending to Durbanville), and Philippi (extending to Mitchells Plain/Khayelitsha). The CTSDF (approved in 2018) provides useful guidance on spatial transformation. The 'Urban Inner Core' represents areas targeted for public and private investment: there is an intention to update the Restructuring Zones to coincide with this urban inner core.

An examination of Figure 7.1 reveals that the existing social housing projects are either well located, or marginally well located. Cape Town is still recovering from the legacy of apartheid spatial planning, and the poorer outskirts of the city have higher residential densities than the central areas.

Disjuncture between policy and practice

Despite the support expressed in various policies for densification generally and social housing in particular, there is a clear disjuncture between the policy intent and the practice of delivery on the ground. Within the CCT Human Settlements Directorate (the City's housing department), social housing has little status. There is only one staff member responsible for the programme across the City: technical support must be gleaned from other departments through their goodwill. Echoing this, social housing projects (and other institutional subsidy projects) only account for 2,7 per cent of the directorate's current allocation of government subsidy grants (CCT 2015).

It is clear that for social housing to make any meaningful impact on the spatial form of the city, it cannot be relegated to a peripheral strategy. This means that the social housing programme would need to be dramatically upscaled.

ID	PROJECT	PHASE	ID	PROJECT	PHASE
1	Conradie site, Pinelands		16	Enslin Road, Ottery	
2	Dillon Lane, Woodstock		17	Pickwick St, Woodstock	
3	Elsies River Housing Development		18	Pine Road, Woodstock	In Planning
4	Eoan Way, Scottsdene		19	Salt River Market	
5	Military Rd, Steenberg		20	Stegman Road, Claremont	
6	Brooklyn Regen Social Housing		21	Woodstock Hospital Site	
7	Smuts Rd, Lansdowne		22	Belhar Social Housing	Construction
8	Frans Conradie Dr, Scottsville	In Planning	23	Scottsdene Social Housing	Completed
9	Daffodill, Brackenfell		24	Glenhaven Social Housing	Construction
10	Briardene St, Parow		25	Bothasig Gardens Ph 1	
11	Rael St, Tamboerskloof		26	Drommedaris St, Milnerton	Completed
12	Kromboom Road, Rondebosch East		27	Military Road, Steenberg	
13	Lentegeur Social Housing		28	Foundry Road, Salt River	Planning
14	Livingstone Avenue, Rytherwacht		29	Royal Road, Maitland	Completed
15	De Villiers Ave, Morningstar				

Figure 7.1: Existing and planned social housing projects, relative to zones of accessibility and opportunity

Source: N. Sasman, 2018; P. Molapo, 2018, Pers. Comm.

The following section interrogates the challenges which the authors have identified in regard to scaling up the provision of affordable rental housing, at the institutional, governance and technical levels.

Challenges to scaling up affordable social housing in Cape Town

This section examines five core challenges which social housing faces at a local level. They have been identified through hands-on engagement with departments in the CCT, as well as through interviews with City officials. Each one of them is vitally important to the project of upscaling social housing, and will need to be overcome if social housing delivery is to be scaled significantly. Investigating these challenges will allow us to 'make sense' of the gap between good policy and better practice, and help us to think through the operational imperatives of climate and sustainability agendas more generally.[7]

1. Target chasing

One of the major obstacles to scaled investment in social housing is the perceived difficulty of reaching delivery targets using this mechanism. For each political term, the National Department of Human Settlements sets targets for the number of subsidised units which cities must provide (Menguele et al. 2008). It is widely recognised that traditional greenfield development (that is, RDP housing) is the most predictable and speedy way to meet these targets (Charlton 2009). In contrast, social housing projects tend to take longer (given the constraints of brownfield sites) and rely more on the capacitation of external actors (such as SHIs). Therefore, for social housing to be scaled up, the public sector would have to move away from the endless 'number counting' and 'target chasing' and be willing to allocate budget amounts to support policy statements which recognise the importance of rental housing and densification.

2. Dated social housing policy

Unlike RDP housing, which only requires a contractor to build it before being handed over to the beneficiary, social housing requires a non-state agency (the SHIs) to develop and manage the housing and the tenancy. These SHIs operate on very tight budgets with limited flexibility. Interviews with a National Association of Social Housing Organisations representative (Interviewee B, 1 April 2015) suggest that a delay in updating the national policy has constrained the expansion of the SHIs. There are few new entrants into this space and existing players fail

7 It is important to note that an additional challenge to scaling up social housing is the impact on the fiscus (since social housing units cost more to deliver than conventional RDP units). However, the medium-term implications of more compact development of local government's operational budgets will probably overcome the initial capital hurdle.

to upscale. The current 'elephant in the room' in any discussion on the future of social housing is the inertia in the SHRA and the National Department of Human Settlements with regard to amending the legislation to increase subsidy amounts and beneficiary income bands in line with inflation. For example, by 2015, the Restructuring Capital Grant subsidy amount had not been increased since its inception seven years earlier. The implication of this is that the subsidy, at that time, amounted to only 42 per cent of its value in 2008. Further, the target population (in terms of the qualifying criteria listed earlier in this chapter) has also been reduced to a minimum because of a failure to increase the subsidy bands to keep pace with inflation.[8]

Fingers are being pointed at the SHRA (as discussed above), which has failed to address the current shortcomings with respect to the quantum of subsidy, income bands, and the capacity of the SHIs (Interviewee A, 19 March 2015; Interviewee B, 1 April 2015). Without these issues being resolved, SHIs may become unviable under the present model, and will not be able to roll out new projects without significant private top-up funding. For this they need significant capital as equity, which is their own stock. Already the rollout of new projects is being hampered, as evidenced by the decline in take-up of new subsidies annually (Figure 7.2). The fact is that it would be relatively simple to make the necessary legislative changes, which would bring the social housing industry back from the brink.

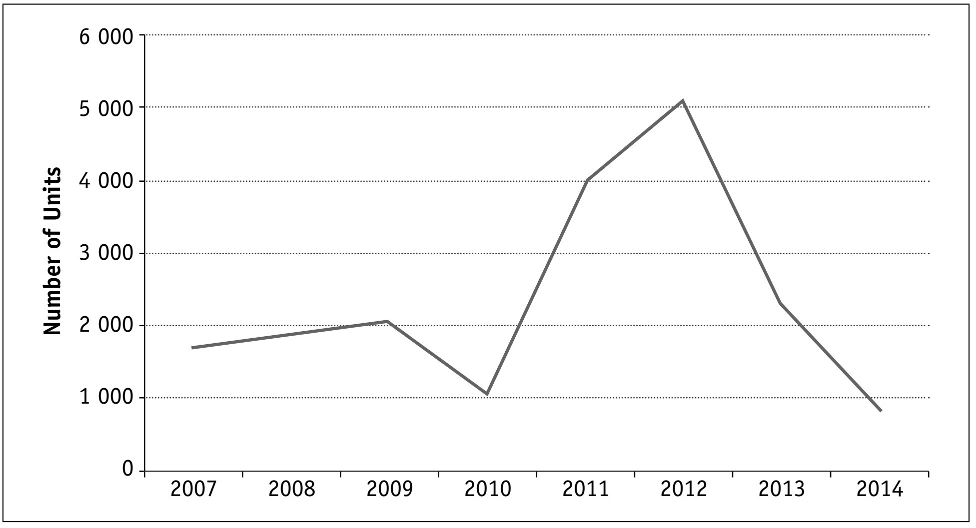

Figure 7.2: Number of social housing units approved for subsidies nationally
Source: Representative of SHRA, 2018 (Pers. Comm.)

8 Subsidy bands refer to household income categories within which a household must fall to benefit from a particular subsidy mechanism.

3. NIMBYism and resistance to local change

A major challenge in South African cities, particularly because of the mandated dedication to 'community participation' in planning processes, is the blocking of planning processes for proposed low-income projects in well-located areas. This hindrance to social and economic integration, and by extension social housing, is not unique to South Africa, and fits the term coined in the USA and the UK in the 1980s for the NIMBY (not in my back yard) phenomenon. Dear (1992: 288) defines it as 'the protectionist attitudes of and oppositional tactics adopted by community groups facing an unwelcome development in their neighbourhood'. This phenomenon, in which individuals and organised neighbourhoods resist local development which they perceive as threatening their property values and lifestyle, can be constructive in increasing the accountability of politicians, and leading to improvements being made to the nature of the development proposal so as to reduce negative externalities (for example, expansion of a sewage plant may be required to include technical improvements to reduce the impact of odour pollution). However, NIMBYism is often targeted at developments which are for the greater public good, and can be a major constraint on any transformation efforts (for example, land restitution plans to resettle low-income land claimants who were removed in terms of the apartheid-era Group Areas Act (No. 51 of 1950) from an area of the city now characterised by upper-middle class housing).

In Cape Town, there is resistance on the part of existing residents to the introduction of social housing into areas where residents believe that their property values could be eroded. Social housing projects experience delays in approval as a result of objections from the surrounding residents. This takes on a particular racial overtone as a consequence of the legacy of planning and implementation undertaken in terms of the Group Areas Act (Interviewee A, 19 March 2015).

Currently, the land use management legislation in South Africa (the Spatial Planning and Land Use Management Act, No. 16 of 2013) and the National Environmental Management Act (No. 107 of 1998) and its associated Regulations inadvertently accommodate and institutionalise neighbourhood resistance to change. While the original intention of the legislation was to ensure environmental protection and protection of heritage, and to reduce the negative externalities of environmentally hazardous developments, it is now equally used to dictate the minutiae of all development proposals through public participation. This has resulted in institutionalisation of an oppositional relationship between existing residents and social housing developers (Interviewee A, 19 March 2015).

4. Competing departmental imperatives

Competing imperatives within the CCT make accessing land for social housing difficult. In Cape Town, there has not been a policy for either land acquisition or land release, or a policy on land banking. The implication of this is that City officials have had to make complex decisions on land parcels within a policy vacuum: there is competition between the Human Settlements Directorate, which is 'land hungry' for new settlement projects, and the Property Management Directorate which aspires to convert land assets into a source of revenue for the City.[9]

The allocation of City-owned land and facilities to departments within the City is managed by the Property Management Department, which is also the custodian of land and facilities which have become surplus to other departments' needs, prior to their reallocation or disposal.[10] The Property Management Department therefore plays a strategic role in managing a significant portion of the City's assets. Traditionally, it has not taken a proactive approach to land holding (in essence land banking), and to releasing land to other organs of state or to the market. While the City's IDP mentions land banking, the department had to operate reactively until it completed its asset register.

This role has changed significantly in recent years, to one of proactively releasing land to the market on the basis of the highest bidder for the highest and best use.[11] Factors contributing to this shift could include: the Local Government: Municipal Finance Management Act (No. 56 of 2003) and its associated Regulations; the need to increase the revenue base outside of the rates and service charges; and the IDP (CCT 2015). But possibly the most significant factor is the location of the Property Management Department within the Finance Directorate. The process of land release, as well as land reservation, is managed according to this directorate's principles and targets, which creates an inherent bias towards land as a financial asset in the management of City-owned land. There is no interdepartmental platform where these competing needs can be articulated and negotiated. While the CTSDF and its related District Plans can offer guidance in some cases, they are not authoritative on the details and changing conditions of each site. Even where these plans provide direct guidance, the Spatial Planning and Urban Design Directorate does not carry the authority to enforce these plans.

A further factor impacting on the development of social housing is the performance management system in the City. 'Because of you I have just lost my

9 The example of the provincial government selling land in Sea Point, a suburb of Cape Town, which could be developed for any sort of human settlements investment, particularly affordable housing options, is a case in point: see http://www.dailymaverick.co.za/article/2016-04-11-groundup-report-activists-ask-court-to-stop-province-selling-sea-point-property/#.Vw-TL6MaKpo, accessed 7 October 2015.

10 See http://resource.capetown.gov.za/documentcentre/Documents/Bylaws%20and%20policies/Asset%20Management%20-%20(Policy%20number%2011724)%20approved%20on%2027%20February%202013.pdf, accessed 14 July 2017.

11 'Highest and best use' is a land valuation standard, defined as 'the most probable use of a property which is physically possible, appropriately justified, legally permissible, financially feasible, and which results in the highest value of the property being valued' (see http://www.sapv.co.za/property-dictionary, accessed 12 April 2019).

performance bonus!' said the Property Management Department official to the Social Housing official, when one of the properties assigned to him for disposal on the open market was requested for social housing purposes (Interviewee A, 19 March 2015). Individual performance management therefore becomes a driver for city development. This also creates conditions for conflict between individual officials at all levels, who are subject to performance rating, as demonstrated above.

The current strategy of the City's Social Housing unit is to chase after sites which the Property Management Department is disposing of. The provision of well-located land for social housing thus occurs more by default than by design, thanks to the tenacity and vigilance of the Social Housing official, rather than to a well-functioning system which works to balance competing imperatives.[12]

5. Technical and land use constraints

Many sites have real technical constraints. These constraints translate into financial costs of development which are often prohibitive. The Spatial Planning Department carries out pre-feasibility studies on request from the Human Settlements Directorate.

With reference to the well-located vacant parcels in the city, a cynical CCT Human Settlements official noted, 'These sites have not been developed yet for a good reason, you just have to find out what it is'.[13] This has been the reality for social housing in Cape Town. It appears as if there are many potential sites for such housing in public ownership, but pre-feasibility studies indicate the existence of significant stumbling blocks to their development. The reality is that most well-located land in well-established areas is encumbered in some way.

Many sites therefore need significant preparatory input before they can be released for development — for example, botanical studies, geotechnical investigations, water use licence applications (due to proximity to a wetland) — which require time, money and expert advice, over and above the normal preparatory responsibilities of the Social Housing official. For example, of nine sites investigated in the 2015 period, one was not viable, five required additional land preparation or further technical investigation, and three were 'project-ready'. The cost of this needs to be excluded from the SHIs' project costs, to keep it viable. These studies were made possible through national government grant funding for staff (the Urban Settlements Development Grant), but this funding has come to an end.

12 Interestingly, the draft Integrated Human Settlements Framework is providing the impetus for formulating a disposal and acquisition strategy for the City as a whole (see http://cityweb.capetown.gov.za/en/Documents/5yrIDP_1516_rev_amend.pdf, accessed 14 July 2017.)

13 Paraphrase of personal communication, c. 2008.

The results of these studies may indicate the need for additional design requirements (for example, expensive foundations if the geotechnical study reveals unstable founding conditions; relocation of rare species and offset arrangements identified in the botanical study; generous setbacks where the site is adjacent to a wetland). These requirements could well jeopardise project viability unless their costs can be offset in some way.

The social housing 'policy moment'

This confluence of challenges has collectively disabled the possibility of social housing at scale, despite policy positions which acknowledge its necessity for creating both a sustainable and just city. However, Cape Town is experiencing a unique 'policy moment' which is bringing social housing back on to the agenda. It is not, as we might have expected, coming from the environmentalists and activists concerned about carbon emissions or the heavy burden of daily travel placed on the urban poor. Instead, this policy moment in which social housing is being taken seriously is being provoked by Cape Town's transport authority, the TCT.

Since the mid-1990s, capital funding for public transport authorities has shifted from road-based investment to public transport (Interviewee C, 15 October 2015). The CCT has created a single transport authority which takes its technical mandate from the Comprehensive Integrated Transport Plan 2013–18 (TCT 2013); this plan provides the rationale for long-term public transport planning as articulated in the Integrated Public Transport Network (IPTN) Plan for 2032 (CCT 2014b). While the City has made significant strides towards changing from its emphasis on private transport to integrated public transport in its planning and resourcing, it is still struggling to actualise the relationship of transport to land use, so as to ensure the long-term sustainability of an affordable public transport system. Transport planners now refer to the need to achieve a 'transport operating density', a target calculated in terms of the number of passengers per unit area specifically (rather than a generic population or unit density) (Interviewee D, 26 October 2016).

The IPTN recognises the potential power of land use management to actively support the transport system, in particular in terms of making such a system financially viable. The existing sprawling spatial structure of the city is proving challenging, as mono-directional, origin-destination trips predominate, with few intermediate and bi-directional trips. From a financial perspective, the intermediate trips enable cost recovery (the endpoint-to-endpoint trips are 'loss leaders') on a system which is not expected to be profitable; however, the current spend from state subsidies and the City's rates base is unsustainable, and the system cannot continue to be so highly subsidised (Interviewee C, 15 October 2015).[14]

14 It is unlikely that changing land use patterns alone will solve the challenges of transport in Cape Town. The public transport product (i.e. the BRT system) may also need to be revised to be more applicable to the context.

Transport officials are so concerned about this that they are actively seeking mechanisms to ensure residential densification along the trunk routes, and not at the residential end-point. They are therefore exploring a new approach, referred to in the IPTN plan as the 'TOD [Transit-oriented Development] Comprehensive' scenario or model, which explores the extent to which land use can be used to maximise the efficiency of the IPTN system.[15] A TCT official noted that this scenario could significantly improve the IPTN's performance against several indicators (Interviewee D, 26 October 2016).

While work is still needed on how to actualise this scenario, transport planners have identified social housing as one key mechanism available to the municipality to increase residential densities with minimal parking provision.[16] This puts an interesting twist on the question of which directorate is the real driver for restructuring the city.

Not only does the TCT have a strong institutional presence within the municipality, it is investing large amounts in infrastructure (it accounted for 13 per cent of the City's total capital budget for 2014/15, rising to 16 per cent for 2016/17 [CCT 2014a]).[17] It also has strong fiscal imperatives to move towards improved cost recovery. It could be that the city restructuring which the City planners have striven for cannot be achieved through planning interventions alone, but rather through those departments which use restructuring to achieve greater fiscal efficiency. This will require greater cross-silo engagement.

More work is needed to flesh out the TOD concept in Cape Town, and it is by no means a 'silver bullet' solution to the challenges facing the city. Each major route and corridor must contend with complexities relating to effective demand, commuting practices, employment locations and many other factors. It is beyond the scope of this chapter to go into detail about these issues. What this TOD moment points to is the way in which impetus for implementing innovations can come from many quarters and be driven by many logics.

Implications and conclusions

This chapter tells a story about social housing in Cape Town. Social housing, as we have argued, could be a useful tool for addressing a myriad of sustainability

15 TOD refers to a body of thinking that recognises the relationship between land use and transport.

16 It has been proven through precedent that vehicle ownership in social housing projects is extremely low, requiring about 0,3 parking bays per unit. Other important mechanisms include private sector rental and multi-storey mortgage housing.

17 The capital budget of the City refers to all expenditure of a capital nature, i.e. the construction of infrastructure and buildings. Much of this funding is through national government grants.

challenges. Of particular importance to the climate agenda is that social housing could help to create more compact cities and address the dire sprawl which apartheid and post-apartheid policies have worked to entrench. While housing departments have typically not been associated with environmental agendas, they do in fact have an important role to play.

Social housing is a marked departure from what is known as 'RDP housing' and, as indicated above, is recognised by a range of policy documents as a vital instrument for meeting the housing needs of the population. However, as this story shows, moving from policy to practice is difficult. Social housing, like many other important social and environmental agendas and innovations, has remained constrained by operational, financial, and institutional processes and conflicts. Some of these challenges are simple (such as adjusting subsidy bands) while others are more complex (such as finding new metrics of accountability or overcoming cost hurdles for land redevelopment).

While this chapter has focused on examining the specific imperatives for and challenges faced by social housing, the need to look at both the *what* and the *how* of climate-related innovations is made apparent. A core lesson, therefore, is that activists and policy-makers must understand the institutional and operational dynamics at work when trying to effect change. There is a need to be critically propositional in this space — that is, to recognise the real constraints while continually pushing for more radical and innovative agendas.

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Interviewee B: Official in National Association of Social Housing Organisations, 1 April 2015.
Interviewee C: Official in Transport for Cape Town, 15 October 2015.
Interviewee D: Official in Transport for Cape Town, 26 October 2016.

CHAPTER 8

Conservation planning for climate change in a rapidly developing city Two case studies: the Biodiversity Network for Cape Town and the Conservation Implementation Plan for False Bay strandveld

Patricia Holmes, Pippin Anderson, Amalia Pugnalin, Julia Wood and Clifford Dorse

During the past decade discussion has intensified on the impacts of climate change on biodiversity, with a call for proactive development of conservation plans that focus on ecosystem resilience in order to secure biodiversity and ecosystem services (Mooney et al. 2009).[1] Because biodiversity is not static in time and space, but is maintained by natural dynamic processes that are impacted upon by global change drivers, it is necessary to ensure that these are adequately addressed in the conservation planning methodology (Pressey et al. 2007; Pressey et al. 2009).

In this chapter we review the impacts of global climate change on biodiversity and conservation planning for Cape Town. Since conservation plans form an important step in biodiversity-related adaptation to climate change, they must be implemented through securing and managing the required land parcels in order to counter immediate threats such as invasion by alien species. As climate change may not be the most imminent threat, planning for biodiversity persistence at the local scale rather than planning for regional climate projections will promote

1 These services relate to the benefits that people obtain from ecosystems, including provisioning services (such as food and water), regulating services (such as flood control), cultural services (such as recreational benefits), and supporting services (such as nutrient cycling and carbon storage) that maintain the conditions for life on Earth.

local adaptation to climate change and other global change drivers simultaneously (Heller & Zavaleta 2009; Pressey et al. 2007).

We present two case studies of conservation planning initiatives to optimise the persistence of Cape Town's unique biodiversity under these different constraints. Case study 1 describes the development of the city-wide Biodiversity Network (BioNet) plan. This new, innovative practice incorporates the latest scientific findings on climate change adaptation and conservation planning. Case study 2 presents a new process for developing a conservation implementation plan to address the endangered False Bay strandveld in the south-eastern part of the Cape Town metropole (henceforward referred to as the metro south-east), which aims to secure biodiversity, reduce the risk of climate-related disasters and identify land for settlements in this rapidly urbanising area.

These case studies demonstrate the shift from a 'business as usual' approach to one that explicitly addresses climate change adaptation and urbanisation pressures.

Biodiversity and climate change in Cape Town: context and setting

Cape Town is a coastal city with a Mediterranean climate; the city covers an area of 2 460 km^2 and encompasses large topographical, geological and climatic variation. Its valuable natural assets include the Table Mountain chain (a national park), 17 nature reserves and a 307-km coastline (Figure 8.1).

Tourism is a major contributor to the city's economy and depends to a large extent on these assets. A study of Cape Town's natural assets estimated their tourism value to be in the order of R1,5 billion per annum (De Wit et al. 2009). The city has a rapidly growing population, currently standing at just over four million. Conversion of natural habitat to accommodate this growing population, impacts of climate change, and infestation by alien vegetation negatively affect biodiversity in the region and the ecosystem goods and services it delivers.

Cape Town's biodiversity

Cape Town has one of the highest concentrations of biodiversity of any metropolitan area in the world, much of it threatened with extinction (Rebelo et al. 2011). It is part of the Cape Floristic Region (CFR) global biodiversity hotspot (Myers et al. 2000), which has high levels of endemism and is the smallest of the world's six plant kingdoms.

The combination of a long glaciation-free history and a diverse physical environment fostered the evolution of the CFR's plants and animals. The onset of the current phase of summer-dry climates dates from about 28 million years BP (Linder 2003). Rapid radiation of the modern Cape flora occurred during the

Figure 8.1: Peninsula sandstone fynbos on the Cape Peninsula, Cape Town
Photograph: P. M. Holmes

last 8 to 15 million years (Linder 2003).[2] There are many range-restricted, locally rare species with limited dispersal ability, some being climate-sensitive relicts or soil type specialists. Of the approximately 3 250 indigenous plant species found in Cape Town, 190 are locally endemic and 319 are threatened (Rebelo et al. 2011) and are Red-Listed according to the International Union for Conservation of Nature criteria.

The five structural vegetation groups in Cape Town are, in order of prominence: fynbos, renosterveld and strandveld shrublands, wetland and forest. There are 19 major national vegetation types recognised across this range of structural groups, of which six are endemic to Cape Town and 17 listed as threatened. This diverse flora supports a rich fauna (Rebelo et al. 2011).

Negative pressures on biodiversity

Habitat loss is the primary driver of biodiversity loss, with infestation by alien vegetation as the second-most important pressure (Holmes et al. 2012b).

2 Radiation is an evolutionary process resulting in the generation of new species.

Additional drivers include habitat fragmentation (Pauw & Louw 2012), unsustainable harvesting (Petersen et al. 2012), inappropriate fire management, loss of keystone species and pollution (Rebelo et al. 2011).

Global climate change is a further prominent threat to biodiversity (Bomhard et al. 2005). Climate change projections for Cape Town include increasing temperatures and altered rainfall patterns (DEA&DP 2014; Taylor & Davies, Chapter 3, this book).

The role of biodiversity in ecosystem services and climate change adaptation

Climate-resilient natural ecosystems deliver a wealth of ecosystem services; they also contribute to both climate change mitigation through improved carbon sequestration ability, and to city adaptation to climate change through buffering surrounding urban areas from intense storm impacts and providing water infiltration areas and groundwater recharge zones. To provide such services, natural ecosystems need to be secured and appropriately managed (Gomez-Baggethun et al. 2014). Traditionally, abundant and dominant species are considered most crucial in ecosystem functioning, but there is a growing literature showing that less abundant species may also have significant roles to play (Lyons et al. 2005).

Global climate change could also shift community dynamics so that different species promote ecosystem functioning under different scenarios (Isbell et al. 2011). In global dryland ecosystems (including the CFR) perennial plant species richness was found to be a significant explanatory variable for the ecosystem multi-functionality that underpins ecosystem services (Midgley 2012). As well-managed ecosystems support higher species richness, biodiversity conservation efforts can significantly contribute to the delivery of ecosystem services and city climate change resilience.

Supporting ecosystem services include soil formation and carbon sequestration. Soils, followed by vegetation, are the largest terrestrial ecological sinks for carbon. Natural ecosystems of fynbos and renosterveld sequester more carbon than degraded and farmed land (Mills et al. 2012, 2013). Therefore, biodiversity management and restoration can contribute simultaneously to climate change mitigation and biodiversity resilience to climate change.

In addition, the health benefits from proximity to nature have been clearly demonstrated as a cultural ecosystem service (Tzoulas et al. 2007).

Conservation and climate change adaptation

In this section we describe the approaches that can be used in conservation planning to promote adaptation of biodiversity to climate change.

Climate change adaptation strategies

Strategies for biodiversity adaptation to climate change involve actions by governments and society. Mawdsley et al. (2009) describe four categories of strategies: 1) land and water protection, 2) direct species management, 3) monitoring and planning, and 4) law and policy.

In the first category, land and water protection, it is recommended that there be an increase in the extent and improved representation and replication of biodiversity features within protected area networks, to protect movement corridors, stepping stones and refugia (Carroll et al. 2010; Mawdsley et al. 2009) and steep ecological gradients, such as elevation gradients (Cowling & Pressey 2001; Sgrò et al. 2011).[3] Existing protected areas should be managed and restored to reduce non-climate stressors such as invasive alien vegetation, in order to improve ecosystem functioning (Carroll et al. 2010; Hansen et al. 2010).

In the second category, direct species management, it is recommended that resources be focused on species that might become extinct. Potential interventions include translocation, assisted colonisation and establishment of captive populations, including seed banking (Mawdsley et al. 2009). Some species will need to adapt *in situ* as they will not move across soil type boundaries (Loarie et al. 2008). They might move short distances to more favourable micro-sites within their habitat (Randin et al. 2009). Evolutionary resilience to climate change may be further enhanced by conserving sufficient genetic diversity and habitat for populations to persist (Sgrò et al. 2011). In the case of threatened species, minimum viable populations should be conserved in order to promote local adaptation (Loarie et al. 2008; Sgrò et al. 2011).

In the third category, monitoring and planning, it is recommended that predicted climate change impacts be incorporated into city-wide plans that address climate change adaptation needs at the landscape scale. Biodiversity adaptation should be seen as complementing societal needs (Tzoulas et al. 2007).

In the fourth category, law and policy, it is proposed that existing environmental laws, regulations and policies be reviewed and modified to ensure consistency with the need for climate change adaptation. However, this is challenging as, contrary to the norm, climate change adaptation requires policies that constrain present activities in order to benefit ecosystems and society in the future (Perry 2015).

Conservation planning and climate change adaptation

Systematic conservation planning methods select complementary areas of habitat in order to meet explicit biodiversity targets that are designed to represent the local

3 Refugia are areas in the landscape where species have survived historical climate shifts; such areas often encompass steep environmental gradients and/or support higher-than-average density of locally restricted species.

biota (Pressey et al. 2007). The spatial components of ecological and evolutionary processes, in addition to the spatial biodiversity pattern, are incorporated to promote long-term persistence of biota in conservation networks. These process components also address climate change adaptation, for example through strategies that promote *in situ* adaptation and local migration of biota (Hansen et al. 2010; Sgrò et al. 2011). Climate change adaptation principles were reviewed and summarised for incorporation into systematic conservation planning by Game et al. (2010). Groves et al. (2012) grouped them into five adaptation approaches. These are: 1) conserving the geophysical stage, 2) protecting climatic refugia, 3) enhancing regional connectivity, 4) sustaining ecosystem process and function, and 5) capitalising on opportunities emerging in response to climate change.

The first adaptation approach, conserving the geophysical stage, is relevant to the CFR, where vegetation communities closely track the land form, geology and soil types, and species have adapted to local micro-habitats (Simmons & Cowling 1996). The various landscape units defined by this approach serve as surrogates for today's biodiversity and tomorrow's climate-driven range shifts (Groves et al. 2012).

The second approach, to protect climate refugia, can imply protecting areas where changes in climate are attenuated or where biodiversity is likely to be robust to climate changes (Groves et al. 2012). Consideration of scale is also important, as there may be local *in situ* refugia within a species' current distribution range, and larger *ex situ* refugia located outside the current range. Areas containing high species richness and turnover, particularly relating to changes along environmental gradients, may be important refugia (Carroll et al. 2010; Groves et al. 2012). Cape Town is an area of high local endemism and has several climate refugia along the mountain chains and on the Cape Flats.

The third approach, to enhance regional connectivity, is one of the most commonly cited climate change adaptation approaches (Heller & Zavaleta 2009). Connectedness is important for evolutionary resilience and to ensure movement of individuals and genes, especially along a climatic gradient, as this has potential to promote *in situ* adaptation (Sgrò et al. 2011). Approach four, maintaining process and function, and approach five, capitalising on opportunities, are best addressed through operational management, although ecosystem processes can benefit from optimal reserve network planning. Management should maintain ecological fire and hydrological regimes to promote ecosystem functioning. Similarly, authorities may capitalise on opportunities when implementing conservation plans: for example, by protecting adjacent land parcels that are high-yield aquifer areas.

It should be noted that addressing climate change adaptation in conservation planning is only one of many approaches required, in concert with improved management and protection, to address the multiple threats to biodiversity (Dorse et al., Chapter 13, this book; Heller & Zavaleta 2009).

Conservation planning case studies

In this section we present two case studies to illustrate how our conservation planning methods have addressed the challenges of climate change. Case study 1 describes the process followed to achieve the city-wide BioNet, and Case study 2 presents the conservation planning process for the False Bay strandveld vegetation type that is under severe development pressure.

Case study 1: The BioNet incorporating climate change adaptation

In 2002, the City of Cape Town Municipality (CCT, also referred to as the City) was the first municipality in South Africa to initiate a systematic conservation planning approach, the BioNet, to efficiently prioritise natural areas in order to meet biodiversity pattern and process targets (Rebelo et al. 2011). Several updated iterations of this BioNet followed, incorporating the latest national vegetation mapping categories (Rebelo et al. 2006), improved remnant mapping, additional species locality information and published national conservation targets (Driver et al. 2012; Rouget et al. 2004). The BioNet aligned with national biodiversity targets and was incorporated into the Western Cape Biodiversity Framework (CapeNature 2014). In 2006, the BioNet was adopted by the CCT. In 2009 the CCT noted that the BioNet must be taken into account in land use decision-making.[4] The BioNet forms a base layer in the Cape Town Spatial Development Framework (CTSDF).

A new objective of the 2012 BioNet methodology was to explicitly include climate change adaptation strategies (Holmes et al. 2012c; Pence 2011).

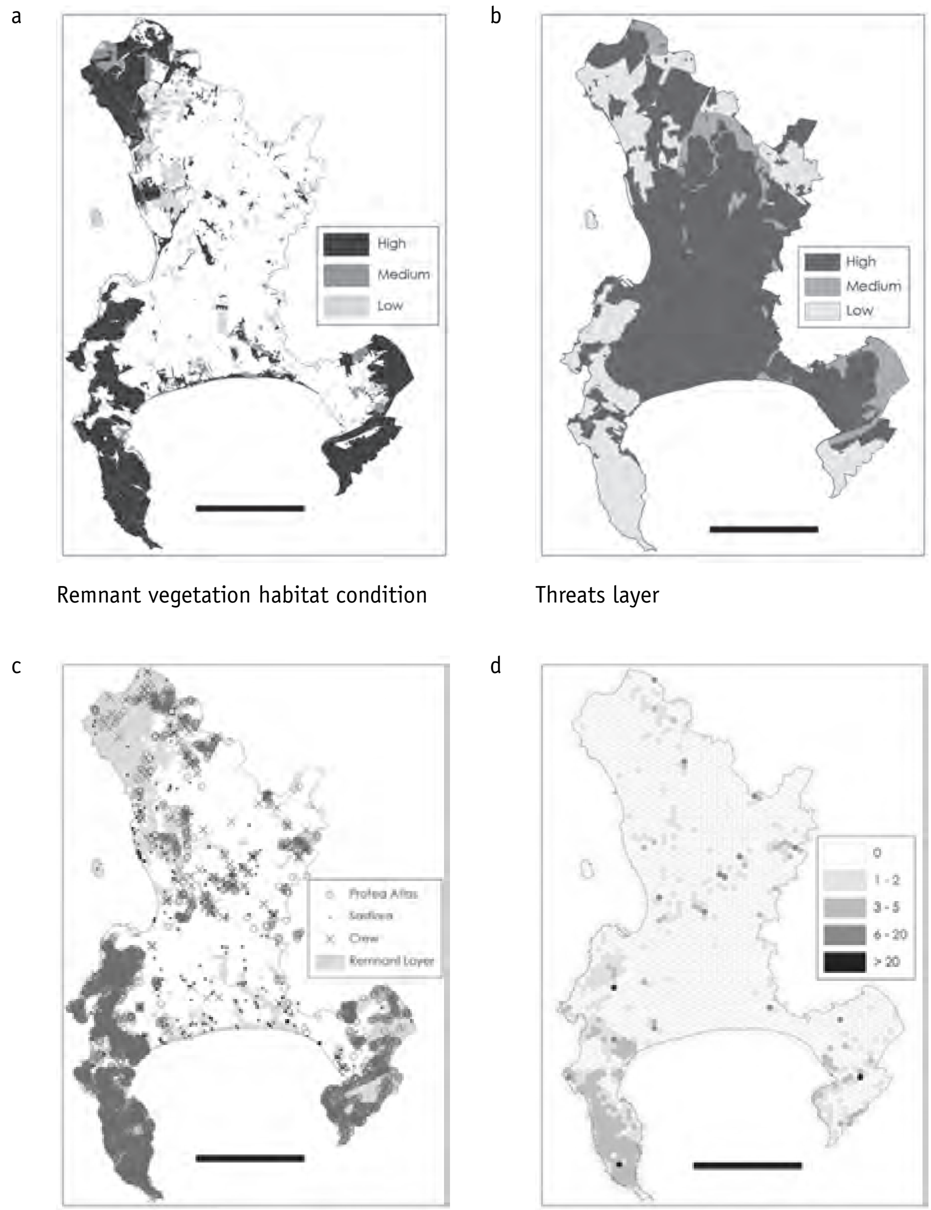
Methods and results

A fine-scale, systematic conservation planning approach (Margules & Pressey 2000) was followed to derive the BioNet (Figure 8.1). Previous analyses had aimed to achieve the most efficient spatial representation of biodiversity pattern and process with the aim of meeting targets as far as possible within a fragmented urban landscape.[5] In this case, outcomes from two approaches were used to explicitly address climate change adaptation strategies in the methodology: a workshop with local experts (Laros 2011) and a review of the relevant literature (Pence 2011).

The review found that the methods used previously already aligned with several climate change adaptation strategies. These included protecting representative, critical and large intact habitats, risk-spreading through replication, incorporating ecological connectivity and reducing threats (Pence 2011). In

4 Council Minutes 27 May 2009: C64/05/09, p.42.

5 Pattern represents the distribution of species and ecosystems in space; process represents additional areas required to maintain ecological processes, such as corridors to allow for faunal movement and gene flow.



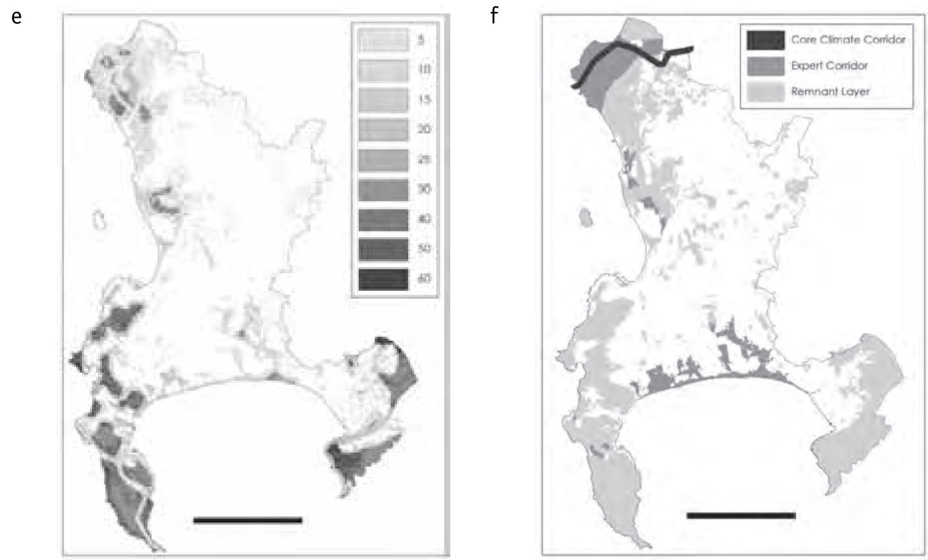
a Remnant vegetation habitat condition

b Threats layer

c Plant species data coverage

d Endemic plant richness

→



Ecosystem-based adaptation layer

Climate change adaptation and expert corridors

Figure 8.2: Spatial data used in the BioNet C-Plan and Marxan analyses in combination with the city-scale national vegetation subtype mapping. The scale bar is 20 km.

Sources: All data created by CCT Environmental Management Department (Holmes et al. 2012c) except for e) sourced from Driver et al. 2012.

the updated method the potential for the BioNet to adapt to climate change was further strengthened by adding the following elements (Figure 8.2):

1. *Important climate refugia*: Core areas of high local endemic species richness indicate areas of high persistence during past climate shifts and local diversification. Using a 100-hectare hexagon grid overlay, endemic species richness was calculated per cell from recent species data records (Figure 8.1d). Remnants with high richness of endemics were prioritised in the 'Minset' selection algorithm using C-plan software (Pressey et al. 2005).[6] The national ecosystem-based adaptation (EbA) layer (Figure 8.1e) identifies areas that promote biodiversity resilience to climate change, such as intact habitat along the coast and steep environmental gradients. The EbA layer was used as a cost

6 A C-Plan analysis is run to calculate the irreplaceability of each planning unit and to select an optimal and efficient set of remnants to meet biodiversity targets. The Minset algorithm in C-Plan is used to preferentially select between two planning units based on a series of rules. Where there is a tie, the algorithm then moves on to apply the next rule. A Marxan analysis is run to consider the spatial patterns within a conservation network and to prioritise planning units such that connectivity is promoted.

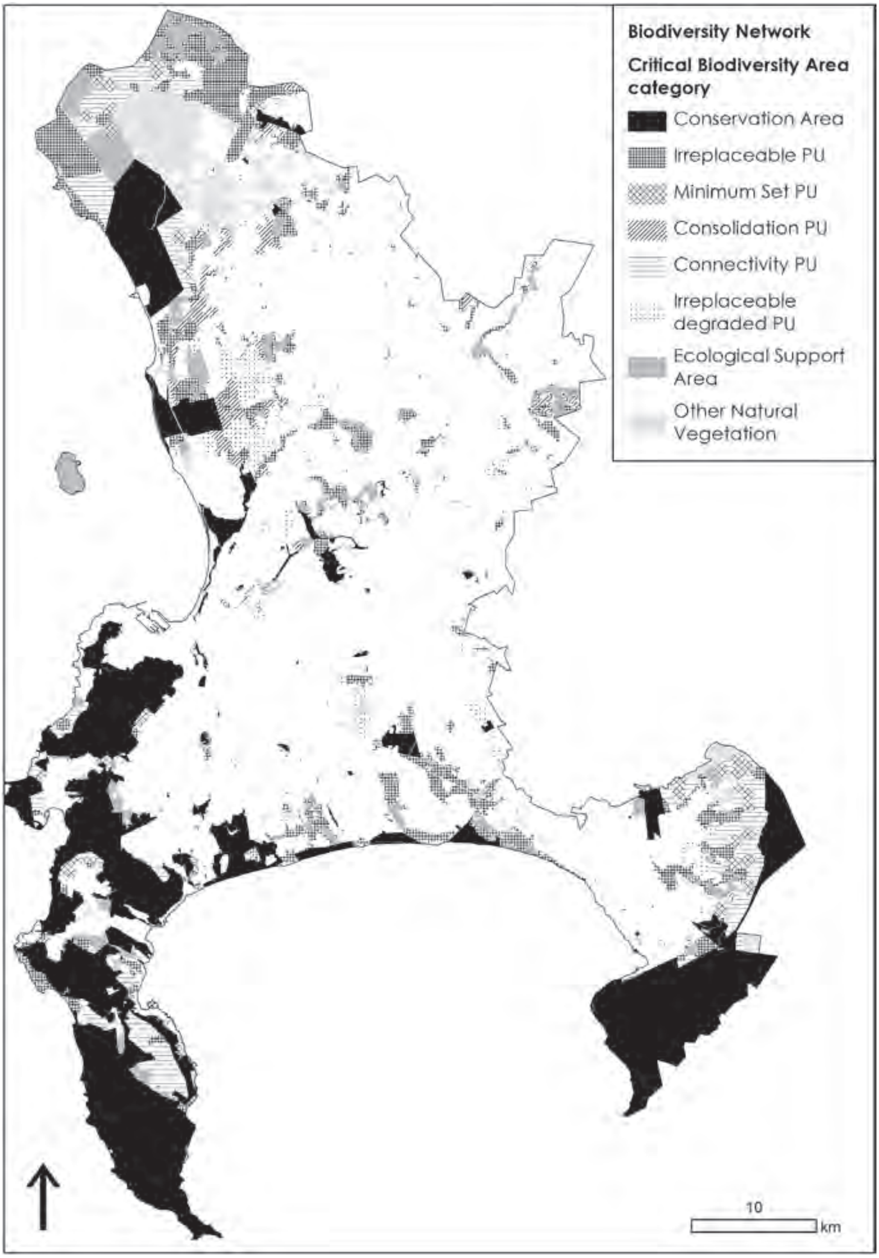


Figure 8.3: BioNet map resulting from the 2012 analysis including climate change adaptation considerations. The map displays natural vegetation remnants that are conserved and natural remnant planning units (PU) selected towards meeting targets. All categories are considered Critical Biodiversity Areas except the Ecological Support Area planning units and the Other Natural Vegetation areas that are unselected. The scale bar is 10 km.

Source: Produced by the authors

surface in the Marxan step of the analysis (Ball et al. 2009) to connect remnants selected for pattern using sites of highest climate adaptation potential.

2. *Prioritisation of regional connectivity*: Open space vegetation corridors that promote connectivity through the fragmented landscapes of Cape Town were mapped (Figure 8.1f) and prioritised in the 'minset' selection. The priority biodiversity climate change adaptation corridor in the north (Pence 2009; Figure 8.1f), was included as a 1 km-wide feature in Marxan.

Rivers and wetlands were included post hoc in the BioNet, as they provide important connectivity function and aquatic habitat. A final expert-led step added Ecological Support Area planning units (Figure 8.2) where required for specific taxa that use the broader landscape, such as Chacma baboon and honey badger (Figure 8.2).

A comparison between the 2009 and 2012 results indicated a one per cent increase in area required when climate change adaptation strategies were included (Figure 8.3). There were two reasons for this similarity. Firstly, extensive habitat loss in most lowland areas since the 1950s and high levels of habitat irreplaceability meant that including specific climate change adaptation strategies made little difference to the areas selected. Secondly, the 2009 analysis included spatial elements of ecological processes, particularly connectivity, that promote biodiversity persistence and simultaneously support climate change adaptation. In conclusion, it can be stated that within the constraints of remaining intact habitat, the latest BioNet represents the optimal area that should be conserved to promote the adaptation and long-term persistence of the local biota to global climate change.

Case study 2: The conservation implementation plan for strandveld in the metro south-east (Strandveld Conservation Implementation Plan)

Endangered Cape Flats dune strandveld (Figure 8.3) is endemic to Cape Town. There are two distinctive subtypes: West Coast and False Bay. The False Bay subtype overlaps with the metro south-east, an area of rapid urbanisation. If conserved and appropriately managed, strandveld provides ecological infrastructure that improves city adaptation to climate change.[7] Strandveld coastal plant communities stabilise dunes to absorb the impacts of storm surges, and attenuate floodwaters in dune slacks and riparian zones. Both of those climate impacts are projected to increase in severity.

The BioNet identifies most remaining False Bay strandveld as necessary to meet biodiversity conservation targets, but it is threatened by land invasion and

7 Ecological infrastructure is the stock of ecosystems and species that provide the flow of essential ecosystem services to humans.

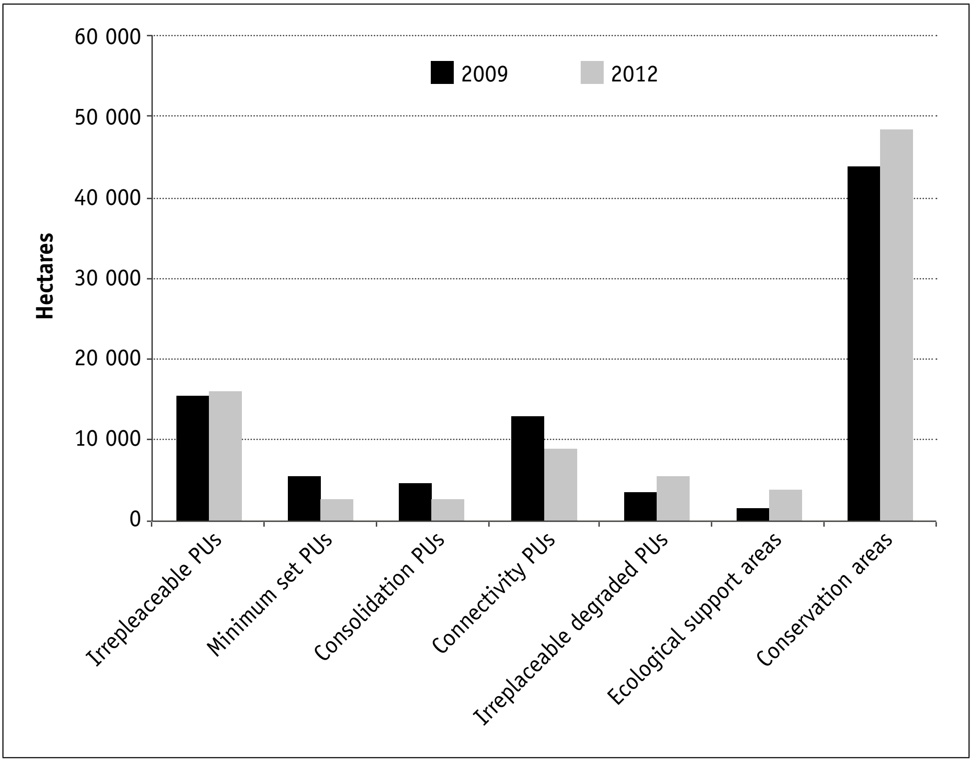


Figure 8.4: Comparison of natural vegetation planning unit (PU) areas selected in the 2009 and 2012 BioNet analyses, pre- and post-incorporation of climate change adaptation strategies respectively. Conservation areas were considered as a priori fixed selections in the analysis. The total area selected was 87 668 hectares in 2009 and 88 654 hectares in 2012.
Source: Produced by the authors

other illegal activities, as land is urgently required for housing. The rationale of the Strandveld Conservation Implementation Plan (CIP) is to secure a subset of the biodiversity target while facilitating development and city climate change adaptation (Holmes et al. 2012a). The innovative Strandveld CIP approach will unlock urgently required operational management resources while facilitating urban development. Central to this model is the mechanism to ensure on-the-ground management of priority strandveld areas before their biodiversity and the ability to deliver ecosystem services is lost (Holmes et al. 2012a).

The objectives of this CIP were:

1. To identify a subset of False Bay strandveld remnants for conservation, in order to conserve the most important biodiversity and ecological infrastructure areas while avoiding development areas.

Figure 8.5: False Bay strandveld vegetation at Macassar Dunes
Photograph: C. Dorse

2. To obtain conservation partner and line department support for a reduced biodiversity target area in support of urban development, in exchange for increased operational budget to initiate on-the-ground management.
3. To investigate mechanisms for securing the operational funding.

Methods and results

1. *Planning analysis:* Analyses were done at a one-hectare grid resolution using ArcGIS 9.3 Spatial Analyst extension, with input grids scored using four categories of ranked and weighted indicators: biodiversity, ecological infrastructure, land use and housing development informants. Biodiversity experts selected a final set of priority areas from the final combined output that it would be pragmatic to conserve.
2. *Stakeholder process:* Over a three-year period, meetings were convened to reach consensus on the proposed methodology and results. Stakeholders included the conservation partner organisations CapeNature, the South African National Biodiversity Institute (SANBI) and the Western Cape Department of Environmental Affairs and Development Planning (DEA&DP); and the City line functions Spatial Planning and Urban Design, Planning and Building

Development Management, Environmental Management (EMD) and Human Settlements.

3. *Funding mechanisms:* Four funding mechanisms were explored:
    a) Additional allocation of City operational budget for unmanaged, City-owned CIP remnants and via savings to Human Settlements projects in a negotiated 'combined environmental impact assessment (EIA)' application for several developments simultaneously.
    b) Establishment of a City Capital Fund whose interest would be used for operations.
    c) Biodiversity offsets: secure alternative sites in mitigation of habitat loss to developments (this could comprise a 'financial offset' in an external audited fund for operational management).
    d) An Urban Settlements Development Grant (USDG): flexible and broad-based funding for development of integrated human settlements, in partnership with Human Settlements, to secure adjacent quality open space areas.

The Strandveld CIP aims to conserve 15 per cent of the historical vegetation instead of the 24 per cent national conservation target (Driver et al. 2012; Figure 8.4). Half of this comprises coastal and flood protection zones that underpin city adaptation to climate change. There remain a few 'impact areas' that are a priority for both development and conservation, to be negotiated through the EIA process (Holmes et al. 2012a; Table 8.1, Figure 8.6).

A report on the Strandveld CIP framework was approved by the CCT in January 2014, with a recommendation that the executive directors convene a task team to implement a management mechanism. A briefing document on potential mechanisms was presented and well received by City management. The City's Finance Department determined that a capital reserve fund could not be set up as this would circumvent municipal finance regulations. The Strandveld CIP and budget projections were presented to the Executive Mayor and Mayoral Committee during 2015 and to members of the Budget Steering Committee. The required CIP budget has been submitted annually for consideration in the City budget since 2014, but to date full allocation of this budget has not been secured.

Biodiversity offsets and a partnership between the EMD and Human Settlements provide an opportunity to unlock the funds saved through a 'combined EIA' together with USDG funding. By agreement with the competent authority, the provincial DEA&DP, the City may submit a 'combined EIA' application for several sites categorised as 'develop with mitigation' in the Strandveld CIP (Table 8.1). Internal drafting of a combined EIA report will save Human Settlements considerable time and resources. For private land, the standard EIA process would be followed, applying the Strandveld CIP framework (Table 8.1).

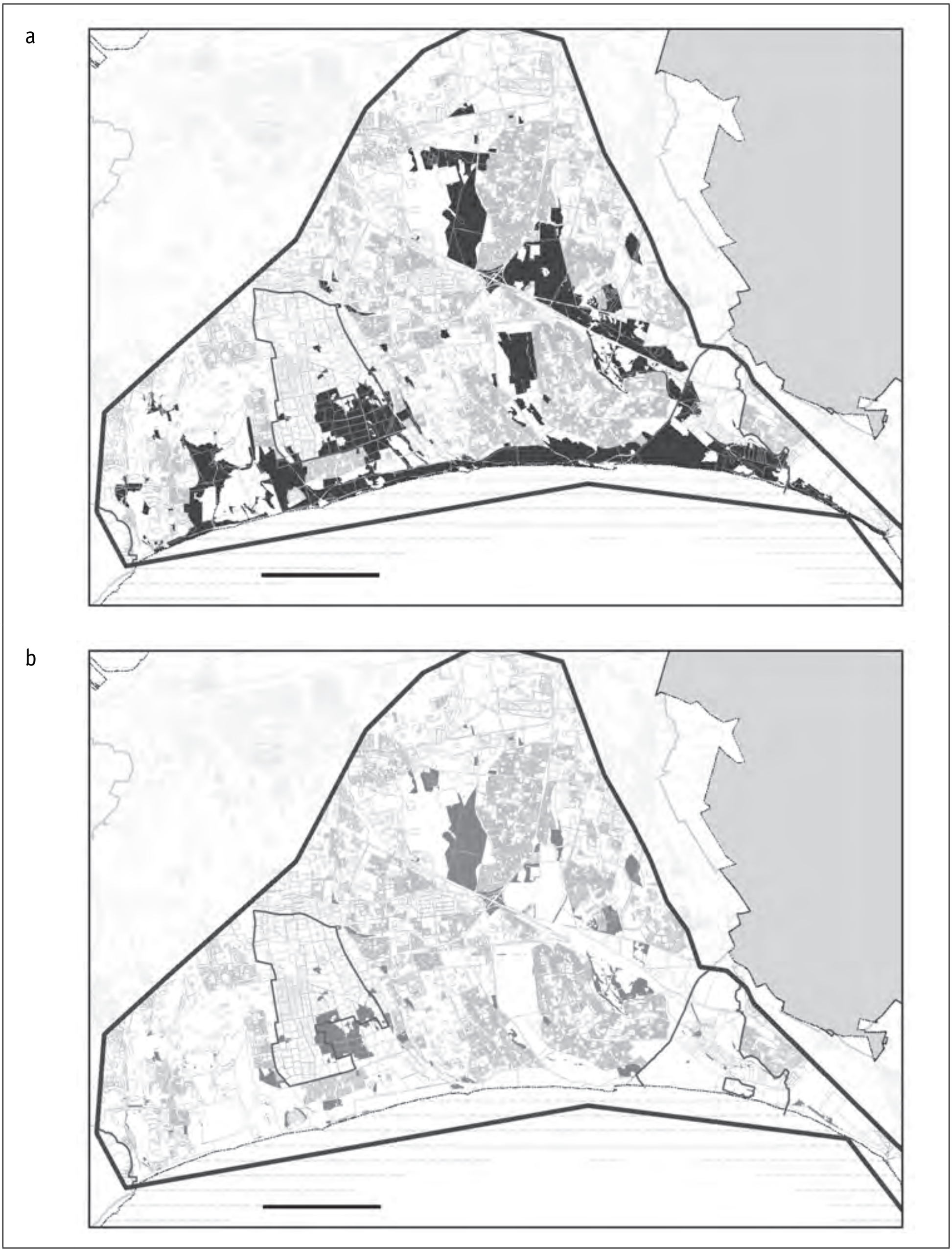


Figure 8.6a: The metro south-east Strandveld Conservation Implementation Plan:
a) remaining vegetation remnants of the False Bay subtype of Cape Flats Dune Strandveld;
b) strandveld remnants supported for development with mitigation.
Source: Produced by the authors

c

d

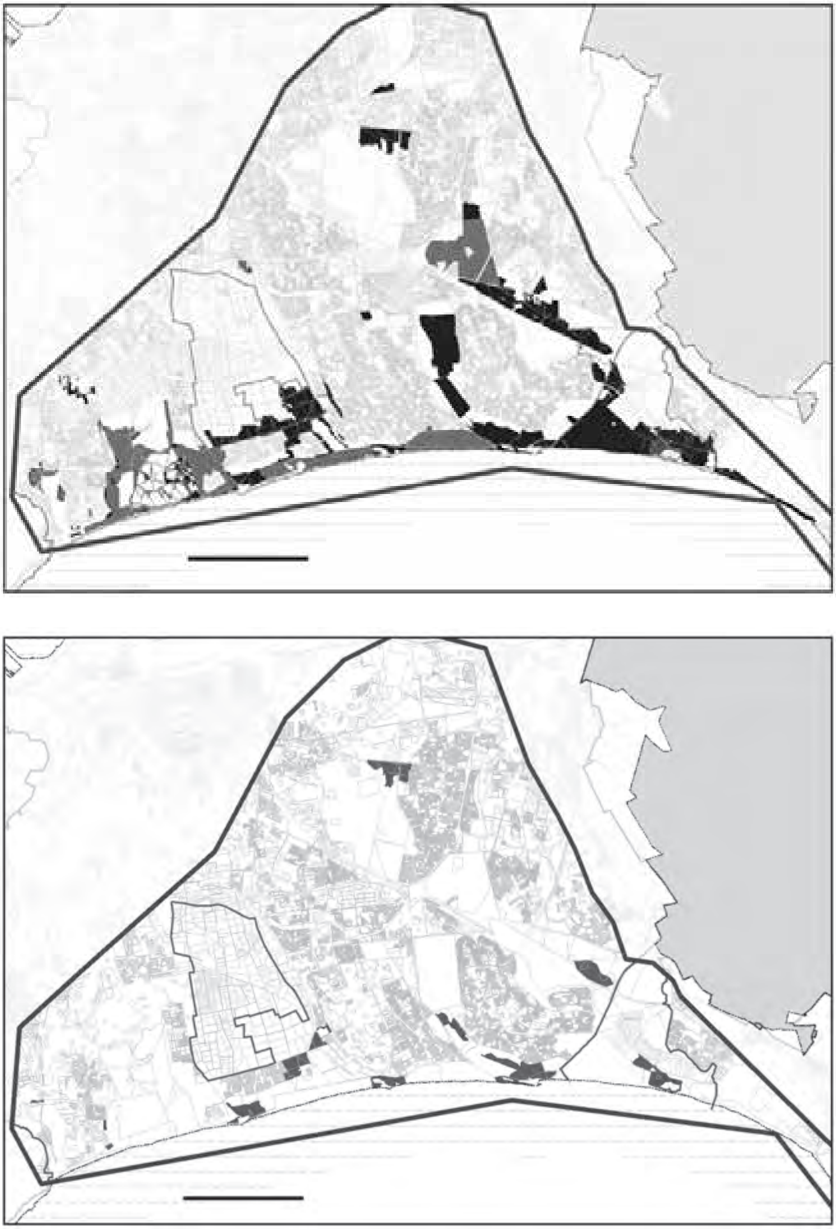


Figure 8.6b: c) priority strandveld remnants to conserve — grey remnants conserved, black remnants not yet conserved; d) impact areas that are a priority for conservation and development.
The scale bar is 1 cm = 5 km.
Source: Produced by the authors

The challenge posed by this project has been the long time frame (six years) from analysis to implementation. Many government processes are reactive to pressing social and economic hardships, and there is some reluctance to support such a proactive initiative, despite its potential long-term benefits to society. Conserving the natural environment is seen as an environmental function, even if this is a condition of an EIA authorisation where another line department is the developer. It is imperative that line functions continue to work together to overcome these institutional barriers and that they unlock the required operational funding to ensure that potential co-benefits are realised.

Table 8.1: A decision-making framework for implementing the metro south-east Strandveld Conservation Implementation Plan, with links to mapped categories in Figure 8.6

Strandveld land category	Description	Public land	Private land
Development^ site with mitigation (Non-CIP remnant) Figure 8.6b	Strandveld remnants that are a lower priority to conserve, based on the CIP study	• An EIA is required; development may be supported with mitigation towards securing and managing CIP remnants • Whereas 75% of the non-CIP remnants are outside the flood-prone area (FPA), the 25% remnants inside the FPA should not be developed with hard infrastructure where they form part of a river or Critical Biodiversity Area wetland buffer	• An EIA is required; development may be supported with mitigation towards securing and managing CIP remnants

→

Strandveld land category	Description	Public land	Private land
Receptor sites (CIP priority remnants) Figure 8.6c	Subset of False Bay strandveld that is a priority to conserve, based on the CIP study; note that small areas of mined strandveld are included in the CIP, and earmarked for restoration as key biodiversity linkages	• No development; these are receptor sites used to mitigate other developments • Any development application* would require an EIA, with an outcome unlikely to be favourable for total development of the site; mitigation for any developed portion	• No development; these are receptor sites used to offset other developments • Any development application would require an EIA; development may be approved only on degraded portions outside the FPAs, with likely mitigation required in a contribution towards securing the CIP
Mixed development and conservation (Impact areas) Figure 8.6d	Subset of False Bay strandveld that is a priority to conserve, but also a priority to develop	• Detailed planning and an EIA process will determine which portions are developed; high-quality strandveld areas are unlikely to be approved for development • Development approval on portions of this land may require mitigation as a contribution towards securing the CIP	• Generally not applicable as this category is mostly on public land; however, the same process would apply to private land
Transformed open space	No strandveld vegetation cover	• If wetlands are present an EIA is required; otherwise development may be supported	• If wetlands are present an EIA is required; otherwise development may be supported

Notes: ^Development includes housing, industrial, mining and agriculture.
*This differs from private CIP land in that consulted City line functions are supportive of conserving these areas.
Source: Produced by the authors.

In conclusion, the Strandveld CIP is a pragmatic and innovative model for an ecosystem under immediate threat of habitat loss, in that it facilitates development while securing biodiversity and reducing the risks of climate disasters. It has involved other line departments from the start, which has promoted a greater awareness of potential co-benefits and verbal support for implementation across line departments. However, budgets are constrained and its implementation will require ongoing interdepartmental collaboration and lobbying at executive management level to overcome institutional barriers.

Lessons learned and the way forward

Cape Town presents a challenge because much of its globally significant biodiversity is endemic, necessary to meet the minimum national biodiversity targets and must be conserved within city borders. The city is growing rapidly and there is increasing pressure to develop unprotected natural areas. However, by securing critical areas of biodiversity in perpetuity, well-managed, resilient ecosystems can adapt to projected climate change impacts, and can continue to provide ecosystem services that underpin the economy. City-dwellers also need access to quality natural open space for spiritual, recreational and health benefits.

The review of the CCT's systematic conservation planning in the context of climate change confirms the benefits of adopting scientific best practice. This leads to credibility within the City and among a wider set of stakeholders, and acceptance of the BioNet as an informant in forward spatial planning, land use planning and EIA decisions. The inclusion of the BioNet in the CTSDF makes available a powerful tool to inform planning decisions across all line functions. However, because previous methods were predisposed towards site selections that support several climate change adaptation principles, and a large proportion of biodiversity sites are irreplaceable, including climate adaptation strategies made only a small difference to the BioNet site selections.

Two other South African metropolitan municipalities have completed systematic conservation plans: Nelson Mandela Bay and eThekwini (Durban). Both followed a similar methodology to that of Cape Town, but did not explicitly incorporate climate change adaptation into their analyses (McLean et al. 2016; Stewart 2010). However, there was a strong focus on ecological processes that resulted in river corridors and coastal ecosystems being selected, and this should underpin a climate-resilient reserve network for those cities.

The Strandveld CIP case study described an innovative approach for a specific ecosystem under imminent threat owing to its location in a rapidly urbanising area of the city. Key line departments and biodiversity sector partners were part of the planning process from the start. The rationale was to proactively obtain operational management funding for a subset of the biodiversity target area, to ensure resilience of ecological infrastructure towards city climate change adaptation, and simultaneously to facilitate urban development. The Strandveld CIP framework indicates the priority sites for development and conservation. The challenge was to convince other City line functions to support this proactive approach, rather than the reactive 'business as usual' approach of responding to land use change only as and when required. Conversely, provincial and national conservation agencies cannot support a lower biodiversity target in the absence of evidence that the smaller set of proposed conservation areas will be proactively secured and managed. Without proactive management, biodiversity will continue to be lost in rapidly urbanising areas, with a concomitant loss of ecological infrastructure and ecosystem services that are critical to developing a sustainable city resilient to climate change. Whereas the planning process has garnered verbal support from line departments in the City, the challenge remains to secure the funding for implementation of this CIP.

Acknowledgements
Colleagues at the CCT's EMD provided input into this chapter. Genevieve Pence (conservation planner) provided recommendations for incorporating biodiversity climate change adaptation principles into the methodology. Tony Rebelo (SANBI) and Barrie Low (COASTEC) assisted with refining the national vegetation mapping at city scale and Tony Rebelo generated the endemic species layer for the BioNet analysis.

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CHAPTER 9

The sea change of coastal risk management in the City of Cape Town: towards a new paradigm of collaborative governance

Sarah Chippendale, Merle Sowman and Darryl Colenbrander

Municipalities the world over are being confronted by novel environmental and socio-economic challenges as a result of climate change. The task of resolving these challenges is made more difficult given that human-in-nature systems are unpredictable, dynamic and complex (Berkes 2015; Folke et al. 2002). Conventional management and governance approaches are failing to achieve sustainability targets and as such there is a growing appreciation for alternative governance strategies (Berkes et al. 2003; Ziervogel & Parnell 2014). The governance of coastal areas at risk from climate-induced sea-level rise is especially pertinent to the City of Cape Town Municipality (CCT, also referred to as the City). Traditionally known as the Cape of Storms, Cape Town comprises a coastline of 307 km in length (of which 60 km falls within the Table Mountain National Park), making it the largest coastal metropole in terms of sea-frontage in South Africa. The coastal environment is a complex space where jurisdictions, legislation and a range of considerations — institutional, social, environmental and economic — converge (DEAT 2000). As such, a holistic approach towards coastal management is necessary in order to consider multiple actor interests and to mitigate risks, especially those posed through climate change. In Cape Town, these risks include an increase in the intensity and frequency of storm surge events and shifting wind regimes leading to flooding, erosion and damage to infrastructure and properties. The impacts of climate change necessitate new and innovative forms of governance, especially by local government. This is because government has a catalytic role to play in creating the enabling conditions for transforming societal expectations, practices and behaviour (Glavovic 2013a).

Integrated coastal management (ICM) is considered the most appropriate framework within which to govern the coastal environment (Bower & Turner 1998;

Cicin-Sain et al. 1998; Olsen 2003) as it 'seeks to integrate policies and actions across sectors, as well as recognising the interlinked nature of the natural environment of coastal land, estuaries and inshore waters' (Atkins Consultancy 2004: 1). Its value lies in its systems-oriented, people-centric and inclusive processes for resolving pressing coastal challenges. Indeed, it is argued that coastal management is an inherently political endeavour (Glavovic 2016) which needs to be reconceptualised as a practice of collaborative and deliberative coastal governance, requiring participation, knowledge-sharing and transparency between public and private stakeholders (Bavinck et al. 2005; Glavovic 2013a, 2013b; Kooiman et al. 2005).

There is growing appreciation within the CCT of the need to initiate and explore alternative governance approaches and innovative forms of interaction between the state and civil society. This is due to the mounting challenges posed by climate change as well as the persistence of unsustainable outcomes within the CCT, as indicated by progress reviews of the CCT's Integrated Metropolitan Environmental Policy (IMEP) in both 2008 and 2013 (Davison et al. 2015). This chapter reports on three coastal adaptation case studies that illustrate how the CCT is reappraising its governance strategies, in particular as they relate to climate change in the context of a coastal city.

Governance of coastal risk

Environmental governance the world over has been largely informed by the natural sciences, and management approaches have been top-down, technocratic and applied sectorally (Glavovic 2006; Oelofse et al. 2006). This management style tends to be nurtured and strengthened within bureaucratic forms of organisation which are synonymous with government institutions (Olsen 2006). Bureaucracy is designed to promote efficiency in achieving production goals, uniformity, top-down command-and-control, rigidity and the limiting of autonomy (Lebel et al. 2006). Yet societies co-evolve with nature and are characterised as being complex, dynamic and unpredictable (Berkes 2015; Folke et al. 2002). Bureaucratic forms of governance within the state — although effective in managing linear problems — have been shown to undermine government's efficacy at responding to contemporary environmental challenges that tend to be characterised by increasing complexity, dynamism and connectivity (Hajer 2014; Lockwood et al. 2012). Indeed, many — if not most — environmental challenges are considered to be 'wicked problems' (Rittel & Webber 1973) which call for innovative institutional and policy responses (Lockwood et al. 2012). Wicked problems can be described as those that lack clear boundaries, solutions and opportunities for experimentation (Rittel & Webber 1973); as such, they require the adoption of novel governance approaches (Davison et al. 2015; Loorbach 2007).

One such approach involves a shift towards a more deliberative and participatory model of environmental governance, which is becoming increasingly recognised in literature and applied in praxis (Glavovic 2016; Lockwood et al. 2012). One of the central tenets of the collaborative governance framework is the conviction that complex and wicked problems are no longer the purview of government alone, but that these issues should become a shared responsibility between government, civil society and the market (Kooiman & Jentoft 2009). This governance approach involves a shift in the way that societies are managed, with a concomitant shift in the role of government. Specifically, it requires a transformation from 'government to governance': from the traditional, top-down, technocratic and regulatory mode of governing by government institutions towards one that is characterised and defined by state-society interactions (Kooiman 2008; Lockwood et al. 2012). Governance may be described as 'the whole of public as well as private interactions that are taken to solve societal problems and create societal opportunities. It includes the formulation and application of principles guiding those interactions and care for institutions that enable them' (Bavinck et al. 2005: 30). Framing governance in this manner proves particularly useful in a local government context, where different actors have differing and often conflicting interests, values and perceptions. Social, economic and environmental responses thus need to be founded on collaborative governance principles and further embedded within policy stances at local government level (Ziervogel & Parnell 2014).

In the context of climate risk and uncertainty, several authors have highlighted the limitations of traditional approaches taken by government, and stressed the importance of stakeholder engagement and the building of partnerships between state and non-state actors to address risks and impacts (Bulkeley 2001; Renn et al. 2011; Scott et al. 2016). This is because the process of meaningful engagement through collaborative governance enables a shift in the values, principles, world views and epistemologies of actors so that a greater awareness exists of the realities of others. Governance challenges could be reduced if these qualities were made explicit, understood and articulated in decision-making processes (Song et al. 2013; Sowman 2015). This is particularly true for the mounting challenges facing coastal risk governance due to climate change. In the context of climate change and social justice, Shi et al. (2016) argue that broadening participation and engaging a wide diversity of actors in adaptation planning is necessary to ensure equity and social justice.

Within the context of a coastal city such as Cape Town, it is important for principles of collaborative governance to be extended to — and embedded within — governance strategies relating to the coast and its resources. ICM is becoming increasingly drawn into the discourse of coastal risk governance, considering the increasing development pressures on and environmental degradation of coastal areas, and the growing vulnerability of coastal cities to sea-level rise and storm surges. Indeed, there is a growing appreciation of the relevance and usefulness of ICM within the discipline of climate change adaptation

(Celliers et al. 2013; Chemane et al. 1997; Nicholls & Klein 2005) and it must be considered as a key management paradigm for instilling and promoting principles of collaborative governance within the context of a coastal city. ICM also recognises that science-based and technological approaches, as well as a sound statutory and legislative basis, are essential prerequisites for effective coastal management (McKenna & Cooper 2006). However, these approaches need to be embedded within a wider governance context that enables holistic, participatory and systems-oriented approaches for building resilient coastal cities (Berkes et al. 2003; Glavovic 2013a; Sowman et al. 2008). For the CCT, a municipality whose coast presents both socio-economic opportunities and substantial risks, understanding its progress in respect of ICM becomes a key governance responsibility.

The institutionalisation of integrated coastal management in South Africa and in the CCT

Integrated coastal management in South Africa

The institutionalisation of ICM within South African policy is the result of a transformation in the perception — and the subsequent governance — of the country's coastal environment. This transformation is reflective of a paradigm shift, from a discourse that was largely oriented towards the natural sciences and was biophysical in nature (a 'conservation discourse') to one that is participatory, systems-oriented and people-centric (a 'sustainable development discourse') (Glavovic 2006). The policy shift associated with this transformation was expedited through South Africa's transition from apartheid to democracy in 1994, which catalysed a massive law reform process across all sectors. The transition to a new democracy provided momentum for the development of policies and legislative frameworks that were rooted in broad-based public participation. This socio-political shift created the opportunity for participatory coastal policy-making and a recognition of the need to promote equity, sustainability, redress and good governance in the management of the country's coastal resources and areas (Glavovic 2006; Sowman et al. 2008).

This was especially pertinent for the development of ICM, which had, up until this point, evolved in an apolitical environment — 'cocooned from the reality of Apartheid' (Glavovic 2006: 893). The process behind the institutionalisation of ICM in South Africa was collaborative and multi-disciplinary: it was a result of the acknowledgment by the then Department of Environmental Affairs and Tourism (DEAT) that a participatory policy formulation process would be essential for the conceptualisation of a meaningful and inclusive coastal policy (Glavovic 2006). The process of developing a White Paper on coastal management was initiated in 1997, with extensive input from more than 5 000 stakeholders, including civil society, the private sector and representatives from all three spheres of government

(DEAT 2000). A Policy Committee, consisting of representatives from government, business, labour organisations, NGOs and community-based organisations, was responsible for steering the policy formulation process, thus laying the foundation for the collaborative governance of the coastal environment (DEAT 2000).

A Green Paper (*Towards sustainable coastal development in South Africa*) was developed in 1998, which served as a precursor to the development of a White Paper in 2000. The *White Paper for Sustainable Coastal Development* (DEAT 2000) served as a watershed moment for ICM in South Africa. It departed from previous coastal management paradigms as it acknowledged that, in the past, 'the value of coastal ecosystems as a cornerstone for development was not sufficiently acknowledged in decision-making in South Africa; coastal management was resource-centred rather than people-centred; coastal management efforts were fragmented and unco-ordinated; an approach of 'top-down' control and regulation was taken in coastal management efforts' (DEAT 2000: 8). The White Paper subsequently evolved into the National Integrated Coastal Management Act (No. 24 of 2008), which came into effect on 1 December 2009 and serves as South Africa's first legal instrument to promote integrated management of the coastal zone (Celliers et al. 2013). This initial Act was subsequently amended and a new Act was promulgated in 2014 (the Integrated Coastal Management Act No. 36 of 2014).

These policies acknowledge the fact that principles such as transparency, participation, deliberation, social justice, responsibility and accountability are considered critical to the establishment and institutionalisation of ICM. As a result, the CCT is beginning to embrace the principles of collaborative governance in its approach towards coastal risk management and, in the process, is strengthening the governance aspects of ICM.

Integrated coastal management within the CCT

The institutionalisation of ICM within the CCT is reflected in a range of policies, strategies and management programmes that have been politically supported and formally adopted within the CCT. The development of these plans involved the use of both formal and informal modes of collaboration and engagement with the public.[1] Formal and broad-based stakeholder engagement is achieved through the Public Participation Process, a mandatory requirement of the Constitution of the Republic of South Africa (Act No. 108 of 1996). Informal engagements, however, are considered by the CCT to be equally valuable, in respect of achieving an understanding of the nuances of coastal challenges and complexities. Informal interactions are typically random and ad hoc, occurring over many years between CCT officials and private individuals, community groups, ratepayer associations

1 The term 'informal' is used to describe stakeholder engagement sessions that do not form part of the CCT's formal Public Participation Process.

and private organisations, as well as with councillors as political representatives of communities. The institutional knowledge held by staff members responsible for aspects of coastal management in the CCT covers a collective period of more than 60 years and has been an important enabler for the CCT to develop its own internal policies and strategies, as opposed to appointing external consultants to do so. This holds tremendous value, as these strategies are sensitive and responsive to the contextual realities of Cape Town.

The City of Cape Town's Integrated Coastal Management Policy

The CCT recognises that an effective policy environment is crucial for good governance, long-term planning and the optimisation of sustainable opportunities and economic growth (CCT 2014a). As such, an ICM Policy was developed and approved by the City in September 2014. The ICM Policy embeds principles that are reflected in the White Paper and the ICM Act, namely: that decisions relating to the coast will be facilitated by broad-based stakeholder engagement and public consultation (meeting the requirement for collaborative governance); that decisions will be made in the interests of the greater good and the broader community (meeting the requirement to be equitable and just); and that accountability will be established (meeting the requirement for transparency).

A Coastal Management Programme

In terms of the ICM Act, all coastal municipalities are required to prepare and adopt a municipal Coastal Management Programme (CMP) for managing the coastal zone. The CCT's CMP was formally approved in May 2015. The CMP provides the CCT with a clear framework for management of the coastline, and serves equally as a substantive document available to the public in that it both clarifies roles and responsibilities and provides an explanatory basis for various coastal management initiatives undertaken around the city (CCT 2015). Both the ICM Policy and the CMP were strongly supported by civil society, as indicated in the comments received through the formal Public Participation Process.

The Transversal Coastal Working Group

In 2012, the CCT established a Transversal Management System in order to address weaknesses emanating from its compartmentalised organisational structure. As an organisation, the CCT is structured as a hierarchy with line departments specialising in specific issues. Such a model aims to achieve a clear chain of accountability and efficiency (CCT 2014b). This structure is, however, prone to the development of 'silo mentalities' which in turn may undermine horizontal integration between the different departments. As a result, the CCT's Transversal Coastal Working Group (CWG) was established in 2014 to enable a more collaborative and deliberative approach towards coastal management. The CWG consists of representatives from 12 different departments, including the Environmental Resource Management Department, Stormwater and Sustainability, Disaster Risk Management, Solid Waste, and Spatial Planning and Urban Design. Representatives from each department meet on a monthly basis to ensure collaboration and shared decision-making on matters relating to coastal management, and to ensure that the CCT's ICM Policy and CMP are implemented.

From policy to practice: is the CCT making progress?

In the case of the CCT's coastal management arena, numerous strategies have been developed and approved in order to promote ICM principles and approaches in planning and decision-making (discussed in the next section of this chapter). Coastal management is now a recognised function within the CCT, as evidenced by the appointment of two coastal coordinators in 2008 as well as the establishment of a small Integrated Coastal Management Unit within the CCT in 2012. In addition, the CCT's Executive Management Team requested that defined and detailed coastal roles and responsibilities be assigned to various departments, thereby ensuring that there would be shared responsibility and clear institutional accountability for coastal management within the CCT. These roles and responsibilities were formally approved and form a component of the CCT's CMP (see below).

While socio-institutional responses have been undertaken to improve ICM and collaborative governance, the effective implementation of ICM remains a challenge in certain areas, in particular those coastal challenges that require intensive and ongoing collaboration between multiple CCT departments. Colenbrander and Bavinck (2016) identify one cause of this as the debilitating and pervasive influence of deeply entrenched bureaucratic forms of organisation that can undermine the CCT's attempts at promoting more collaborative and adaptive forms of governance. Davison et al. (2015: 13) posit another cause: '[t]he continuation of a knowledge-based approach to policy, rather than an approach that views responding to sustainability as a governance challenge requiring fundamental transformation of institutional structures'.

There is evidently a greater need for deliberation, communication, the adoption of trans-disciplinary approaches and sharing of knowledge in the management of risk and pursuit of sustainability. As Davison et al. (2015: 3) argue, the mandate of local government agencies is expanding to confront issues of sustainability by incorporating 'planning and policy-making for issues such as climate change, the green economy and social justice, using equally new processes that embrace participation and transparency'. Understanding the drivers behind the CCT's institutional inertia in this regard is a prerequisite for identifying and mobilising alternative strategies in response to climate change pressures.

Coastal risk in Cape Town: a delicate balance between risk aversion and socio-economic upliftment

Cape Town's coastline serves as one of the CCT's greatest socio-economic and environmental assets: the governance of the coastline is therefore of critical importance to the future prosperity of the CCT and its citizens (CCT 2015). A recent analysis indicated that five out of South Africa's 10 most expensive suburbs (Clifton, Llandudno, Bantry Bay, Camps Bay and Fresnaye) are located along Cape Town's coastline, where residential properties were valued at an average of R10 million in 2015.[2] Yet this is in stark contrast to many other suburbs within the CCT, particularly in the Cape Flats region. This is partly a result of the spatial legacy of apartheid planning under the Group Areas Act (No. 41 of 1950), in terms of which areas in Cape Town were segregated according to race and ethnicity. As a result, there is an inverse relationship between income group and population density in the city (Turok et al. 2010), as thousands of black residents were relocated to the less desirable and environmentally harsh areas (a process known as 'environmental apartheid'), away from the city's coastline and its associated socio-economic opportunities. As such, inequality in Cape Town still possesses a distinctly racial character (Taylor et al. 2014), and a spatial dimension to socio-economic vulnerability continues to exist in the city and along the coastline (CCT 2009). In addition, development is occurring in close proximity to the coastline (Cartwright 2008), which, juxtaposed with poor historical decision-making and an under-estimation of the dynamic nature of coastal systems, has led to significant exposure to coastal risks within the city (CCT 2012). This is especially pertinent considering that 75 per cent of the coastline consists of hard infrastructure (both public and private) falling within 100 m of the high water mark.[3]

In an attempt to limit these risks, various strategies such as coastal management lines and the declaration of coastal protection zones have been implemented. However, in light of Cape Town's legacy of apartheid spatial planning and the perception that coastal development offers significant economic rewards, mechanisms to promote development that is risk-averse can be perceived as anti-development or elitist (Colenbrander et al. 2012). As such, governance decisions relating to sustainable development within the city's coastal environment need to possess strong elements of both social justice and moral conviction. The CCT's coastal adaptation strategies therefore need to find a delicate balance between the promotion of socio-economic upliftment through the conduit of development,

2 http://www.fin24.com/Wealth-and-Investment/News/top-10-most-expensive-suburbs-in-sa-20151117, accessed 19 January 2019.

3 The proximity of infrastructure to the high water mark provides a crude proxy of exposure to risk from coastal processes.

and simultaneously ensuring that this development remains risk-averse and sustainable. Given the politicisation of coastal risk governance in Cape Town and the uncharted waters of responding to emerging pressures of climate change, the CCT is undergoing a 'sea change' regarding its approach to governance.

A shift in governance approaches — through the lens of coastal adaptation strategies

Despite some of the difficulties involved in the translation of environmental policy into praxis and increasing degrees of ICM (discussed below), the CCT has made progress in certain respects. The case studies presented in this section illustrate how the CCT is embracing the principles of collaborative governance as a form of coastal adaptation in order to address the wicked problems arising within the dynamic coastal environment. It is these successes, and the principles and processes that led to them, that the CCT intends to build upon.

An inclusive deliberative process for formulating the CCT's coastal management line

The delineation of a coastal management line is a mandatory requirement for all coastal municipalities within South Africa, in terms of the ICM Act. The ICM Act states that the purpose of this line is 'to demarcate an area within which development will be prohibited or controlled in order to achieve the objectives of this Act or coastal management objectives'. Specifically, the ICM Act states that management lines must be established in order to:

1. protect coastal public property, private property and private safety;
2. protect the coastal protection zone;
3. preserve the aesthetic values of the coastal zone; and
4. prohibit or restrict the building, alteration or extension of structures that are wholly or partially seaward of the coastal management line.

The CCT initiated the process of delineating its coastal management line in 2007 as a proactive measure to promote risk-averse decision-making within the coastal space. This was important considering the CCT's pressing developmental responsibilities as well as the escalating risks associated with climate change and associated sea level rise. Given the developmental and fundamental human challenges within an urban hub, the CCT considered an inclusive and deliberative process as non-negotiable for delineating an effective coastal management line. This was achieved through the use of both informal and formal modes of stakeholder engagement. The CCT's informal stakeholder engagement process was initiated in 2007 and entailed numerous engagements with ratepayer associations, presentations to relevant stakeholders and site inspections with local councillors (CCT 2012).

Desportes and Colenbrander (2016) argue that decisions and objectives relating to the simultaneous attainment of both socio-economic and environmental goals — as is the case with the CCT's coastal management line delineation — can only be reached if the decision-making process is perceived to be inclusive, legitimate and just. This was achieved in Cape Town due to the CCT's insistence that:

> *[t]he stakeholder engagement process takes place over periods of time that allow and encourage dialogue and meaningful two-way communication between the implementing authority and Interested and Affected Parties (I&APs). This is key in allowing the process to determine the outcome (CCT 2012: 46).*

Equally important for the successful adoption of the CCT's coastal management line is that socio-economic, cultural, political and ecological informants were used in defining its position.[4] The public support displayed for the CCT's management line reflects the importance of coalescing different 'knowledges' in the interests of coastal risk governance. Indeed, Colenbrander and Sowman (2015) demonstrate that the inclusion of socio-economic considerations in the formulation of management lines is non-negotiable.[5] Without including these dimensions, management lines are unlikely to succeed.

The Glencairn Rail Remediation Study

The South Peninsula Transport Corridor, located on the eastern side of False Bay, consists of both road and rail infrastructure that connects the coastal suburbs of Muizenberg and Simon's Town. Glencairn Beach is a pocket beach approximately 400 m in length located along this corridor. This beach originally formed part of a sediment by-pass system where sand would be transported by wind between Glencairn and the Noordhoek basin (CSIR 1987). As a consequence of the prevailing wind system, however, transport infrastructure within this dynamic space is frequently smothered by wind-blown sand (Figure 9.1). In addition to this, the railway line is being increasingly exposed to erosion, either from persistent

4 The CCT's coastal management line has been formally adopted as the Coastal Urban Edge in terms of the City's Spatial Development Framework. It is yet to be adopted in terms of the ICM Act.

5 Historically the establishment of coastal management lines has relied exclusively on the natural sciences and empirical modelling of biophysical elements, with no consideration of socio-economic dimensions. The absence of such considerations has presented a significant obstacle to their acceptance and formalisation (Colenbrander & Sowman 2015).

Figure 9.1: Exposure of the Glencairn Rail to coastal processes such as wind-blown sand
Photograph: D. Colenbrander

south-easterly-driven wave chop during the summer months or from winter storms. Both these natural processes present a hazard that may cause structural damage to the rail and the road, ultimately placing commuters, cargo and the relevant management authorities at risk.

From a management perspective, the area has an added layer of complexity in that three government agencies, each with different mandates and agendas, are responsible for different aspects within the same space, namely the CCT, the provincial Western Cape Department of Transport and Public Works and the national Passenger Rail Agency of South Africa. As such, an integrated and consensual solution was needed to meet the needs of the three agencies, while ensuring that the protective intervention was sensitive to the interests of the general public, notably to retaining the recreational and amenity value of the beach.

In order to find a solution to the problem that accommodated the different visions, knowledges, and values of the governance actors, a Project Management Team (PMT) was established with the aim of providing a platform from which to drive an inclusive and deliberative decision-making process between the agencies. A Multi-Criteria Decision Analysis (MCDA) tool was used by the PMT to achieve a multi-disciplinary consensus on the most appropriate intervention (see Daron and Colenbrander 2014). An understanding of the public interests, gained from informal interactions with local stakeholders, was used to inform the criteria of the MCDA, as set by the PMT. Through this process a range of possible interventions were identified, including both 'hard' and 'soft' engineering options, as well as a 'do nothing' approach. The process culminated in the identification of a combination of interventions, namely the installation of geo-fabric sandbags at the most exposed section of the railway line, the rehabilitation of an existing sea wall and the rehabilitation of a degraded dune cordon. Upon completion of this process, a formal Public Participation Process was initiated with interest groups from the Glencairn community to describe the process adopted by the PMT and to present the recommended interventions for the protection of the rail infrastructure.

This process symbolised a move away from the traditional engineering and technocentric response to coastal erosion and wind-blown sand problems, typically undertaken through a cost-benefit analysis. Instead the process embraced principles of collaborative governance with legitimate representation of all relevant stakeholders.

Responding to coastal erosion: the Milnerton case study

Milnerton beach is located along the western coastline of Cape Town, and has been identified as one of the more vulnerable areas according to the CCT's Sea-Level Rise Risk Assessment (Brundrit 2009). This area, which is exposed to storm surges and beach regression (Figure 9.2), is approximately 2 km in length and is bordered by five apartment blocks, each managed by a different body corporate comprising owners of individual units, and a private golf club. Since 1900, this stretch of coastline has been experiencing progressive erosion which has been attributed, in part, to the construction and subsequent extension of the Table Bay Port (CSIR 1988) as well as to other climatic and anthropogenic effects.

Recent research has indicated that the Milnerton coastline has receded by approximately 100 m (Brundrit 2016). As a result, property owners are resorting to ad hoc and, in some cases, illegal measures in order to protect their properties against erosion and storm surge events. However, interventions such as fences are limiting public access to and use of the beach (Figure 9.3), leading to potential conflict between different actors within this space. This stretch of coastline is now beginning to resemble a 'dog's breakfast'[6] and the CCT has recognised that the recreational, amenity and intrinsic value of Milnerton beach needs to be protected, as it serves as a valuable public open space for the broader community.

Milnerton beach is an example of a case where wicked problems persist, creating what could be considered a 'wicked space', due to the socio-ecological complexities that converge within this confined area, where 'social and natural elements ... are intertwined in multiple ways and where the environment itself is

6 CCT official, CWG presentation, 13 April 2015.

Figure 9.2: Beach erosion and storm surges at Milnerton beach.
Photograph: D. Colenbrander

Figure 9.3: The installation of protective fences is restricting the width of the beach, thereby impacting on recreational users.
Photograph: D. Colenbrander

an "actor" contributing to the construction of the Milnerton Beach issue' (Scott et al. 2016: 2). The CCT has recognised that resolving the potential conflict in this space requires a departure from the typical state-centric, top-down approach in responding to these challenges. Instead of perceiving this complex problem through an engineering or legal lens, the CCT is adopting a deliberative approach that is informed by social justice considerations and principles of collaborative governance. As such, the CCT is in the process of engaging with economists, social scientists, land surveyors, coastal engineers, oceanographers, legal experts and members of the public in order to gather information to help inform the various options for addressing this wicked problem. The engagement with various landowners, business owners and representatives of civil society to share information, deliberate on possible solutions and reach an acceptable way forward through knowledge-sharing is seen as an important part of this process. Adopting a more collaborative style of governance in this context is recognised by the CCT as providing a far greater chance of achieving ethical, just and sustainable outcomes.

Towards a new governance approach: lessons and insights

The shift towards a more collaborative style of governance requires a concomitant transformation in institutions (see Davison et al. 2015) as well as in the values, principles and epistemologies of those involved in coastal adaptation and risk reduction at the local government level. In order to enable this transition towards a paradigm of collaborative governance, governance actors, in particular those representing the state, need to be willing to engage, share information and deliberate on issues and options. However, it is equally important to understand the reasons behind institutional inertia which may be preventing actors from initiating and thus operationalising collaborative governance. From a coastal governance perspective, and although there is a growing awareness of the need to explore alternative governance pathways, there still remain pervasive and deeply entrenched blockages within the CCT that need to be overcome (Colenbrander & Bavinck 2016). It remains critically important to build understanding and trust so that creative ideas and possible solutions can be explored honestly and openly. Key principles that are critical for building momentum for this 'sea change' are identified as follows:

1. A multi-disciplinary approach

A multi- and interdisciplinary approach is key to the attainment of sustainable development goals. This is especially pertinent within the dynamic coastal environment, where processes occur across jurisdictional, legal and ecological boundaries. Adopting such an approach ensures that the values, objectives and knowledge from a wide range of stakeholders are captured and that these are considered in decision-making processes. The MCDA used in the Glencairn rail remediation project is a useful tool by means of which to enable the implementation of a multi-disciplinary approach in the coastal environment.

2. Social justice

The CCT's Sea-level Rise Risk Assessment states that the most appropriate response to sea-level rise will need to take a multitude of different factors into account, namely geological, social, financial and ecological considerations (Cartwright et al. 2008). Balancing past injustices and the need for socio-economic development with ecological imperatives, and with a precautionary approach in the context of uncertainty, requires involvement of non-state actors in deliberative planning and decision-making processes. It also necessitates that ethical considerations be taken into account, as 'governance decisions of whatever sort have to be embedded in moral convictions' (Bavinck et al. 2005: 40). The need to consider social justice in the course of decision-making processes is especially pertinent in South Africa, where the inequalities that were institutionalised during apartheid persist today.

3. Deliberation

Deliberation is considered to be a key principle in the implementation of collaborative governance. This is because deliberation and collaboration form the cornerstones of governance, which is otherwise defined as a 'political but nonpartisan process of negotiating diverse interests and views to solve public problems and create public value' (Boyte 2005: 537). It is important that these deliberative processes should be reflective, non-coercive and reasoned (Glavovic 2013b).

4. Co-production of knowledge

Different actors and agencies contribute different types of knowledge. The co-production of knowledge ensures a more holistic understanding and acknowledgement of problems, which is especially pertinent for the discipline of coastal management where different actors and their interests converge at the juncture between land and sea masses.

5. Bureaucratic activism (the role of 'champions')

The CCT officials who were involved in the processes discussed above took it upon themselves to 'shift the boundaries of the weak ecological management discourse and associated knowledge management practices' (Desportes & Colenbrander 2016: 132). This enabled a transition away from a technocratic and top-down approach, thereby creating a space for deliberation, innovation and institutional opportunities (Oelofse et al. 2006). CCT officials have had to serve as activists or 'champions' of this shift, in order to defy this technocentric and state-centric approach to environmental governance.

6. *Clearly defined institutional responsibility*

The CCT's ICM Policy acknowledges that the governance of the coastal environment is a shared responsibility between the local municipality, parastatals, government agencies and civil society. At the same time, clearly defined institutional responsibility for coastal management in the CCT is necessary to enable a sense of accountability. Unless responsibilities are defined and authorities held accountable, the CCT runs the risk that, 'where everyone is responsible, no one is responsible'.[7]

7. *Duty of care*

The CCT recognises that institutions, policies and legislation can only achieve so much. In order to reduce negative impacts upon Cape Town's coastline, civil society and organisations are expected to act with due care. In order to achieve this, individuals need to be accountable and responsible for their actions within and upon the coastal environment.

Conclusion

It is argued that coastal management is an inherently political endeavour which is best approached through collaboration between a multitude of different stakeholders (Glavovic 2006), and that coastal management is in fact a 'transformative practice of deliberative coastal governance' (Glavovic 2013b: 934). Having experienced the positive results of a coastal management line founded on inclusivity, consensual decision-making in Glencairn and a multi-disciplinary approach to resolving erosion challenges in Milnerton, practitioners of ICM in the CCT are beginning to embrace the principles of collaborative governance in order to implement sustainable adaptation and risk reduction strategies within the coastal environment. However, it is important to stress that this governance approach does not make the role of government inconsequential or obsolete (Bavinck et al. 2005). If anything, it is quite the opposite: McKenna and Cooper (2006) argue that government is considered a key actor in eliciting institutional responses to enable ICM and more collaborative forms of governance.

Despite the comment by Celliers et al. (2015) regarding the lack of proactive forward planning by local municipalities in the context of ICM, this chapter has illustrated how the CCT is proactively engaging with civil society, scientists, business, property owners and a multitude of other professionals in order to realise sustainable coastal management. It has been argued here that the act of governance is being increasingly shaped by the interactions between a diversity of stakeholders,

7 Statement was made by a CCT manager, quoting a line from Friedrich Dürrenmatt's play *The Physicists* (1962).

rather than by government institutions alone. Indeed, there is evidence to indicate that the CCT is moving towards a novel form of negotiated decision-making within the coastal space, as shown in various case studies such as those concerning the delineation of the coastal management line, the Glencairn rail remediation study and the Milnerton erosion controversy. There is evidence to suggest that a shift is taking place in the CCT's silo mentality towards deliberative, multi- and interdisciplinary knowledge-building discourses and practices (Desportes & Colenbrander 2016): this is particularly evident in departments that are involved in climate change adaptation. Indeed, the case studies presented in this chapter serve to illustrate how the CCT is attempting to adopt a more collaborative approach towards coastal management in light of the effects of climate change. The institutionalisation of collaborative coastal governance will help to build more cooperative communities (Glavovic 2013b) and to ensure sustainable and ethical outcomes for coastal risk management into the future.

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CHAPTER 10

Reframing urban flood responses: gravel platforms as a means to address emergency flood relief and climate change adaptation?

Zahra Noorbuckus and Gina Ziervogel

Flood exposure is increasing in many cities (Hallegatte et al. 2013). This is due to numerous factors including high numbers of people migrating to cities, which are often situated next to water bodies, as well as infrastructure growth that includes extensive surface hardening and increased runoff (Zevenbergen et al. 2008). Flooding is exacerbated by extreme rainfall events, which are expected to increase in intensity, frequency and duration with climate change (Field et al. 2012). Cities of the South are particularly exposed to flood risk, as the urban poor tend to settle on marginal land, which has poor infrastructure to manage stormwater and sewage (Douglas et al. 2008). This often leads to poor living conditions and related impacts on quality of life, health and damage to assets (Douglas et al. 2008; Satterthwaite et al. 2007). Adapting to flood risk should therefore be a priority, given the expected increase in flood risk under climate change conditions, as well as the fact that flooding is currently the most common natural hazard (Wilby & Keenan 2012).

Climate change impacts contribute to a feedback loop that impacts on poverty reduction, human well-being and socio-economic development, and on longer-term prospects of sustainable development. Climate change can therefore be seen as a 'threat multiplier' that compounds existing social, economic, political and environmental challenges (Leck 2011). Understanding how to adapt to current climate variability is therefore central to ensuring that current human development responses are not undermined. Integrating an understanding of future climate risks into development plans and projects formulated today is critical to ensuring that they are not negatively impacted upon by future climate risks. If a housing development built today does not consider higher temperatures and how the floodplain might change, residents might be unduly exposed to flood impacts and heat stress, for example.

At the international level, there is more and more focus on the importance of integrating climate concerns into development practice, with many donors and international bodies talking about climate-compatible development (CCD) (Suckall et al. 2015). CCD is defined as 'development that minimises the harm caused by climate impacts, while maximising the many human development opportunities presented by a low emissions, more resilient future' (Mitchell & Maxwell 2010: 1). By examining how an intervention reduces climate risk as well as meeting development needs, double-wins can be considered.

On the ground, in developing countries, socio-economic development goals need to be prioritised (Schipper 2007). Often the implementers who are battling to meet development goals do not consider the possibility of also meeting climate change adaptation goals. Or they consider it, but are unsure how to add climate change adaptation to their current responses (Ziervogel et al. 2010). It is therefore not surprising that in some contexts, socio-economic development is prioritised and the actors implementing projects do not stop to consider that their projects could be framed as having both development goals and climate adaptation goals.

This chapter suggests that responses that have not been framed in terms of climate adaptation, yet help to reduce climate risks, could be reframed. Laws and Rein (2003) suggest that although there can be a dominant framing of public policy, often there can be a form of pluralism in which multiple frames can coexist. Although the climate change agenda might be unfamiliar to some actors, there is growing recognition that climate risks need to be addressed in an integrated manner. Reframing a response that reduces climate risk as one of climate change adaptation has the advantage of securing additional resources, engaging a broader range of decision-makers and adopting a longer-term socio-economic perspective.

The aim of this chapter is to examine how flood risk has been addressed in Green Park, an informal settlement located on the edge of Driftsands Nature Reserve in Blue Downs in Cape Town. The response in this case was framed as one of humanitarian relief and not of climate adaptation. However, reframing the response as one that addresses both humanitarian needs and reduces climate risk could be considered, as there may be co-benefits in doing so (Suckall et al. 2014). The chapter focuses specifically on a technical intervention that reduces flood risk, namely gravel platforms that raise the level on which informal dwellings are built.

Urban water technologies play an important role in managing flood impacts and are one way to reduce climate and flood risk. Technologies such as sustainable urban drainage, canals and flood barriers need to be complemented by policies, decision-making and collaborative processes (Pahl-Wostl et al. 2008). As Sultana (2013: 343) states, '[no] water technology is neutral; it is saturated with historical, geographical, political, and social imaginaries'. Increasingly there is the recognition that the process of implementing a technology is as important as the technology itself. Many climate change adaptation interventions are starting to see technology as one part of the solution, but not that the technology is embedded in the greater institutional and governance context (Polsky & Cash 2005; Sultana 2013). Understanding this context requires a deeper look at who the actors are, how the technology has been developed and how the implementation process has unfolded in order to evaluate the success of the technology as an intervention.

Flooding is a particular concern in Cape Town, where many of the informal settlements are located in the low-lying Cape Flats wetland areas and are prone to annual flooding events. Informal settlement residents often establish dwellings where vacant land is available. The pockets of land that are generally vacant are wetland areas. Informal structures are not able to cope with the rising flooding and water often seeps into houses and damages property and assets. Annually people are removed from their houses and placed in temporary relocation areas. Although flood risk is increasing in urban areas because of surface hardening, the nature of this risk is also changing, linked to more intense rainfall events in which water takes longer to drain away.

Since 2003, the City of Cape Town Municipality (CCT, also referred to as the City) has been upgrading informal settlements by providing access roads and improved services in line with the National Housing Code (National Department of Human Settlements 2009). One of the first upgrades took place in Joe Slovo informal settlement, Cape Town, in 2003 and then subsequent upgrades were undertaken in Kosovo and Sweet Home Farm informal settlements in 2006 and 2007. In many instances, upgrading of services is not possible when current structures are built on private land. The CCT has many directorates and departments that are involved in managing flood risk (see Ziervogel et al. 2016). One of the responses to flooding in informal settlements in the CCT has been to use gravel platforms to raise the height of the ground on which informal dwellings are built. The use of local-scale experimentation has been encouraged by Zevenbergen et al. (2008), who suggest that interaction across scales is necessary to understand how local interventions might strengthen urban flood resilience. Gravel platforms have been implemented by the CCT through the Emergency Flood Relief Programme, which aims to intervene in situations that require urgent attention. The Informal Markets Department in the CCT's Human Settlements Directorate has implemented gravel platforms in 10 informal settlements since the department was initiated in 2004. This chapter is written from the perspective of this department. In particular one of the co-authors, who is a project manager in Informal Markets: Engineering Services (a subdivision of the Human Settlements Directorate's Informal Settlements Department), has been centrally involved in implementing gravel platforms in Green Park and the adjacent Los Angeles informal settlement.

The implementation of this project in Green Park was framed through the lens of humanitarian relief. This chapter asks whether the humanitarian relief focus could have been reframed to include a climate change adaptation frame that might deliver co-benefits. The chapter starts by describing the general context of emergency relief implementation in the CCT, before considering the implementation of the platform technology within the project planning cycle as it occurred in Green Park. In the concluding section, the chapter reflects on the potential co-benefits of addressing socio-economic development and climate change adaptation goals.

'Business as usual': challenges to informal settlement upgrading

Rapid in-migration is contributing to the expansion of informal settlements in Cape Town, which is putting more communities at risk and creating serious challenges for the CCT. These challenges include the provision of suitable brick-and-mortar housing within short periods of time and, coupled with this, provision of adequate infrastructure such as water and sanitation. The rapid in-migration thus presents a problem when a uniform governance policy has to be followed, as existing policy does not address the urgent need to provide housing in an emergency situation. In response to these pressures, the CCT's Human Settlements Directorate is in the process of reworking and developing innovative solutions for informal settlement upgrading. Since this process is still under way, pilot projects have been rolled out in order to develop an engineering model which will be viable in the future. The range of programmes involving long-term innovative solutions that the Informal Markets: Engineering Services Department is undertaking are listed in Table 10.1.

The Project Manager of the Informal Markets: Engineering Services Department has the duty of overseeing various processes that feed into these programmes such as planning, project coordination, internal and external stakeholder engagement, public engagement (project facilitation), project-related funding applications and technical designs. Her responsibilities include coordination and initiation of supply chain management processes, construction supervision management and the management of internal project teams within the Human Settlements Directorate, as well as liaising and coordinating with various line departments within the CCT.[1] These processes are often time-consuming and complex due to the extensive public engagement required. Because of the social problems encountered in informal settlements, some settlements are more volatile than others and facilitation or mediation is often required before City officials can access the settlement.

1 Senior professional officer job description, CCT Human Settlements Directorate, Informal Markets, Engineering Services, 2012.

Table 10.1: Programmes being implemented by the CCT Department of Informal Markets: Engineering Services (Informal Settlements)

Programme	Description
Upgrading of Informal Settlements Programme	Provision of formal services such as stormwater, water, sanitation, electricity and blacktop access roads.
Re-blocking Programme	Restructuring of informal settlement structures in a more organised manner, similar to a subdivision layout, and including access tracks and basic services.
Backyarder Programme	Basic service provision to housing backyarders, including toilets and washbasins, rolled out only at rental units on City-owned land.
Incremental Development Area Programme	Sites are provided with basic or formal services and incrementally developed over years. Blacktop or gravel access roads are also provided, along with either serviced sites or sites with emergency housing top structures.
Emergency Flood Relief Programme	A combination of interventions to mitigate flooding in existing settlements, including basic services and gravel platforms.

Source: City of Cape Town. Integrated Human Settlements Five-Year Strategic Plan July 2012–June 2017 2013/14 Review

This chapter focuses on how flood risk in these settlements has been reduced through the Emergency Flood Relief Programme. An Emergency Flood Relief project can be classed as a small to medium-size project. However, it should be noted that regardless of project size, these projects must be taken through the necessary regulatory, statutory and inter-departmental consultation processes. Small projects usually require the same amount of effort as the larger projects, because both types have to follow the same project life cycle which includes planning, design, procurement and construction. Whether the construction work planned in an informal settlement is of a minor nature, such as emergency flood relief, or a complex construction project, the same legislative application process must be followed by all government officials.

These types of projects are intended to be temporary; they address urgent needs. The Emergency Flood Relief project methodology was developed by building on standard engineering practices used to address stormwater drainage issues in formal urban areas.

The Incremental Development Area (IDA) projects are similar in nature, but provide formal serviced sites and therefore require land use applications to obtain an approved subdivision layout. The Emergency Flood Relief projects are implemented on a more ad hoc basis when extreme flooding occurs that can be considered an emergency. Sites that are identified for IDA projects are usually sites that would qualify for Grade 'A'-level services/formal serviced infrastructure upgrades as set out in the National Norms and Standards.[2] Emergency Flood Relief projects do not receive a full service upgrade but rather basic service improvement (water and sanitation). Some informal settlements might be prioritised over others depending on the level of existing services, the extent of flood risk and those earmarked for New Housing Project implementation (CCT 2013a).

Although flooding is a concern for the Human Settlements Directorate, no formal policy exists for Emergency Flood Relief projects. Given this, the CCT's Proactive Re-blocking Policy (CCT 2013b) is used as a foundation for implementing Emergency Flood Relief projects. If a settlement is flagged as requiring emergency flood relief, the procedure described below is followed.

Overview of an Emergency Flood Relief project cycle

Given that the gravel platforms used for flood relief fall under the Emergency Flood Relief Programme, this section gives an overview of what a general project cycle in this programme might entail. Table 10.2 presents the phases involved in implementing Emergency Flood Relief projects, with the various actors on the left and the steps taken in each phase on the right. Some of the phases shown in Table 10.2 are discussed in more detail below.

Table 10.2: Emergency Flood Relief project implementation process

Phase	Department responsible	Response
Phase 1A	Informal Settlements Management (ISM) and Informal Markets: Engineering Services	Residents approach City of Cape Town due to flooding experienced in settlement
	Disaster Risk Management	Incident report drafted
	Informal Settlement Management	Verification of persons affected by flooding
	City of Cape Town and NGOs	Provide aid eg. feeding schemes, blankets etc.
	Transport for Cape Town and Informal Markets: Engineering Services	Make sure there is sufficient access on site. Stormwater management issues addressed

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2 Letter dated 19 March 2013 from the National Department of Human Settlements to the Provincial Head of Department, Human Settlements.

Phase	Department responsible	Response
	Disaster Risk Management	Incident report kept on record at Disaster Risk Management Centre
Phase 1B	Disaster Risk Management and all related CCT Departments	Meeting held before winter to discuss winter readiness programme
	Informal Settlement Management & Disaster Risk Management	Monitoring of informal settlements and flood occurrences
		If flood prone, matter is escalated to ISM: Engineering Services
Phase 2	Informal Markets: Town Planning and Informal Markets: Engineering Services	Site visit and meeting arranged with community
	Informal Markets: Town Planning and Informal Markets: Engineering Services	Flood-affected area identified
	Informal Settlements Management & Informal Markets: Engineering Services	Flood-affected verified/enumeration
	Informal Markets: Facilitation and Informal Markets: Engineering Services	Public participation to get approval for project scope of works. Engineering plan drafted
	Informal Markets: Engineering Services	Obtain/make necessary statutory and regulatory application. Preliminary cost estimate for Scope of Work
	Informal Markets: Engineering Services	Urban Settlements Development Grant funding application submitted to CCT, National Housing Programme Office for approval
	Relevant Directorates and Human Settlements, Expenditure Department sign off	CCT Line Directorates submit comments about the application. USDG final approval.
Phase 3	Informal Markets: Engineering Services	Appointment of service provider to do topographical survey
	Informal Markets: Engineering Services	Detail design commences

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Phase	Department responsible	Response
	Informal Markets: Engineering Services & Facilitation	Public participation with community
	Informal Markets: Engineering Services	Final stormwater methodology submitted to Water Affairs for approval
	Informal Markets: Engineering Services	CCT, Water and Sanitation Department consulted regarding toilet facilities
	Informal Markets: Engineering Services, Informal Settlement Management, Facilitation, Community Organisation Resource Centre (CORC) & ISN	Layout planning of gravel platforms. Workshopping with community
	Informal Markets: Engineering Services & Informal Settlement Management	Temporary relocation area identified
Phase 4	Informal Markets: Engineering Services	Approval granted by CCT, Supply Chain Management to use an existing TCT Term Tender
	Informal Markets: Engineering Services	Preparation of Works Project, construction cost estimate and construction ranking distributed to tenderers
	Informal Markets: Engineering Services	Site clarification meeting with contractors
	Housing Finance & Informal Markets Engineering Services	Project budget loaded
	Informal Markets: Engineering Services	Public participation
Phase 5	Contractor	Preparation of Temporary Relocation Area (TRA)
	Informal Markets: Engineering Services	Construction phasing discussed with community
	Informal Settlements Management	Transportation arranged for demolishing of structures
	Informal Settlements Management	Relocations commence
	Contractor	Platform construction

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Phase	Department responsible	Response
	Informal Markets: Engineering Services Facilitation, Contractor	Contractor employs local labour obtained through Subcouncil 21
	Informal Markets: Engineering Services, Informal Settlement Management, Facilitation, CCT: Water and Sanitation Project Manager	Water and Sanitation discuss sanitation requirements with community

Source: The authors

There are two ways in which Emergency Flood Relief projects are identified. The first is through an anticipatory approach whereby a forum comprising various CCT line directorates meets annually to discuss the possible interventions that can be implemented during the winter months to assist flood-affected informal settlement residents. This forum is coordinated by the Disaster Risk Management Centre (DRM). In these meetings potential disaster sites are flagged. The Informal Settlements Management Department forms part of this meeting. The second way of identifying communities in need of emergency flood relief is reactively. When a disaster occurs, a representative from the community reports it to the DRM, which then refers it to the various CCT line directorates, for example Transport for Cape Town (TCT), Water and Sanitation and Electricity, for further feedback and action. Non-governmental organisations (NGOs) assist with feeding schemes, blankets and other basic necessities. Depending on the severity of the flood damage, the Informal Settlements Management Department provides extra materials for damaged structures so that families can repair their homes. The settlement is then monitored for future flood incidents and a decision is made as to whether an Emergency Flood Relief project needs to be implemented there.

To initiate the Emergency Flood Relief project, the Informal Markets Department: Engineering Services submits a funding application to the CCT's National Housing Programmes office. Grant funding is then made available by the National Treasury in terms of the Division of Revenue Act (No.1 of 2015). Various line departments are then consulted across the CCT for comment and approval regarding use of the funds. If all legislative authorisations are in order or pending, funds will be allocated subject to their approval. The approval to use grant funding is officially authorised when the Human Settlements Directorate's executive director signs off the necessary administrative documents, and if the budgeted funds are available.

In alignment with the CCT's Proactive Re-blocking Policy (CCT 2013b), projects in informal settlements must have a Project Steering Committee (PSC), which is elected by the community. This PSC then acts as a liaison between the community and the developer. The PSC is the vehicle for participatory planning, which includes ensuring that the implications of the development process for the community are explored. The establishment of a PSC allows residents from the informal settlement to play an active role in the project and to assist in conflict resolution. Having such policies in place contributes to the building of crucial relationships between the CCT and vulnerable communities, which allows relationships to be established at 'grassroots' level. These relationships are often challenging, with or without the institutional support for them.

Gravel platforms in Green Park: emergency relief to reduce flood risk

The context of the project site

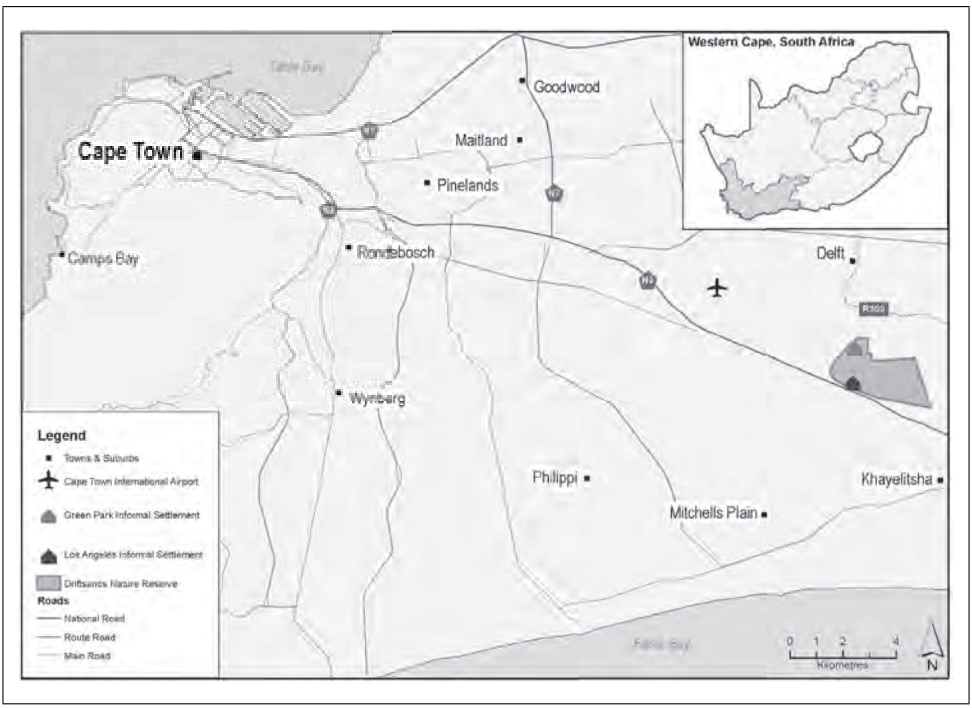

Figure 10.1: Location of Green Park and Los Angeles in the Driftsands Nature Reserve
Source: Prepared by Eduaction for the authors

A survey conducted in 2014 by the CCT's Informal Settlement Management Department revealed that 275 structures were located in Green Park informal settlement (Figure 10.1). Due to its low density and situation in a nature reserve (Figure 10.2), the settlement still retains its rural character. One of the main livelihood strategies in the community is subsistence gardening, and some

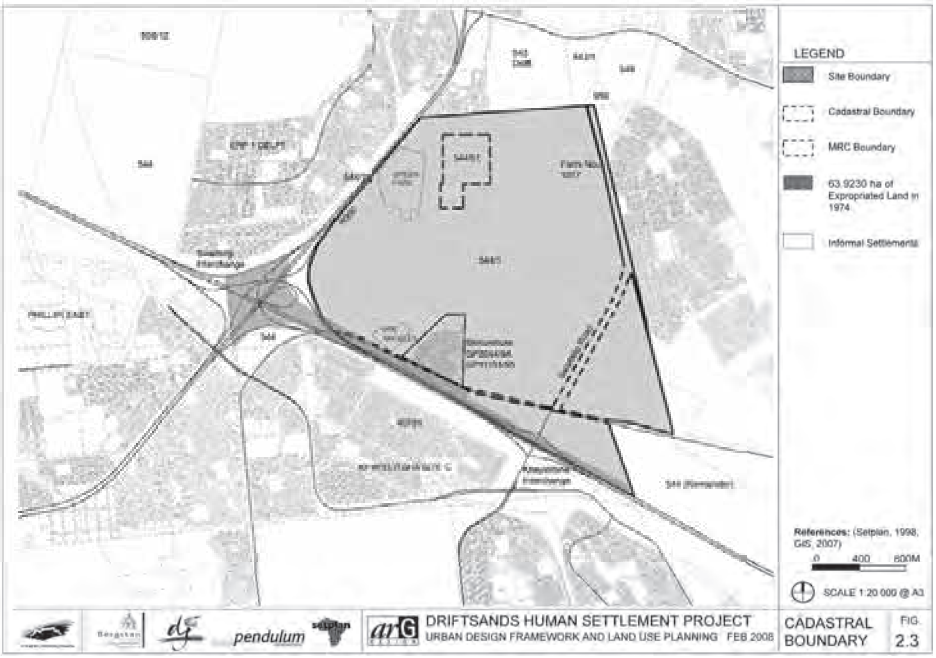

Figure 10.2: Map showing location of Driftsands Nature Reserve and Green Park informal settlement
Source: ARG 2008: n.p.

residents undertake formal and informal work outside the settlement. According to the DRM, part of Green Park faces constant flooding annually, as water rises in the surrounding wetlands. Figure 10.3 shows the hydrology of the Driftsands Nature Reserve, indicating the location of low-lying wet areas in Green Park.

The NGO Gender for Climate Change (GenderCC) conducted a socio-economic survey in Green Park in October 2014.[3] Results suggested that 50 per cent of the community had an education level below Grade 12 (the final year of secondary school). There was an average of five permanent residents per household, and more than 80 per cent of households obtained income from social grants. This settlement has a high level of unemployment, a high crime rate and exhibits extreme poverty. The site has no electricity and currently only has basic services of water standpipes and temporary toilets.

Low-cost formal housing opportunities are planned in future for Green Park informal settlement, but due to the pending land deproclamation process (see

3 The study, 'Green Park informal settlement baseline study, October 2014' was not published. See http://gendercc.net/our-work/past-activities/raising-awareness-building-capacity-and-influencing-policy-south-africa.html , accessed 10 January 2019.

Figure 10.3: Driftsands Development Framework map showing water bodies, wetlands and flood-prone areas
Source: ARG 2008: n.p.

next section), the implementation date of the new housing project is uncertain. The Human Settlements Directorate: Informal Markets Department identified the need to assist Green Park families in the short term by providing temporary flood relief. Currently, this settlement cannot be considered for a full service upgrade, as this would be seen as wasteful in terms of government expenditure, because of the future planned formal upgrade. An Emergency Flood Relief project was therefore initiated.

Implementation of gravel platforms in Green Park

This section describes the steps taken to initiate and implement the gravel platforms in Green Park, as outlined in Table 10.2.

Phases 1a and 1b: identification or reporting of flood risk

In 2014, the Informal Markets Department managers were alerted to the problem of flooding in Green Park, in line with the reactive approach documented in Phase 1a (see Table 10.2). Email correspondence from a regional coordinator in the

Informal Settlements Management Department illustrates the nature of the Green Park flooding problem:

> *Right through the course of 2013, permission documents of renovations (replacing material and roofs which were in a bad state to minimise the effect of winter which usually causes 'flooding'), were issued to residents requesting it, after verification per site visit was done. This was besides the approximate 200 flood kits that were issued (during the month of June 2013) to flood-affected residents.*
>
> *With the rainfall in August/September 2013, even residents that were previously internally relocated, as a means of moving from lower to higher grounds to avoid 'flooding', were again affected. Internal relocations to alternative dry land within the area, remained the only alternative and those residents willing to move, were assisted with relocation kits in order to do so. The Regional Co-ordinator noted that 'we internally relocated a total of 36 informal residential structures then. We may face the same scenario for possibly another winter season or more'.*[4]

The matter was then escalated to Informal Markets: Engineering Services for further investigation, assessment and implementation of a response to the problem.

Phase 2: Planning

Site investigation: The Informal Markets Department management arranged a site meeting in August 2014 with the Green Park community leadership who highlighted their concerns about flooding issues, as well as about the lack of toilet facilities and public lighting within their settlement. A visual assessment of the site was completed during the meeting and flood-affected areas were identified.

Site topography: The existing site topography normally dictates where stormwater will flow. However, when planning for a low-income community such as an informal settlement, it is not possible to construct formal stormwater infrastructure due to maintenance issues. In the case of Green Park, the land was still owned by the provincial government as part of the Driftsands Nature Reserve. Although a deproclamation process was under way, formal services could not be constructed.[5]

In other settlements experiencing flooding, small gravel platforms had been constructed to raise the foundation of single dwellings. In Green Park the site

4 Email from regional coordinator, Informal Settlements Management Department, 17 March 2014.

5 Deproclamation is the legal process whereby the rights to the nature reserve land are taken away from the province, which was the custodian, and transferred to the CCT, in order for the housing project to go ahead.

topography was uneven and the site was surrounded by wetlands, so a new solution was needed. It was decided that a different approach involving larger platforms would be more suitable in order to: 1) accommodate more flood-affected families in a more structured manner; and 2) make it easier to control stormwater runoff.

Beneficiary verification: Based on the flood-affected areas that had been identified, household beneficiary counts were conducted to identify the number of families affected. Individual structure numbers were recorded and beneficiary details were captured for 79 families who were eligible to rebuild their structures on the planned gravel platforms.

Project scope defined: The project scope for Green Park emergency flood relief entailed the construction of raised gravel platforms, which would enable informal settlement residents to relocate and rebuild their informal settlement structures away from flood-prone, low-lying areas. On the platforms, stormwater would be diverted via earth drains and gravel access roads would be raised and shaped to prevent flooding. Plans were made to repair existing toilets and water standpipes, and it was agreed that electricity would be supplied in the interim before the new housing project was implemented.

Budget application: To initiate this project, the Informal Markets Department: Engineering Services submitted a funding application on 10 September 2014 to the CCT National Housing Programmes office. The approval to use grant funding of R3,44 million (VAT excl.) was officially authorised on 5 November 2014.

Project Steering Committee establishment: Although informal settlements usually have their own community organisations, it was necessary to set up a PSC. Through extensive consultation with the community leadership, the CCT project facilitators conducted an election process whereby the community selected representatives from their community to act as members of the PSC. A City agreement, called the Terms of Reference for PSCs, was then signed by the nominated members (CCT 2014). This agreement supports the communications and engagement framework for project actors. Thereafter the PSC was presented with the design proposal and project scope of works for the settlement. Meetings were held with the PSC on an ad hoc basis for the duration of the project.

Statutory and regulatory requirements: Given that Green Park falls within Driftsands Nature Reserve, it is currently managed by CapeNature on behalf of the Western Cape Government. As a result, the necessary provincial statutory and legislative requirements must be met. A formal submission was made to the provincial Department of Environmental Affairs and Department of Water and Sanitation for project approval. A checklist application was submitted to the Department of Environmental Affairs for the intended project scope of works and a record of decision received. No further environmental authorisations were required.

A meeting was held with the Department of Water and Sanitation on 19 September 2014. Related correspondence with comments was received on

29 October 2014, requesting that a Water Use licence application be submitted in accordance with the National Water Act (No. 36 of 1998). Subsequent to this, the Department of Water and Sanitation also requested a Stormwater Management Plan, which the CCT submitted. The CCT received comments and responded in a formal letter dated 31 October 2015, accepting construction liability and confirming that construction activities would be monitored to prevent disturbance to the existing biosphere.

Phase 3: Engineering design

Topographical survey: A land surveyor was appointed as part of the construction contract, to do a topographical survey of the Green Park site. This was done to expedite the construction contract which had already experienced delays due to outstanding statutory and legislative approvals, as well as prolonged supply chain management processes. The rationale behind this was to have the topographical survey completed before the start of the 2014 builders' holidays in December, so that construction could commence early in 2015.

Detailed design: The detailed design was completed internally in mid-December 2014, using the Civil Designer engineering design software. A geotechnical investigation was also conducted to determine the depth of the water table. The water table was observed to be 800–1 000 mm below natural ground level. The level of the water table was considered accurate by the TCT materials technician, and considered reliable because this test was performed after the winter season.

Because of the temporary nature of the project, it was decided to create the platforms from gravel material. However, gravel erodes over time due to recurring stormwater runoff, and therefore it is essential to undertake routine maintenance to rectify any pavement deformation that might occur. The designer would have preferred to use a more durable material, but this would have been more costly, and hard to dig into when erecting informal dwellings.

Effective stormwater drainage is essential for good pavement performance. Formal stormwater concrete channels and earth channels were therefore constructed to prevent stormwater ponding in roadways and on platforms. The platforms were designed to facilitate overland stormwater drainage, thus being self-draining.

Phase 4: Procurement strategy

Approval was sought from the CCT TCT Directorate and Supply Chain Management Directorate to utilise an existing Roads Term Tender. The construction project specifications were compiled, and then added to the Works Project as part of the original tender document. The tender closed on 21 November 2014, with Roadsmart Construction (Pty) Ltd being awarded the tender.

Subsequently the Informal Markets Department: Engineering Services compiled a financial report which was submitted to the Human Settlements:

Housing Finance Office to establish if budget was available for the intended works. The report was accepted, budget was loaded, a requisition was obtained, and to complete the process a purchase order was sent to Roadsmart Construction Pty (Ltd) to commence construction works.

Phase 5: Construction and relocation

Temporary relocation area: In order for construction to begin, a temporary relocation area (TRA) was needed to accommodate the affected residents. In Green Park, the community selected a TRA location (Platform 6 in Figure 10.4), and discussed and agreed upon the timing of relocations and phasing of construction. When construction started, in order to avoid a double move, some community members decided to live with other family members rather than move to the TRA.[6]

Local labour: During construction the contractor appointed local labour from Green Park informal settlement, in response to the community's insistence that economic opportunities be granted to those residing in Green Park. A random selection process of registered persons from the informal settlement was undertaken by CCT Subcouncil 21. Eleven people were then selected for temporary job opportunities; the selection process and the subsequent work done were overseen by an appointed community liaison officer.

Layout of platforms: In August 2011 a partnership agreement was established between the Shack/Slum Dwellers International (SDI) Alliance and the CCT. The Informal Settlement Network (ISN) and Community Organisation Resource Centre (CORC) are NGOs which form part of the SDI Alliance. CORC, in conjunction with the Informal Markets Department, assisted with the development of community-based layouts for the various completed construction platforms, which were then workshopped with the community. These layouts addressed access, firebreaks and plot sizes on the gravel platforms; they were similar to the re-blocking layouts undertaken in other settlements in terms of CCT reblocking policy. The locations of the platforms and previously flooded areas are shown in Figure 10.4.

Prior to relocation, residents relayed their concerns to Informal Settlement Department management about the sizes of plots on the gravel platforms.[7] Free-standing plots have varied sizes, but on the platforms standard plot sizes were planned, restricting the residents' freedom to choose plot sizes.

Relocation to completed platforms: A meeting was arranged with CCT officials, the Green Park PSC and community members on 6 February 2015 to decide which beneficiaries would be relocated to the first completed platform. The meeting also

6 Minutes of PSC meeting, Green Park informal settlement, Community Hall, 6 February 2015.

7 Personal communication, Regional Coordinator, Informal Settlements Department, 2015.

Figure 10.4: CCT Green Park Emergency Flood Relief project: construction layout
Source: The authors

provided feedback to the greater Green Park community about the progress of the project. In this meeting the community advised that vulnerable persons such as the elderly and the disabled should be relocated first. Individual plots were pegged by the CCT before families were relocated to their new designated plots and provided with material assistance to rebuild their structures, including steel sheeting, wooden poles and nails. Letters of relocation were issued in January 2015 and the first relocations were conducted over the weekend of 7 February 2015 (Figures 10.5, 10.6 and 10.7).

Due to the structural liability issues that might arise between community members and the CCT surrounding the breaking down of structures, a contractor, employed by the CCT, was called in to assist the community members with the breaking down and transportation of their existing structures. The onus lay with each beneficiary to rebuild their structure after plot allocation.

Informal Settlement Department management and the DRM conducted a site visit in May 2015 and discovered that certain residents had not constructed their

Figure 10.5: Occupation of Green Park Platforms
Source: The authors

dwellings as expected, which resulted in minor flooding of dwellings. As a solution, residents were asked to construct a floor for their structures.

A close-out meeting was held on 6 June 2015 with the Green Park PSC to end the project. In this meeting, the CCT supplied material to lift the ground level inside the structures to alleviate the minor flooding problem. The PSC confirmed that residents would lift the floor levels themselves. Going forward, Informal Settlement Department management will conduct regular routine inspections to make sure the platforms are still in good condition to fulfil their objectives.

Implementing emergency relief of flood risk: challenges and opportunities

The challenges of stakeholder engagement and delivering on expectations

The requirement for communities to take control of their own decisions is enshrined in the South African Constitution (Act No. 108 of 1996). Subsequent legislation and policies developed by government therefore identify communities as central to successful development. However, in practice it can be challenging for government officials to engage with local communities (Ziervogel et al. 2016).

There is no 'best' strategy for undertaking development work; rather, a mix of strategies is needed (Gwala & Theron 2012). No two informal settlements are

Figure 10.6: Occupation of Green Park Platforms
Source: The authors

the same; every settlement requires its own unique participation strategy. Different types of public participation activities were therefore drawn on during the Emergency Flood Relief project life cycle in Green Park, including the following:

1. Public meetings were held with the community, CCT officials, the PSC and the ward councillor.
2. Face-to-face discussions were held with the PSC and members of the community.

Figure 10.7: Occupation of Green Park Platforms
Source: The authors

3. Community facilitation and information-sharing sessions were held. They were coordinated by a project facilitator from the Human Settlements Directorate, who helped to run the process to elect the PSC and then helped to facilitate future community and project meetings (described in more detail below).
4. Household beneficiary surveys were conducted by the Informal Settlement Department management team to identify the flood-affected structures and the number of household members.
5. Platform layout designs were provided by CORC and the ISN in consultation with the PSC.
6. A consumer education session was conducted with the residents of Green Park on 18 June 2015 to provide information regarding personal hygiene, hand-washing and diarrhoea, electricity safety, and fire and flood awareness. The directorates involved included City Health, City Electricity and City DRM.

For the Green Park project, the project manager consulted other project managers for guidance on tried and tested public participation methods within vulnerable communities. The CCT currently has one public participation policy that is not specific to informal settlement communities but provides more general guidelines (CCT 2013c). Overcoming language barriers was a challenge. The project facilitator often had to translate as well as facilitate, despite having been appointed only to facilitate community participation and engagement. The CCT currently has a limited number of staff employed to conduct facilitation processes across more than 200 settlements. The project manager found that it was difficult to communicate with residents, and thus also required assistance with translation. It was not always possible for facilitators to accompany the project manager to community meetings. Residents would therefore get upset because their queries could not be heard and addressed.

Another challenge, as stated earlier in this chapter, concerned questions about the temporary nature and technical suitability of the earthworks platforms. This was the first time that large platforms had been constructed. Given that some beneficiaries still experienced localised flooding on the platform where they had rebuilt their structures, the nature of such large platforms could be further interrogated. Although more households can be accommodated on large platforms, the drainage and ability to erect structures on them is not ideal. Those households that did experience local flooding were advised to contact the DRM for assistance, and affected residents were given extra milling material to elevate their structures above platform level. Given the intended temporary nature of the platforms it is unclear how well they will weather future usage and storms.

Green Park beneficiaries had been requesting long-term housing from the CCT for many years but timelines for provision of houses were unclear. Because formal housing falls outside of the remit of the project manager, she escalated the matter to the Human Settlements: New Market Development Department which is the custodian of housing projects. The gravel platforms are a temporary measure to ensure that informal structures are out of the flood plain. One of the reasons that residents wanted to move onto the platforms was the promise of future electricity (Kühne 2015). This was highlighted in a meeting held with Eskom and the Green Park PSC on 30 March 2015. Green Park is currently on Eskom's list of sites to be electrified. However, electricity is supplied to Driftsands by Eskom (Pty) Ltd, and the national Department of Energy is funding the electrification of the site.

The Green Park Emergency Flood Relief project was implemented timeously because residents worked well with the CCT. There was willingness on the part of community members to see the project through from beginning to end, which is not always the case. In other settlements it has often been more difficult to conduct robust facilitation processes due to contested goals and challenges involving community leaders.

If the Emergency Flood Relief Programme is maintained, it would be helpful for a policy to be formulated as a guideline for future project managers. The public participation process was difficult because of a lack of public participation guidelines available within the CCT. The existing CCT Public Participation Policy (CCT 2013c) could be developed further, in order to guide the interaction between officials and communities so that communities could positively influence, direct, control and own the projects. The types of resources that would support this include increased human and financial resources as well as a database of flooding frequency in informal settlements.

Engaging community leadership and keeping community members informed of the various stages of the project were central to enabling its implementation. Involving the community from the outset of the project allowed members to provide valuable input into the finalising of a re-blocking layout for the individual platforms. The presence of a community leader who was proactive in approaching local government officials and working with them also helped to support the process.

An opportunity to reframe gravel platforms as climate change adaptation

Climate change adaptation is an emerging field, with more policy and rhetoric than action (Carmin et al. 2012). Many cities have been at the coal face of reducing climate risk, yet have not framed their responses as climate change adaptation. The case of Green Park is no exception. Gravel platforms were developed as an experimental response to reducing the flood risk to informal houses that were located in a flood plain. Due to the temporary nature of the settlement, which was not in line for formal upgrading at the time, gravel platforms were seen as an emergency response to reduce immediate flood risk. Yet this type of response could help to reduce flood risk in other informal settlements at a relatively low cost and within a rapid time frame. But because of its short-term nature, it would need to be seen as one step towards reducing flood risk in the long term.

The growing attention given to climate change adaptation has been met with growing international funding. Cities in the global South are battling to fund all the infrastructure that is needed to keep up with their growing urban populations. Exploring co-benefits of being able to access funding and expertise related to climate change adaptation as well as meeting socio-economic development needs is worth considering. This will require the reframing of humanitarian issues, which could be driven by high-level city actors. The CCT was recently named as one of the Rockefeller Foundation's global 100 Resilient Cities.[8] Addressing flood risk and humanitarian needs both contribute to building a resilient city, and so this type of

8 See http://www.100resilientcities.org/, accessed 19 January 2019.

innovation might be attractive if portrayed as such to senior government officials and politicians.

Important concerns to address before pushing a reframing of humanitarian relief as climate change adaptation include challenges relating to participation and resources. The process in Green Park suggests that gaining community participation and meeting community expectations is a challenging process, even in a case where there is a community leader who is very willing to cooperate with the City. There is the possibility that a climate change adaptation framing could bring more resources that could help to support a more integrated participatory approach. In addition, integrating climate change adaptation requires a longer-term perspective. So although the platforms are a temporary measure, understanding the climate change scenarios relating to future rainfall intensity could help in the planning of both the temporary gravel platforms and the positioning of future formal housing as a more robust long-term climate adaptation response.

The way forward

The Emergency Flood Relief Programme has shown significant potential for reducing the impacts of environmental hazards, and flood risk in particular. In the case of Green Park informal settlement, residents were moved from a wetland that flooded frequently to gravel platforms that reduced the risk of rising floodwaters impacting on households in the future. However, initial problems with local flooding were experienced on the platform because of the way the houses were built. Flooding is an insidious event that has been causing severe disruptions to livelihoods across Cape Town's informal settlements. Given that flooding events are expected to become more intense and frequent with climate change, reducing flood risk by moving people to higher ground is a way of adapting to this.

The implementation of gravel platforms in Green Park was framed as a humanitarian response. Although the Emergency Flood Relief Programme was focused on reducing the impact of what was seen as an emergency event in an area that was not due for formal upgrade immediately, it was also focused on reducing the risk of a hazard. This aligns with climate change adaptation goals that aim to reduce the risk of climate hazards, particularly for more vulnerable groups. We have suggested that reframing flood responses as both humanitarian and climate change adaptation responses could have co-benefits that could help households and communities to reduce their flood risk, thereby addressing both socio-economic and climate change adaptation goals. This case suggests that this type of response could be developed further into a viable long-term approach to flood relief in informal settlements. Given that cities worldwide are moving towards strengthening resilience and climate change adaptation measures, it is useful to have pilot projects that have been tested on the ground.

Participation emerged as central to all the steps involved in implementing the platforms in this project. The project manager is an engineer by training, yet she was facilitating the participation process. The CCT is adopting a 'transversal management' approach that recognises the importance of integrating line directorates to support socio-economic programmes (CCT 2016). If the goal is to ensure meaningful participation and collaborative governance, as well as humanitarian relief and climate change adaptation, it is critical that people with different expertise are brought together (Burris et al. 2005). This is challenging in the development context, where there are myriad development pressures and urgency in moving forward to provide services (Ziervogel et al. 2010).

Urban areas worldwide are struggling with flood risk (Douglas et al. 2008; Hallegatte et al. 2013; Kirshen et al. 2008; Lane et al. 2011). In Cape Town, informal settlements are often sited on land that is termed 'wetlands'. In many other cities and towns, informal settlements are also located on marginal lands that are highly exposed to flood risk (Douglas et al. 2008). This suggests that flood risk reduction needs to be addressed more systematically, particularly in informal urban areas. Many cities in the global South have accepted that informality is here to stay, so finding ways to integrate short-term risk reduction with long-term planning for informal urban settlements in the context of climate change and increasing numbers of urban dwellers is a priority. It is therefore important to draw on lessons and reflections from the innovative process of implementing gravel platforms in Cape Town, so that other cities might consider some of the challenges and opportunities presented by this case.

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CHAPTER 11

Managing stormwater and flood risk in a changing climate: charting urban adaptation pathways in Cape Town

Anna Taylor

As cities grow and climatic conditions change, so the need to make urban development more sustainable and resilient becomes a pressing one (Bahadur & Tanner 2014; Leichenko 2011; Satterthwaite & Dodman 2013). One of the critical ways in which urban and climate conditions intersect is through flows of water that lead to flooding, erosion and pollution if not adequately dealt with. Ideally, a well-designed and managed city is capable of absorbing, capturing, filtering, utilising and draining water to increase the safety, health and well-being of its residents and urban ecosystems (Donofrio et al. 2009; Morison & Brown 2011). This aspect of sustainable urban development is becoming increasingly critical as patterns of rainfall, temperature, sea levels and storm surges change in many parts of the world, including Cape Town (Brundrit & Cartwright 2012; Döll et al. 2015; Hallegatte et al. 2013). The aims of this chapter are, firstly, to describe how climate risks are being factored into the ways in which stormwater and flooding are managed in Cape Town; and secondly, to identify key challenges associated with departing from a 'business as usual' approach to managing stormwater, based only on past climate information, in order to adapt in light of possible future conditions.

The analysis presented in this chapter uses the concept of an adaptation pathway to understand how decisions and actions aimed at reducing the risks and impacts of climate change emerge over time. The findings stem from an organisational ethnography (Ybema et al. 2009) undertaken within the Stormwater and Sustainability Branch of the City of Cape Town Municipality (CCT, also referred to as the City), Cape Town's local government, between November 2014 and May 2015, facilitated through the Mistra Urban Futures Programme.[1] Relevant qualitative data were collected through participant observation, open-ended interviews with City officials and reviews of a range of documentary sources. A combination of process analysis (Langley 1999) and applied thematic analysis (Guest et al. 2012) was undertaken, within the adaptation pathways conceptual framework, to produce a chronology of decisions and actions relating to climate change and stormwater management in Cape Town and identify patterns or themes that characterise the adaptation process more broadly. Doing so highlights a number of challenges faced in undertaking climate adaptation.

Adaptation pathways

An adaptation pathway can be defined as the sequencing of decisions, over decadal timescales, to select and implement climate adaptation measures, accounting for irresolvable uncertainty, unacceptable levels of risk and excessive or wasteful expenditure (Haasnoot et al. 2013; Reeder & Ranger 2011). The concept has mostly been used in a forward-looking sense to sequence future adaptation actions that may be deemed technically robust and socially acceptable under various scenarios, notably in the UK's Thames Estuary (Reeder & Ranger 2011), the Rhine Delta in the Netherlands (Haasnoot et al. 2013), New York City (Rosenzweig & Solecki 2014), and Lakes Entrance (Barnett et al. 2014) and the Murray-Darling Basin in Australia (Abel et al. 2016).

Wise et al. (2014) and Gorddard et al. (2016) critique the early work on adaptation pathways as not adequately accounting for the social and institutional aspects of decision-making. They draw attention to the decision context within which the adaptation agenda is situated, promoting careful consideration of the complexities and uncertainties pertaining to:

1) knowledge of the system in question that is being developed, managed and adapted;
2) the goals and underlying values of any policy or actions; and
3) the distribution of power, encoded in rules, that shapes decision-making and implementation.

Wise et al. (2014) suggest it is useful to distinguish between two levels of adaptation: 1) *incremental actions* within the prevailing governance regime that address proximate causes of vulnerability or developmental needs; and 2) *transformative adaptation* that entails changing the rules and values that frame decisions and assign power in the decision-making process to produce a more just

1 Prior to 2014 the Stormwater and Sustainability Branch was named the Catchment, Stormwater and River Management Branch, and previous to that the Catchment Management Branch. For simplicity it will be referred to as the Stormwater Branch throughout this chapter.

and fair society in light of global environmental change. Wise et al. (2014: 332) argue that socio-institutional enablers and constraints need to be better understood in order to progress adaptation, pointing to the importance of historical context by suggesting that 'the current status of the system and its future trajectory are heavily influenced by the past'. This '*antecedent pathway*' provides an indication of '*institutional preparedness*' for future climate adaptation. It is when institutions are not prepared to enable the social processes needed to realise a more fair and sustainable society that incremental adaptation is deemed insufficient to address the root causes of climate risks and transformative adaptation is required (Wise et al. 2014).

This chapter responds to the call by Wise et al. (2014) to look back at what has been done previously (that is, to chart the antecedent pathway) as a basis for identifying social and institutional challenges associated with ongoing adaptation in a given context. It does so by investigating how climate change has been incorporated into the management of stormwater in Cape Town and what this reveals in terms of institutional preparedness for adapting in the future. The adaptation pathways framework is used here as an analytical tool applied retrospectively. The CCT has not used the pathways approach to guide how stormwater is managed, although there is the potential to do so, a point that will be returned to in the chapter's conclusion.

Managing stormwater in Cape Town

Rainfall varies considerably across Cape Town, both spatially and between years, because of topography and local weather systems. As a city comprised of many small catchments, short-duration and high-intensity rainfall events generate run-off that periodically causes flooding associated with damage to property and infrastructure and the disruption of movement, economic activities and important services, and in extreme cases threatens lives (DiMP 2010; Pharoah et al. 2016). Parts of Cape Town are also characterised by a high groundwater table that, in times of prolonged rainfall, creates standing floodwater. As a coastal city, Cape Town is also susceptible to flooding caused by storm surges that push sea water further inland. Flooding is a persistent problem facing Cape Town, but some areas, households and businesses are more vulnerable than others, based on their location, quality of infrastructure, access to services (such as refuse removal and insurance), and financial capacity to recover from losses and damages (Ziervogel et al. 2016). As a city with high inequality, many residents live in low-income and informal settlements with minimal public services. The lack of adequate sanitation and waste removal services increases the amount of contaminates entering the water system, increasing the pollutant loads and creating blockages, especially during periods of high temperature and minimal rainfall (that is, reduced low-flows).

Urban stormwater management involves dealing with water runoff from the built environment to limit the risks of flooding and water pollution. Increasingly, it also involves managing runoff to limit the degradation of ecosystems and make water available for reuse (CCT 2013a; Mguni et al. 2016; Walsh et al. 2016). As Cape Town's urban footprint grows and land cover changes from vegetation to hardened surfaces, so the volume, rate and pollutant load of runoff continue to increase (CCT 2014; Haskins 2012; Thomas et al. 2010). Patterns of rainfall, temperature, river flows, groundwater levels and sea levels have to be factored in when designing, operating, maintaining and expanding the city's stormwater system to keep the risk of flooding, water pollution and ecosystem degradation at acceptable levels. Climate change, together with urban development, is increasingly affecting those patterns and therefore needs to be taken into account when determining risk levels and working towards achieving and maintaining levels that are deemed acceptable.

Cape Town's stormwater system comprises a complex and extensive network of natural and engineered features, including streams, rivers, wetlands, pipes, surface canals, channels, swales, stormwater ponds, dams and pumping stations (CCT 2015). The replacement value of the stormwater infrastructure network was, in 2009, conservatively estimated at R13 billion (CCT 2013b). The coverage, age and quality of the current system varies considerably across the city. Within the resource constraints of the municipality, this gives rise to difficult decisions weighing up relative costs and benefits associated with maintaining and upgrading existing infrastructure and expanding the network to under-serviced areas. The historical legacy of inequality makes these decisions particularly difficult. Projected future urbanisation and climate change makes them even more so.

Responsibility for managing Cape Town's stormwater is assigned to the Stormwater Branch within the CCT.[2] Reflecting conceptual, legislative and policy developments at the national and international levels, the Stormwater Branch has, over the past 15 to 20 years, been shifting from an engineering focus of efficiently piping stormwater away to a sustainability focus of facilitating stormwater absorption into ecosystems as naturally as possible (Haskins 2012; Obree 2004). An integrated and sustainable approach to stormwater and catchment management was formalised in the CCT's 2002 Catchment, Stormwater and River Management Strategy (CCT 2002). The strategy was strengthened by two policies adopted by the City in 2009. The Floodplain and River Corridor Management Policy sets conditions and limits on new developments close to wetlands and rivers to achieve 'balanced consideration of potential flood risk, environmental impacts and socio-economic needs' (CCT 2009a: 5). The Management of Urban Stormwater Impacts Policy (CCT 2009b) introduced principles of Water Sensitive Urban Design

2 CCT, 4 July 2014, PowerPoint presentation entitled 'Stormwater & Sustainability Branch: Briefing Session', presented by the Director of Planning Transport for Cape Town, City of Cape Town.

(WSUD) and parameters for Sustainable Urban Drainage Systems (SUDS) into the process of development applications and approvals, directly influencing planning and design. The policy targets a reduction in the quantity of stormwater runoff and in the phosphorous and sediment load of stormwater to improve water quality, thereby emphasising ecological health and sustainability in drainage management. Climate change was not a primary motivating factor for introducing WSUD and SUDS to deal with detrimental impacts of urbanisation on receiving waters. However, the benefits of these approaches for positioning stormwater as a resource to supplement water supplies are now actively being considered in light of climate change. Both stormwater policies were integrated into the CCT's Spatial Development Framework and Integrated Development Plan (Haskins 2012). Considerable progress has been made in institutionalising principles of sustainability in the Stormwater Branch, and in the CCT as a whole, yet full realisation of sustainability in practice is far from complete (Davison et al. 2015). The shift to sustainability has opened up opportunities for addressing questions of climate change.

Adapting the way stormwater is managed

The discourse of climate adaptation is not evident in the work of the Stormwater Branch, where concepts and language of risk mitigation and sustainability dominate. However, there are strong conceptual and practical linkages between climate adaptation, risk management and sustainability (Solecki et al. 2011; Swart et al. 2003), and the process of adapting the management of stormwater in response to climate change is evident in Cape Town over the past decade. The process is described below as an adaptation pathway with six key features.

The 2004 flood event

> *We became acutely aware of climate change questions around the time of the August 2004 large flood event ... we commissioned some research to analyse the damages and impacts of the event and also to look at whether any change in rainfall was evident ... this event and study got climate change onto the agenda ... we moved forward with some trepidation ... it makes sense to be conservative in the face of uncertainty and then to re-assess as new data and information comes to light ... so getting climate change in is a process, it is still in its infancy, there are still things to be verified, but as a forward-looking coastal city it makes sense to do it (Interviewee A, 17 March 2015).*

A large flood in 2004 began raising questions of climate change for CCT officials working in the Stormwater Branch. Consequently, an interdisciplinary post-flood assessment was commissioned from the University of Cape Town (UCT), undertaken by a team of disaster management specialists and climate scientists. It included an analysis of rainfall data to identify whether any long-term trends were evident. The assessment showed that the flood had been caused by the culmination of two storm systems passing over the city, bringing heavy rainfall that led to quantifiable losses in excess of R6,5 million (DiMP 2005, 2010). The study suggested that, while the average annual rainfall totals had not changed significantly over recent decades, the seasonality and intensity of rainfall might have altered; more data would be required to confirm this (DiMP 2005). The study raised concerns regarding potential future increases in the intensity and frequency of storm events, heavy rains and extreme flows under scenarios of climate change, requiring further research. The study findings were used by the Stormwater Branch to motivate for completing the annual maintenance work on the stormwater system in June, instead of April, to account for a later onset of the rainy season (Interviewee A, 17 March 2015).

The Environment Resource Management Department leads the way

Between 2005 and 2008 work on addressing climate change grew within the City's Environmental Resource Management Department (ERMD), notably including the development of the Energy and Climate Change Strategy, the preparation of a Climate Adaptation Plan of Action, and commissioning of a Global Climate Change Sea-Level Rise Risk Assessment for the CCT (Brundrit & Cartwright 2012; Taylor 2016). These activities included various consultations between the ERMD and Stormwater Branch staff on issues relating to climate change, stormwater and flooding, opening up dialogue and debate within the CCT's administration about the extent of local risks posed by climate change and the nature and suitability of proposed responses.[3] These engagements remained largely within the technical realm, out of the political and public domains. Initiatives by the ERMD added weight to the climate change agenda, but did not initially link directly to the core ongoing work of the Stormwater Branch. The potential for creating collaborative linkages between the ERMD and the Stormwater Branch on climate change issues emerged through strategic planning.

Stormwater strategic planning

In 2005, the Stormwater Branch commissioned the development of a city-wide approach to managing and upgrading the stormwater system. This involved performing a high-level demand prediction, creating an asset register, and estimating a 10-year expenditure framework. The consultants noted that climate change was not included as a factor in forecasting demand for stormwater services

3 CCT internal communication, email between officials in the Stormwater Branch and the ERMD regarding the Stormwater and Catchment Management section of the draft Climate Adaptation Plan of Action, 17 April 2009.

and calculating expenditure (SibaCon 2006). The study recommended that a consolidated stormwater master plan be developed for the entire metropolitan area, as a basis for detailed planning to manage and operate existing stormwater infrastructure assets and prioritise the acquisition and construction of new assets. It was this recommendation that led the Stormwater Branch to identify the need for, and opportunity to, include climate change in the modelling of catchments.

The Salt River was the first catchment to be modelled for a master plan. This was a pilot to 'enhance the City's ability to plan future provision and upgrade of stormwater infrastructure, determine service levels, improve development control and undertake scenario planning associated with urban densification, climate change and maintenance regimens'.[4] In July 2009, consultants were appointed to undertake the work. This included an analysis of rainfall and flow data, the quantification of potential climate change impacts on rainfall, the development of a prototype Climate Change Factor to account for uncertainty in future rainfall patterns, and the preparation of design storms for use in the catchment modelling across the city. Researchers at the University of KwaZulu-Natal (UKZN) were subcontracted to work on the rainfall analysis component. Using statistically downscaled climate data derived from five global climate models (GCMs), forced with one emissions scenario, the UKZN researchers simulated hydrological attributes of sub-catchments in and around Cape Town (Schulze et al. 2010).[5] A ratio was calculated between the hydrological attributes simulated for two future periods (2046–2065 and 2081–2100) and the recent past (1971–1990) from each of the GCMs. While the results varied considerably between models, catchments and variables (that is, rainfall durations and return periods), the study recommended adopting a conservative position when developing hydraulic designs in light of future conditions. Based on the average of the ratios from the GCMs yielding the two highest values, Schulze et al. (2010) recommended increasing design rainfalls by 15 per cent. They also recommended that the study be updated in three to five years, when more and better climate data and improved analytical techniques were available to further refine changes in design rainfalls. The Stormwater Branch decided to increase design rainfall intensity by 15 per cent, with the intention of reviewing this decision as new scientific evidence became available (Interviewee A, 17 March 2015).

The 15 per cent increase was added to the gridded design rainfall data developed by Smithers (2010) for use in the modelling and master-planning of the Salt River catchment and subsequent catchments. The inclusion increased

4 CCT internal communication, email between officials in the Stormwater Branch and the ERMD providing an overview of projects dealing with stormwater management and climate change, 30 September 2009.

5 The climate data for this simulation were developed by the Climate Systems Analysis Group at UCT.

the area designated as floodplains and high-hazard zones, thereby expanding the land area where limitations and conditions are set on developments and where additional stormwater interventions are planned to reduce flood risk to existing developments. In addition to being used in master-planning, the design rainfall grid replaces the old Intensity-Duration-Frequency curves used in designing all stormwater facilities and infrastructure in Cape Town (Interviewee B, 12 December 2014). The development of the design rainfall grid to include a prototype Climate Change Factor marks a significant departure from the 'business as usual' approach of managing stormwater based only on historical rainfall data. However, the new design rainfall data are yet to be comprehensively applied, as master-planning has not been completed for all catchments across the city. While this is partly due to budget constraints, staff turnover and organisational (re)structuring processes that put planning and contracting on hold (Interviewee C, 9 April 2015), as of 2019 new budgets have been applied for and organisational restructuring was completed in 2017. The Catchment, Stormwater and River Management Branch was placed in the Water and Sanitation Department as part of the vision 'to be a beacon in Africa through the progressive realisation of Cape Town as a water sensitive city'.

External influences and policy-making

The impetus for including climate change considerations in stormwater management came not only from within the CCT. The Stormwater Branch heard from municipal colleagues in Durban that they had already commissioned UKZN to analyse rainfall and runoff data in light of climate changes, thereby increasing their confidence to follow a similar approach (Interviewee A, 17 March 2015). Also, in early 2009, the Western Cape Government commissioned a study on stormwater and climate change in the region, which focused on water-sensitive urban design and the inclusion of sustainable urban drainage interventions as an important aspect of dealing with increasing flood risk under scenarios of climate change (Interviewee C, 12 December 2014). The provincial government was also finalising a Western Cape Provincial Climate Change Response Strategy and Action Plan that involved hosting a climate change forum for provincial government and CCT officials, including a Stormwater Branch representative. The aforementioned work of the ERMD, together with that of Durban's eThekwini Municipality and the Western Cape Government, added weight and impetus to the Stormwater Branch's use of climate change as one of many reasons for taking a sustainable approach to managing the city's stormwater system, as articulated in the 2009 Floodplain and River Corridor Management Policy and Management of Urban Stormwater Impacts Policy (CCT 2009a, 2009b). These policies signalled a strong intent to shift the stormwater management paradigm from one of efficient water removal to one of ecologically sensitive and sustainable integrated water management that is forward-looking.

The Climate Change Think Tank

The climate-related work of ERMD and the Stormwater Branch converged in 2009 through the formation of the Climate Change Reference Group, which became the Climate Change Think Tank (Cartwright et al. 2012).[6] It was designed to facilitate collaboration between researchers, consultants and local government officials to better understand and prepare for climate change. Work was structured around four research themes, one of which focused on the local consequences of climate change at the interface between marine and freshwater systems, led by the Stormwater Branch. This presented an opportunity to extend the work already under way to prepare a high-level master plan for the Salt River catchment. The extension focused on developing a detailed case study of the Salt River catchment to test various scenarios of the combined effects of increases in storm surge, mean sea level, rainfall and freshwater runoff, on flood risk and infrastructure damage over a 50-year time horizon.

In 2010, consultants were commissioned to estimate local sea levels at the mouth of the Salt River for various return periods, under current conditions and scenarios of climate change for 2035 and 2060 (PRDW 2011). The study built on the sea-level rise modelling completed as part of the Global Climate Change Sea-Level Rise Risk Assessment for the CCT study commissioned by the ERMD (Brundrit & Cartwright 2012). It, in turn, fed into the flood modelling being done for the Salt River catchment high-level master plan to simulate flood routing. The study found that the upper estimate of climate change conditions resulted in a predicted increase in maximum high-tide water levels at the mouth of the Salt River from +1,90 m to +2,57 m above mean sea level (MSL) for the 1:20-year return period and from +2,01 m to +2,70 m MSL for the 1:100-year return period by the year 2060.[7] These increases in water levels resulted in overtopping volumes increasing by an order of magnitude, signalling the potential of significantly increased damage to coastal defence structures around the Salt River Canal and the infrastructure behind these defences (Harris et al. 2012; PRDW 2011). The consultants also investigated the correlation between extreme storm surges in Table Bay and intense rainfall events in the catchment of the Salt River, to establish if the 1:100-year storm surge event should be combined with the 1:100-year rainfall event when calculating flood levels. Using limited available rainfall data, the findings suggested that these events do not occur concurrently (Harris et al. 2012). The inclusion of these results in the flood modelling of the Salt River catchment revealed the inadequacy of the existing river channel and floodplain area to cope

6 This was a partnership between the CCT and the African Centre for Cities at UCT, with funding from the Royal Danish Embassy.

7 The upper estimate was downscaled from 10 GCMS by climatologists in UCT's Climate Systems Analysis Group.

with a 1-in-100-year flood and expanded the area delineated as floodplains and high-hazard zones.

Building on the Salt River pilot study

Based on results from the Salt River pilot study, the Stormwater Branch has promoted a number of climate risk reduction (or adaptation) measures. These measures include: supporting and commissioning further research on flood risk assessment and preparedness; improving policy implementation to regulate urban development; adjusting the timing and intensity of maintenance activities; and communicating to other stakeholders the potential impacts of climate change; how the City is responding and what more is needed (Interviewee A, 17 March 2015). Many of these measures are included in the final version of the Climate Adaptation Plan of Action (CCT 2011). However, implementation has been slow to materialise, requiring additional resourcing, collaboration with other CCT departments and external stakeholders, and political will (Taylor 2016). The rainfall Climate Change Factor and sea-level rise projections were incorporated in subsequent modelling and master-planning of the Eastern catchments in 2013.[8] The intention is that the remaining two regions will be modelled and master plans developed using the same methodology. However, shortages in funding, changes in staffing, and CCT organisational redesign have caused these initiatives to be postponed.

The challenges of navigating adaptation pathways

The investigation of climate change implications for managing stormwater and introduction of adaptation measures, described above and summarised in Table 11.1, is understood as an antecedent adaptation pathway made up of numerous decision points over time. The case study reveals a number of important challenges associated with navigating urban climate adaptation pathways.

Table 11.1: Timeline showing the antecedent adaptation pathway of stormwater management in the CCT

DATE	EVENT
MAY 2002	Integrated approach to catchment management based on principles of sustainability formalised in Catchment, Stormwater and River Management Strategy
AUGUST 2004	Flood event raises concerns of increasing extreme events due to climate change within Stormwater and Sustainability Branch

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8 The Eastern catchments include the Kuils–Eerste River system and the Lourens, Sir Lowry's Pass and Soet Rivers.

DATE	EVENT
MAY 2005	Post-flood assessment commissioned by Stormwater Branch finds limited local evidence of long-term trends in the rainfall but cautions possible shifts in timing and intensity requiring further research
AUGUST 2005	Stormwater Management By-law passed by Council with no mention of climate change
JUNE 2006	Framework Stormwater Infrastructure Management Plan completed, recommending high-level masterplanning for entire city
JUNE 2006	Energy and Climate Change Strategy finalised by ERMD
AUGUST 2006	Framework for Adaptation to Climate Change in Cape Town commissioned by ERMD completed
AUGUST 2007	Global Climate Change Sea-Level Rise Risk Assessment for the City of Cape Town commissioned by ERMD
MARCH 2009	Report on Stormwater and Climate Change for Western Cape Province produced for provincial government
MAY 2009	Urban Stormwater Impacts Policy and Floodplain and River Corridor Management Policy adopted by Council, both citing climate change as a rationale
MAY 2009	Provincial government finalising Western Cape Provincial Climate Change Response Strategy and Action Plan and hosting a climate change forum, including a CCT Stormwater Branch representative
APRIL 2009	Draft Climate Adaptation Plan of Action prepared by ERMD reviewed by Stormwater and Sustainability Branch
JULY 2009	Salt River Catchment Masterplan CAPS commissioned by Stormwater Branch, including quantification of potential climate change impacts on rainfall
SEPTEMBER 2009	Formation of the Climate Change Reference Group, which became the Climate Change Think Tank
AUGUST 2010	Rainfall analysis completed by UKZN and decision taken to increase rainfall intensity by 15% to account for future climate change
SEPTEMBER 2011	Study of local consequences of climate change at marine-freshwater interface in the Salt River catchment completed through the Climate Change Think Tank
OCTOBER 2011	Final version of the Climate Adaptation Plan of Action for the stormwater sector signed off by the Portfolio Committee, facilitated by ERMD

→

DATE	EVENT
MAY 2012	City Council adopts the Cape Town Spatial Development Framework integrating the two stormwater policies
MARCH 2013	Modelling and masterplanning of the Eastern catchments completed including 15% increase in rainfall intensity and projected local sea level rise
APRIL 2015	Models and masterplans for remaining catchments still not developed due to lack of funding and staff turn-over

Source: Produced by the author

The first challenge pertains to the temporal nature of adaptation pathways. The Cape Town stormwater case reveals the long lead time required to build the knowledge base and lay the planning and policy groundwork to enable the detailed design, selection and implementation of adaptation measures. The assessment and preparatory work for including climate change considerations in Cape Town's stormwater management has been under way for more than 10 years, and still it is far from complete. For example, the flood modelling work and master-planning has yet to be completed for all catchments. It is therefore critically important to factor realistic lead time into the design of future adaptation pathways. This applies to other CCT departments and line functions, as well as to other cities.

Another important temporal challenge is that once a decision has been taken, the lifespan of that decision is often longer than initially intended. This is because review and revision is resource-intensive and there are many other competing demands. For example, the analysis that led to the decision to include an extra 15 per cent rainfall intensity in the design rainfall data was completed in 2010. Recognising rapid developments in the science, there was an expressed intention to review that figure every five years. Yet six years later, a review is not yet on the agenda or in the budget. Also, many of those involved in commissioning the original study and making resulting decisions have left the Stormwater Branch. Although the associated documents remain, much of the knowledge and institutional memory of the work and resulting decisions left with these officials. The lack of review mechanisms limits the CCT's current capacity for proactively navigating adaptation pathways.

The second challenge is coordinating between the multiple actors that play a critical part in shaping and progressing a city's adaptation pathway. The case examined in this chapter shows that changes made are a result of intersections between the work of the Stormwater Branch, the ERMD, the Western Cape Government, two universities and five consulting companies. More coordination and collaboration is required within local government and with others to further progress adaptation efforts. For example, collaboration between the Stormwater Branch, the Disaster Risk Management Centre and the insurance industry is needed to manage increases in flood risk to areas that are already developed. From a theoretical perspective, the fact that the Stormwater Branch is only one of a number of actors progressing the climate change adaptation agenda within Cape Town suggests there may be value in characterising pathways in three-dimensional space. This entails conceiving of a city's adaptation pathway not only as a sequence of decisions about adaptation measures over time, but also as being influenced by various actors.

A third challenge evident in the case study is the complex relationship between knowledge and decision-making. It is interesting to note that the decisions documented above were all driven and made by officials in the city administration and not by politicians, who are often assumed to be the decision-makers. This is, in part, a result of the complex and contingent nature of the scientific knowledge underpinning the decisions. It requires considerable technical expertise to interrogate and assimilate the range of results accounting for numerous possible scenarios with extensive spatial heterogeneity at the local scale. That said, many of these decisions have potentially far-reaching implications for the development of the city and the allocation of public resources, suggesting that the decisions should also be debated and weighed up within the political domain of a democratic system. Much of the evidence base underpinning the decisions remains locked away in technical consulting reports that are not easily accessible to others outside of the unit that commissioned them. This undermines collaborative, integrated and inclusive decision-making.

Conclusion

This chapter has presented an application of the adaptation pathways approach as an analytical tool to understand and make legible the process of integrating climate change considerations into managing stormwater in Cape Town. This conceptual framework has enabled the identification of the main decision points, the actors involved, and the temporality of the process. The application of this approach has revealed that both the conceptual framework and the case itself have engaged poorly with the politics of decision-making. This political dimension may be a critical element of explaining and addressing the three identified challenges for progressing adaptation, namely: 1) reducing the long lead time for decisions and the persistence, yet incomplete application, of those decisions; 2) strengthening the coordination and collaboration between multiple actors with a stake in city-wide climate adaptation; and 3) combining the technical expertise required to deal with the complex and evolving knowledge base with the political expertise to address contested trade-offs and value-based judgements that underpin these decisions.

The chapter, and this book as a whole, focus primarily on challenges that give rise to the slow, partial and incremental progress being made to mainstream climate change in Cape Town. However, it must be said that the Stormwater Branch has made considerable progress in confronting questions of climate change, and this sets it apart from many other CCT departments, as well as counterparts in many other cities around the world. Strategic leaders and skilled technicians should be given due credit for this progress, as should those around them who are helping to create a conducive and supportive environment for undertaking such work. That said, there is much more to be done to build the climate resilience and sustainability of Cape Town in the face of changing climate patterns and sea levels. The manner in which this is done needs to be informed by an understanding of the existing challenges, as identified by charting the antecedent pathway in this chapter.

Use by the CCT of the adaptation pathways approach as a diagnostic tool to support decision-making could be one avenue for exploring and navigating future adaptation pathways, particularly those that transition from incremental measures addressing proximate causes of flooding and water pollution to those that are transformative in addressing the root causes and unequal distributions of such risks and vulnerabilities. Such an initiative would require and enable deeper engagement and collaboration between technical and political stakeholders within and beyond the CCT local government sphere, addressing stormwater in relation to other water service sectors, as well as those of sanitation, waste management, environmental management, disaster risk management, spatial planning and the like. Aligning itself with recommendations put forward by Wise et al. (2014), such an initiative should create the space and opportunities to innovate and experiment with alternative values, ideas and practices by enabling a range of actors, with different power and agency, to renegotiate the prevailing distributions of resources, rights and responsibilities in order to address climate change and urbanisation in a sustainable, resilient, inclusive and equitable way. It would probably best be led by a strategic high-level body such as the CCT Green Economy, Energy and Climate Change Working Group.[9] This might reduce some of the budgetary, staffing and restructuring constraints faced within the Stormwater Branch, while increasing the influence, extent and effectiveness of resulting decisions. The work of Pelling et al. (2014), Bulkeley et al. (2014) and Leach et al. (2012) on transformation, climate justice and sustainability pathways provides fertile ground for finding ways to enhance the political aspects of the adaptation pathways framework. This presents a promising avenue for further research to support the policy-making, planning and practices of Cape Town's local government.

9 The Green Economy, Energy and Climate Change Working Group is one of the CCT's transversal management structures set up in early 2015 to promote the integration of policy development, implementation and service delivery across local government. It comprises representatives from 14 different line functions and is a critical forum for mainstreaming climate change issues and pursuing the adoption and implementation of the Climate Change Policy. (See also Chapter 3 of this book.)

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CHAPTER 12

Assessing the management effectiveness of the City of Cape Town's protected areas as a tool for climate-change resilience

Julia Wood, Pippin Anderson, Clifford Dorse, Patricia Holmes and Leighan Mossop

Protected areas play a critical role in climate change resilience, contributing to both climate change mitigation and adaptation (Dudley et al. 2010). Mitigation in the climate change context is defined as 'a human intervention to reduce the sources or enhance the sinks of greenhouse gases' (IPCC 2014). Protected areas assist in mitigating climate change by preventing the loss of carbon that is tied up in vegetation and soils, and by sequestering further carbon dioxide from the atmosphere. While all vegetation sequesters carbon to some extent, some types are more efficient than others at doing so. One study in South Africa has demonstrated the greater potential of natural vegetation than, for example, vineyards (Mills et al. 2013). This mitigation benefit is secured through actively managing protected areas to restore functioning ecosystems which capture carbon, and by avoiding loss of carbon through transformation of these areas to other land uses (Dunlop et al. 2013; Hopkins et al. 2015; Mills et al. 2013). Adaptation involves responding to and coping with climate change. Well-managed protected areas which maintain functioning ecosystems can buffer and reduce the impacts of extreme events associated with climate change such as changes in water supplies, fisheries, disease and agricultural productivity (Dudley et al. 2010; Hopkins et al. 2015).

In light of the important role of protected areas in anticipation of, and in response to, climate change, Dunlop et al. (2013) have compiled a group of management actions that are required to ensure 'Climate-Ready Conservation'. This work recognises the importance of a sustainable connected network of well-managed, healthy and representative ecosystems for their adaptive and mitigatory contributions in the face of climate change. Such a network would also allow for *in situ* species adaptation and adjustment of microhabitat as required to address the vulnerability of ecosystems to climate change impacts (Hopkins et al. 2015).

A critical component of ensuring effective protected area management and climate change resilience is a robust monitoring and evaluation system. This chapter presents an overview of the emergence of the Management Effectiveness Tracking Tool (METT) in the City of Cape Town Municipality (CCT, also referred to as the City), and how this innovative practice was mainstreamed into the City's and South Africa's protected areas. With the emerging climate change theme, the METT is analysed with regard to how it has been used (or not used) to assess climate change robustness, and in particular with regard to its inclusion or omission of metrics both directly and indirectly related to climate change. The chapter also identifies challenges posed by the METT and considers what could be done to improve the use of the tool for this purpose.

Management effectiveness worldwide

The number of protected areas in the world has increased exponentially since the establishment of Yellowstone National Park in 1872, which saw the start of the modern era of protected areas (Chape et al. 2005). In 2014, a document published by the United Nations Environmental Programme World Conservation Monitoring Centre (UNEP-WCMC) reported that the approximately 209 000 protected areas worldwide cover 15,4 per cent of the planet's terrestrial and inland water areas, and 3,4 per cent of the oceans (Juffe-Bignoli et al. 2014). The Convention on Biological Diversity (CBD) 10th Conference of the Parties (COP) hosted in 2011 in Nagoya, Japan, saw the adoption of the 2011–2020 Strategic Plan for Biodiversity and its Aichi Biodiversity Targets (CBD 2011a). Target 11 states:

> *By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes (CBD 2011b, emphasis added).*

Furthermore, Target 15 states:

> *By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation, and to combating desertification (CBD 2011b).*

The establishment of protected areas, their restoration and their effective management are key elements in reaching these targets by delivering on the biodiversity conservation targets, reducing habitat loss and working towards climate change resilience (Dudley et al. 2010; Dunlop et al. 2013). In addition, protected areas provide many other elements including ecosystem services such as water provisioning, and other direct benefits to society such as recreation, tourism, education, job creation and resource utilisation (Worboys 2015a).

Despite the global increase in protected areas, biodiversity worldwide is still declining as a result of several factors, including continuing habitat loss, insufficient and poorly located protected areas, poor connectivity and integration into the broader landscape (or seascape), and inadequate management (Juffe-Bignoli et al. 2014).

As early as 1992, at the Fourth World Parks Congress in Caracas, it was recommended that the International Union for Conservation of Nature (IUCN) develop a system which can assess management effectiveness of protected areas. In response to this, the World Commission on Protected Areas set up an international task force to attend to this (Hockings et al. 2006). This task force developed a framework to evaluate or assess protected areas management effectiveness which could be applied in different situations (Hockings & Phillips 1999). The framework was divided into six areas to guide evaluations and standardise approaches (Hockings et al. 2000, 2006; Stolton et al. 2003). These were the following:

1. Context (status and threats): Where are we now?
2. Planning: Where do we want to be and how will we get there?
3. Inputs: What do we need?
4. Processes: How do we go about management?
5. Outputs: What did we do and what services or products were produced?
6. Outcomes: What did we achieve?

This management framework, with its prompting questions relating to the management areas identified, was to guide evaluations and standardise evaluation approaches.

The evaluation tools based on the management framework developed by Hockings et al. (2000, 2006) include, among others, the Rapid Assessment and Prioritisation of Protected Area Management developed by the World Wide Fund for Nature (WWF) (Ervin 2003; Hockings et al. 2015); the METT developed by the WWF and the World Bank (Stolton et al. 2003; Stolton et al. 2007); the PROARCA/CAPAS scorecard evaluation (Corrales 2004); the Parks in Peril Site Consolidated Scorecard (TNC 2004); and the Enhancing our Heritage Methodology developed by the IUCN and UNESCO for use in World Heritage Sites (Hockings et al. 2008). Leverington et al. (2010) undertook a global study of 8 163 protected areas and found that there were 54 Protected Areas Management Effectiveness (PAME) methodologies/tools in use. By 2015, Coad et al. found 95 PAME methodologies in use in their analysis of the global database for PAME.

Coad et al. (2015) found that the most widely used management effectiveness tool was the METT. The METT, developed to track progress in specific sites over time (a 'specific site assessment'), has been applied in at least 127 countries in 2 500 protected areas covering 4,2 million km^2 or one-fifth of the world's protected areas (Stolton & Dudley 2016). The METT is now being used by the WWF, the World Bank and the Global Environment Facility (GEF) as the mandatory tool in protected areas where they are involved as funders (Coad et al. 2015; Craigie et al. 2015; Stolton & Dudley 2016). Management authorities of Ramsar sites are encouraged to monitor effectiveness via a PAME tool or the R-METT that has been developed specifically for Ramsar sites (Ramsar 2015a).[1] The rationale for their selection of the METT relates to an assessment of needs and takes account of certain features as identified by the World Bank and WWF as critically important. Stolton et al. (2003: 10) list these features of the METT as follows:

1. Capable of providing a harmonised reporting system for protected area assessment within both the World Bank and WWF
2. Suitable for replication
3. Able to supply consistent data to allow tracking of progress over time
4. Relatively quick and easy to complete by protected area staff, so as not to be reliant on high levels of funding or other resources
5. Capable of providing a 'score' if required
6. Based around a system that provides four alternative text answers to each question, strengthening the scoring system
7. Easily understood by non-specialists
8. Nested within existing reporting systems to avoid duplication of effort.

The most useful aspects of the METT are its ability to track progress and trends of specific protected areas, and the fact that it is a simple site-based tool that relies on a framework of multiple-choice questions, making it very easy to apply. It ensures that the high-level basic requirements for any protected area such as a management plan, legal status, staff structure and a budget are tracked, and need to be in place to obtain an acceptable score. The METT score sheet is usually filled in by a team of protected area managers, consultants and researchers; and managers have noted the significant added value offered in stimulating interaction and discussion, and the identification of actions required to improve scores and management (Leverington et al. 2010). Cook and Hockings (2011) further suggest that in order to avoid a bias and ensure robust data, a validation of the scores should be undertaken.

1 A Ramsar site is a site designated by the Ramsar Convention as being of international importance for wetlands. See http://www.ramsar.org/sites-countries/the-ramsar-sites, accessed 19 January 2019.

Global climate change is a major challenge for protected area managers in the 21st century (Worboys 2015a; 2015b). The PAME tools (and the METT) were initiated as climate change was mainstreamed into practice in the early 2000s (Hannah et al. 2002). However, only recently have climate change considerations become critically important in protected area management (Dudley et al. 2010). Therefore, there is limited reference to the suitability of the management effectiveness tools as regards their ability to assess whether protected areas are meeting climate change mitigation and adaptation expectations. The assumptions are that a) a high METT score indicates a well-managed and functioning protected area (Leverington et al. 2010); and b) well-managed protected areas will provide mitigation and adaptation to climate change (Dunlop et al. 2013; Mills et al. 2013). In the latest METT review the lack of incorporation of climate change considerations was recognised and a set of questions to address this was proposed (Stolton & Dudley 2016).

The biodiversity context of the CCT

The CCT, a metropolis located in the Cape Floristic Region (CFR), is a biodiversity hotspot of international significance, containing a large number of unique habitats and endemic species (Holmes et al. 2012; Mittermeier et al. 2004; Myers et al. 2000; Wood et al. 1994). Around 3 250 plant species occur in the CCT, with 13 of these species now extinct and 319 threatened according to the IUCN Red List (Rebelo et al. 2011). The largest threat to this biodiversity is habitat loss and associated fragmentation, particularly in lowland ecosystems where the bulk of the pressure from human settlement and agriculture exists. Should the current rate of natural habitat loss not be significantly reduced, irreplaceable biodiversity will be lost, reducing the City's ability to adapt to climate change.

The CCT's approach to protected area management

The City has a long history of conservation planning to identify which parcels of land it should proclaim, protect and manage, but in the past implementation was slow or non-existent. This changed in 2005 with the City significantly strengthening the Biodiversity Management Branch which falls under the Environmental Resource Management Department. This Branch currently operates with a permanent staff component of more than 170 (including more than 50 qualified conservation/environmental management staff), and manages 16 protected areas (with a total area of more than 15 000 ha). It undertakes systematic conservation planning (Holmes et al., Chapter 8, this book), protected area expansion, conservation stewardship (Dorse et al. 2016, Chapter 13, this book), a range of off-protected area activities, invasive species control, job creation and skills development, environmental education and awareness, and land use advice.[2]

The City's Biodiversity Strategy was adopted in 2003 (CCT 2003) and the Local Biodiversity Strategy and Action Plan (LBSAP) for 2009–2019 was approved in 2009 (CCT 2009). The original LBSAP did not specifically mention climate change considerations, but the updated draft LBSAP incorporates the most up-to-date international frameworks, science and management considerations as well as climate change. In line with this, the City is assessing the impact climate change could have on ecosystems and the role of the City's protected areas in mitigating and adapting to climate change. For example, a report on the impacts of climate change and biodiversity was completed in 2011 (CCT 2011). Climate change considerations have also been incorporated into the latest re-run of the City's fine-scale conservation plan, the Biodiversity Network, or 'BioNet' (as reported in Holmes et al. 2016, Chapter 8, this book). Similarly, climate change is being incorporated into protected area expansion plans and the City is focusing on the Dassenberg Coastal Catchment Partnership, the WWF-identified climate change adaptation corridor in the north-west of the City (Dorse et al. 2016, Chapter 13, this book). This local experience is aligned to the trends in South Africa and worldwide, where conservation organisations have only started seriously incorporating climate change into conservation planning and protected area management in recent years (Hannah et al. 2002; Heller et al. 2009).

Management effectiveness in the city's protected areas, mainstreaming an innovative tool

In the process of consolidation of the protected areas, it was quickly identified that it was important to monitor reserve management performance. It is now widely recognised that the most important factor affecting the resultant protected areas' continued survival, and their ability to provide ecosystem services and climate change resilience, remains their effective ecological management (Hockings et al. 2015). The foundations were being laid for mainstreaming protected area management effectiveness into City practice, which should contribute to climate change mitigation and adaptation.

During a discussion in 2006, the coordinator of Cape Action for People and the Environment (CAPE), a bioregional conservation partnership in the CFR (Ashwell et al. 2006; SANBI 2017) suggested using the METT tool, which had not been frequently or widely used in South Africa. The CCT was the first organisation in the country to adapt the METT to South African needs. The tool was adapted

2 Off-protected area activities are activities that occur in areas not proclaimed a protected area.

during a series of workshops run in 2007 with the City's protected area managers and conservation services staff (Britton & Langley 2007). The adaptations were made to the original WWF/World Bank METT (Stolton et al. 2003) and saw the slight modification of the language and issues specified there to make it more understandable to local users. Importantly, climate change impact was not included as an indicator at this stage, and was not mentioned or identified as important in any of the workshops run with City staff. For the protected area managers in the City in 2007, the focus was on more pressing issues such as resources, budget and security issues. The issue of climate change was considered by senior managers but was left out, as it was felt that it was not the most important issue. There was also a recognition that climate change impacts are difficult to measure directly and to quantify in relation to other impacts; for example, impacts affecting ecosystems in urban areas include fragmentation and increase in soil nitrogen (Wilson et al. 2009).

The CCT METT became the standardised tool that best suited the urgent need to determine management effectiveness and to place the City's protected areas on a path to best practice in keeping with national and international expectations and agreements. The METT was used as a measure for internal use and as a baseline against which subsequent assessments could be compared. Within a year many other conservation organisations had applied the adapted METT, and thus a body of practice developed which allowed for comparison of methods and troubleshooting of the challenges involved in its implementation.

Mainstreaming the City's METT into national practice

Formal recognition of the City's METT version was achieved when it was taken up by the CAPE partners, who in turn further adapted it in 2008 and called it the METT-SA version 1 (Cowan et al. 2010). The METT-SA has now been applied to all provincial and national protected areas in South Africa and is the prescribed method by means of which the Department of Environmental Affairs (DEA) assesses management effectiveness for all protected areas proclaimed under the National Environmental Management: Protected Areas Act (No. 57 of 2003), and on the Protected Area Register. This illustrates the success and extent of uptake of this tool. The DEA did another minor update which it referred to as the METT-SA version 1 with 2012 updates (DEA 2012). This version was further developed into the METT-SA version 3 (DEA 2015), which is significantly different from the original WWF/World Bank METT (Stolton et al. 2003), the current GEF METT (GEF 2013) and the earlier South African versions. The METT-SA version 3 does not have the data sheets and threats/pressures section, has more than double the number of indicators, and calls for evidence to qualify the scores given and, in some cases, for proven involvement of external specialists. It has also significantly departed from the original METT requirement of being quick and easy to use and understandable by non-scientists.

In the World Bank/WWF 2007 version (Stolton et al. 2007) and in the R-METT (Ramsar 2015b), climate change is specifically mentioned as a threat and the significance of this threat is recorded. The 2016 METT review (Stolton & Dudley 2016) added an additional climate change question. None of the South African METT versions mentions climate change, directly monitors its impacts, or illustrates the contribution of the protected area to climate change mitigation or adaptation. In the METT-SA version 1 with 2012 updates (DEA 2012) climate change mitigation and adaptation are monitored directly if climate change is mentioned in 'pressure/threats' or 'objectives'. However, the METT-SA version 3 has removed the 'pressures/threats' section of the METT-SA 2012 version, resulting in the only possible mention of climate change occurring in the objectives or indirectly through assessment of some of the indicators which are discussed in more detail below and in Table 12.1. Any specific mention of climate change, or prompt to consider climate change, is lacking.

Table 12.1: An analysis of the METT-SA version 3 (2015) and whether it monitors ecological integrity, the impacts of climate change, or the contribution of the protected area to climate change mitigation or adaptation

Elements/ indicators	Monitoring of ecological integrity	Monitoring of impact of climate change on PA*	Measurement of PA contribution to climate change mitigation/ adaptation	Comments
Objectives articulated for the PA	Possibly — depends on objectives	Possibly — depends on objectives	Possibly — depends on objectives	Ecological integrity and climate change will only be monitored if this is a specific objective articulated for the PA.
Pressures/threats NOT INCLUDED in METT-SA version 3	*Direct/ indirect impact — depends on nature of objectives/ activity*	*Direct/indirect impact — depends on nature of objectives/ activity*	*Direct/indirect impact — depends on nature of objectives/ activity*	*Depends on pressure or threat and whether climate change is mentioned as a pressure or threat — if not, it could be indirect. However this indicator/ set of variables has been excluded from the METT-SA version 3.*

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Note: * PA = protected area; CDF = conservation development framework; APO = annual plan of operation; PPP = public-private partnership

Elements/ indicators	Monitoring of ecological integrity	Monitoring of impact of climate change on PA*	Measurement of PA contribution to climate change mitigation/ adaptation	Comments
• Context — where are we now? • Legal status	No	No	No	Legal status indicates whether the PA is proclaimed and does not have any direct bearing on climate change.
• Context — where are we now? • Boundary demarcation (is the PA's boundary demarcated?)	No	No	No	Boundary demarcation *per se* will not monitor ecological integrity or climate change impacts; and will not assist with the measurement of the contribution to climate change mitigation and adaptation. However the location of the boundary and its demarcation will contribute to the success of the PA and will assist in its contribution to climate change mitigation and adaptation.
• Context — where are we now? • Biodiversity inventory	Yes	Possibly	Yes — possibly	Determines whether biodiversity inventory information supports key biodiversity objectives. Will therefore assist in monitoring of ecological integrity (on the understanding that ecological integrity is an important biodiversity objective). Biodiversity inventory information over the long term could determine the effects of climate change. However, it will be difficult to determine which impacts are related to climate change. Biodiversity inventory could also assist in the determination of a PA's contribution to climate change mitigation/ adaptation.

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Note: * PA = protected area; CDF = conservation development framework; APO = annual plan of operation; PPP = public-private partnership

Elements/ indicators	**Monitoring of ecological integrity**	**Monitoring of impact of climate change on PA***	**Measurement of PA contribution to climate change mitigation/ adaptation**	**Comments**
• Context — where are we now? • Risk assessment	Possibly — depends on the nature of risks assessed	Possibly — depends on the nature of risks assessed	No	Depends on risks assessed and whether climate change is mentioned as a risk.
• Planning — where do we want to be? • Desired states, management plans, CDFs, APOs*	Possibly — depends on the nature of the plans' objectives	Possibly — depends on the nature of the plans' objectives	Possibly — depends on the nature of the plans' objectives	Depends on whether ecological integrity and climate change criteria are included in a Management Plan/CDF.
• Planning — where do we want to be? • Protected Area Expansion Plans; Corridor Management Plans	No	No	Yes — possibly	Will not monitor ecological integrity or climate change impacts, or measure climate change mitigation/adaptation. However, Protected Area Expansion Plans and Corridor Management Plan boundaries will ensure that these areas continue to contribute to climate change mitigation/ adaptation. Restoration will increase the contribution.
• Planning — where do we want to be? • Restoration of degraded areas	Yes	No	Yes	Will directly assist with contribution to climate change mitigation and adaptation. Will also contribute to ecological integrity, as a good restoration plan will have a monitoring component. Will not, however, monitor the effects of climate change.

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Note: * PA = protected area; CDF = conservation development framework; APO = annual plan of operation; PPP = public-private partnership

Elements/ indicators	Monitoring of ecological integrity	Monitoring of impact of climate change on PA*	Measurement of PA contribution to climate change mitigation/ adaptation	Comments
• Inputs — what do we need? • Staff, budget, equipment	No	No	No	No for all activities, e.g. staff budget, equipment. There is an opportunity here to include measurement of sustainable operations principles. Especially important for income-generating activities, and design of infrastructure and operational processes.
• Inputs — what do we need? • Research and monitoring and evaluation programme	Yes	Yes — possibly	Yes — possibly	Baseline research will monitor ecological integrity and could deal with climate change. It is difficult to monitor climate change impacts.
• Process — how do we go about it? • Maintenance of infrastructure and equipment • Education programmes; performance management	No	No	No	Management of infrastructure, staff and facilities will monitor ecological integrity or climate change impact. Green considerations need to be included in all activities.
• Process — how do we go about it? • Standard operating procedures, including management of biological resources, APOs	Yes	Possibly	No	Processes will contribute to monitoring ecological integrity and could monitor the impact of climate change. This indicator is unlikely to measure the contribution to climate change mitigation/adaptation.
• Process — how do we go about it? • Environmentally responsible practice	No	No	Yes — possibly	Environmentally responsible practice talks about a 'green standard' and will include reducing carbon footprint, which will directly benefit climate change adaptation/ mitigation.

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Note: * PA = protected area; CDF = conservation development framework; APO = annual plan of operation; PPP = public-private partnership

Elements/ indicators	**Monitoring of ecological integrity**	**Monitoring of impact of climate change on PA***	**Measurement of PA contribution to climate change mitigation/ adaptation**	**Comments**
• Outputs — what were the results? • Tourism, facilities, community benefits	No	No	No	Tourism decisions, facilities and community activities can actually set the PA back in terms of climate change mitigation. This is not addressed by the METT unless there is a strong performance measurement indicator to ensure that the manager adheres to the constraints of the CDF, if this has been well-designed.
• Outcomes — what did we achieve? • Economic and social benefits; cultural heritage	No	No	No	Very indirectly related to climate change, except where citizens choose sources of income that can contribute to or mitigate climate change symptoms: e.g. dwindling fish stocks attributed to changed sea currents means more fishing communities may need to change to coastal eco-tourism as an alternative livelihood. This could be facilitated by the relevant PA with a PPP* agreement.
• Outcomes — what did we achieve? • Biodiversity targets; ecological processes and services assessment; water use planning (quality and quantity)	Yes	Yes — possibly	Yes — possibly	Biodiversity targets/ecological processes and services assessments will show impact or monitor mitigation/ adaptation of climate change if included in activities in the assessment.

Note: * PA = protected area; CDF = conservation development framework; APO = annual plan of operation; PPP = public-private partnership
Source: Produced by the authors

The challenge: how well is the critical issue of climate change captured in the METT-SA version 3?

The METT-SA version 3 was specifically assessed to see if the indicators it contains relate to or provide information which will monitor or indicate the impact of climate change on the protected area, and/or will measure progress and success of efforts to mitigate and/or adapt to climate change. Ecological functioning was also assessed, as it is integrally linked to climate change resilience. The results of this assessment are set out in Table 12.1.

Key indicators relevant to ecological functioning and climate change resilience listed in the METT-SA version 3 (DEA 2015), each requiring an audited plan drawn up by specialists, include:

- 'risk assessment'
- 'protected area expansion'
- 'corridor management'
- 'restoration of degraded areas'
- 'environmentally responsible practice'
- 'biodiversity targets'
- 'ecological processes and services' (this last one replaces 'ecological integrity' as detailed in the METT-SA version 1 with 2012 updates).

While ecological functioning elements relating to climate change are undoubtedly included, there is no direct reference to climate change. A specific note on the inclusion of climate change considerations in protected area expansion plans and corridor management could be included. This could monitor the level of preparedness of a protected area to address climate change and could be assessed and scored under the Planning section, as a required item in the set of sub-level plans such as the protected area expansion plan. Similarly, the METT in the restoration of degraded areas could include indicators for ecosystem integrity. This would give an indication of progress in restoration and a measure of the contribution of the protected area to climate change mitigation.

At a minimum, climate change as an element needs to be included in a threat section in line with international METT versions, and/or the additional climate change questions need to be included. With climate change being a threat in its own right to biodiversity, and manifesting in different ways and to varying degrees in different areas or ecosystems, it is necessary to list climate change as an element on its own, with the level of effort required to prepare for this threat to be scored and assessed specifically. Climate change considerations should also be included in indicators related to reserve operations, procurement of goods and services, and development and maintenance of infrastructure.

The success of the METT-SA version 3 (and all South African versions) in relation to the monitoring and/or measurement of ecological functioning and climate change resilience depends on the quality of the underlying conservation plan, the protected area expansion plan and also the detailed supporting plans. Thus the tool *per se* has very little direct impact on ensuring the success of ecological functioning and/or climate change resilience, since it focuses on systems being in place as opposed to the actual outcomes. Although Coad et al. (2015) and Geldmann et al. (2015) did not look at climate change resilience, they concluded that the correlation between biodiversity outcomes and PAME scores was in many cases very weak. In line with this, a high METT score would also not necessarily mean that the biodiversity/ecosystem is functioning optimally or that the impact of climate change is being monitored; similarly the contribution of the protected area to climate change mitigation and adaptation is also not monitored. It seems there is some modification required to the existing monitoring structures to ensure that climate change is more explicitly addressed in protected area management. However, consideration of the METT shows that the ability of the tool to be used in a versatile and context-informed manner is a particular strength. This suggests that climate change could readily be included where relevant. While the necessary elements exist, the explicit inclusion of climate change considerations would see the climate change agenda included in management conversations, which are a strength of the METT, and ensure an additional level of awareness of this significant global threat. On a final note, care needs to be taken when updating the tool, as Table 12.1 clearly shows that the METT-SA version 3 has already become very cumbersome and has departed from the original intention of the METT, which was to be a tool that is easy and quick to use.

Conclusion

Management effectiveness is a critical component in the management of protected areas and needs to be supported by best practice conservation planning and detailed management plans. While numerous proxies exist relating to ecological functioning and integrity, as it stands the METT will in all likelihood not determine whether climate change is impacting on the protected area or whether the protected area is able to mitigate or adapt to climate change. Either the METT could be modified to include these elements more explicitly, or the METT needs to be better supported by robust and detailed ecological monitoring plans and a clear measurement-oriented management performance evaluation framework. The pragmatic approach is a combination of both. Thus a measure of each protected area's contribution to climate change mitigation and adaptation could be investigated within the bounds of the METT and the associated assessments. It is also critically important that climate change considerations are at least discussed at the level of the METT. It is essential that because of the difficulty of monitoring climate change impacts, climate change considerations are also incorporated into conservation planning and protected area expansion. In the City, climate change considerations are already incorporated into its systematic conservation plan (Holmes et al., Chapter 13, this book) and into the protected area expansion plan (the Dassenberg Coastal Catchment Partnership; see Dorse et al. (Chapter 13, this book).

The CCT is busy reviewing and refining its entire monitoring and evaluation system to ensure that a simple method for ecological integrity measurement and monitoring of climate change resilience can be devised and included. Finally, any system must be mindful of the high pressure and workload of the protected area managers, particularly in an urban area with a large number of user groups, community and development pressures, pollution, and security and crime issues, to ensure that whatever tools are developed are simple and not labour-intensive to use.

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CHAPTER 13

The Dassenberg Coastal Catchment Partnership: a governance approach to promoting ecosystem-based adaptation and climate-resilient protected areas expansion in Cape Town

Clifford Dorse, Julia Wood, Dianne Scott and Alexander Paterson

The aim of this chapter is to introduce the Dassenberg Coastal Catchment Partnership (DCCP) as an innovative governance arrangement to manage a conservation corridor which lies predominantly within the City of Cape Town Municipality (CCT, also referred to as the City). Due to the biodiversity importance of the area as well as the fact that it is a significant aquifer recharge catchment, the aim of the partnership is to implement an ecosystem-based approach to adaptation through increasing the area under conservation, in order to increase ecosystem resilience to climate change (Roberts 2010).

The main actors in the partnership, which together provide significant resources in implementing the DCCP corridor, are the CCT along with the Western Cape provincial conservation authority, CapeNature. The DCCP does not replace the mandated legal role of the state, but rather consists of a range of interdependent actors, including the three spheres of the state, acting purposefully together to achieve a societal aim (Sørensen & Torfing 2007). This form of interactive governance is a global phenomenon that both policy theorists and state decision-makers have accepted as effective and democratic (Hajer & Wagenaar 2003). Thus, according to Sørensen and Torfing (2007: 3):

> *the idea of the sovereign state governing society top-down through comprehensive planning, programmed action and detailed regulations is losing its grip, and being replaced by new ideas about a pluricentric governance based on interdependence, negotiation, and trust.*

The DCCP provides an example of such an alternative mode of urban governance (Cartwright et al. 2012; Sørensen & Torfing 2007) nested within the City. As an urban initiative, the DCCP is only one of a complex set of competing priorities in the CCT alongside the other critical development issues of poverty reduction, job creation and economic growth (Cartwright et al. 2012). Due to the increasingly complex and dynamic nature of society, particularly in cities, there is an increasing reliance on governance networks to provide knowledge-based decision-making. Given that network governance is a relatively new research area, and that experimentation around climate adaptation is taking place in cities, this chapter aims to present an empirical case study of this mode of governance in the form of the DCCP. It aims to understand how such a network makes collaborative policy decisions and also adopts innovative mechanisms for the implementation of ecosystem-based adaptation in a large conservation corridor in the CCT.

The work of the partnership is also framed in relation to several of South Africa's climate change policies and reports which have emerged in the past five years, notably the *White Paper on the National Climate Change Response* (Republic of South Africa 2011) and the *Climate Change Implications for the Biodiversity Sector in South Africa: Technical Report* (DEA 2013a) where the integral link between biodiversity, ecosystem health and human well-being is well noted. In addition, the current and anticipated further impact of climate change on South Africa's species, ecosystems and the valuable services they provide to local communities is also reflected in these policy documents.

The main adaptation policy response options which have emerged in the climate change and biodiversity nexus in South Africa are ecosystem-based adaptation, the expansion of protected areas and the creation of ecological corridors using climate-resilient approaches (DEA 2010, 2011, 2013a, 2013b; DEAT 2009; Pasquini & Cowling 2015; Pasquini et al. 2013). Spatial biodiversity planning,[1] landscape initiatives,[2] promoting stewardship[3] and the mapping of important ecological infrastructure areas are also important policy responses.

1 Spatial biodiversity planning is a spatial plan that identifies one or more categories of biodiversity priority area, using principles and methods of systematic biodiversity planning (SANBI 2016).

2 A close connection with stakeholders and local engagement combined with a way of working on and off protected areas resulted in the concept of landscape initiatives. Landscape initiatives conserve protected areas as well as buffer areas and other land uses, with the aim of maintaining viable ecosystems and supporting evolutionary processes (Palmer et al. 2015).

3 Stewardship involves '[a]n approach to securing land in [a] biodiversity priority area through entering into agreements with private or communal landowners led by conservation authorities' (SANBI 2016: 11).

The question being explored in this chapter is how the DCCP provides a shift from the 'business as usual' governance practices in biodiversity conservation and climate change adaptation.

The background to the partnership

The need for protection: the ecological importance of the DCCP area

The DCCP corridor encompasses some of the most extensive endangered lowland habitat within the Western Cape.[4] This area is also the last relatively intact and ecologically functional area of critically endangered and poorly protected Atlantis sand fynbos. In addition, extensive portions of critically endangered Swartland granite renosterveld and endangered Cape Flats dune strandveld are included in the DCCP (Figure 13.4). Helme (9 September 2011) estimates that more than 200 plant species of conservation concern occur in the DCCP corridor; 30 per cent of these are endemic to the corridor and 60 per cent are endemic within 50 km of the corridor (Figure 13.1).

In addition, the DCCP corridor is known to contain critical ecological infrastructure, with 46 per cent of the area falling within the Witzands Aquifer Protection Zone.[5] The Witzands Aquifer is a critical water resource for Cape Town, and particularly for Atlantis, providing 40 per cent of its water supply. If this aquifer were to be significantly polluted or degraded, as has happened to the Cape Flats Aquifer, the capital costs of replacing the water are estimated to be R1 billion to build a reticulation system to pipe water in from further afield, or R15 billion to build a desalination plant.[6] It is predicted that, with climate change, Cape Town will become increasingly water-stressed and, as such, the protection of all water resources is considered a critical priority.

The framing of parts of the DCCP corridor as critical ecological infrastructure has raised the profile of this area and demonstrated the value of the benefits it provides.

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4 Nick Helme, University of Cape Town, personal communication, 9 September 2011. Nick Helme is widely considered as one of South Africa's leading botanists. Since 1997 he has been working as a botanical consultant specialising in the diverse flora of the south-western Cape.

5 Ecological infrastructure is a concept which forms part of the dominant approach to natural resource management; it can be defined as 'naturally functioning ecosystems that generate or deliver valuable services to people. It is the nature-based equivalent of built infrastructure, and is just as important for providing services and underpinning economic development' (SANBI 2016: 19).

6 Peter Flower, Director: Water and Sanitation Services, Water and Sanitation, CCT, personal communication, 28 July 2016.

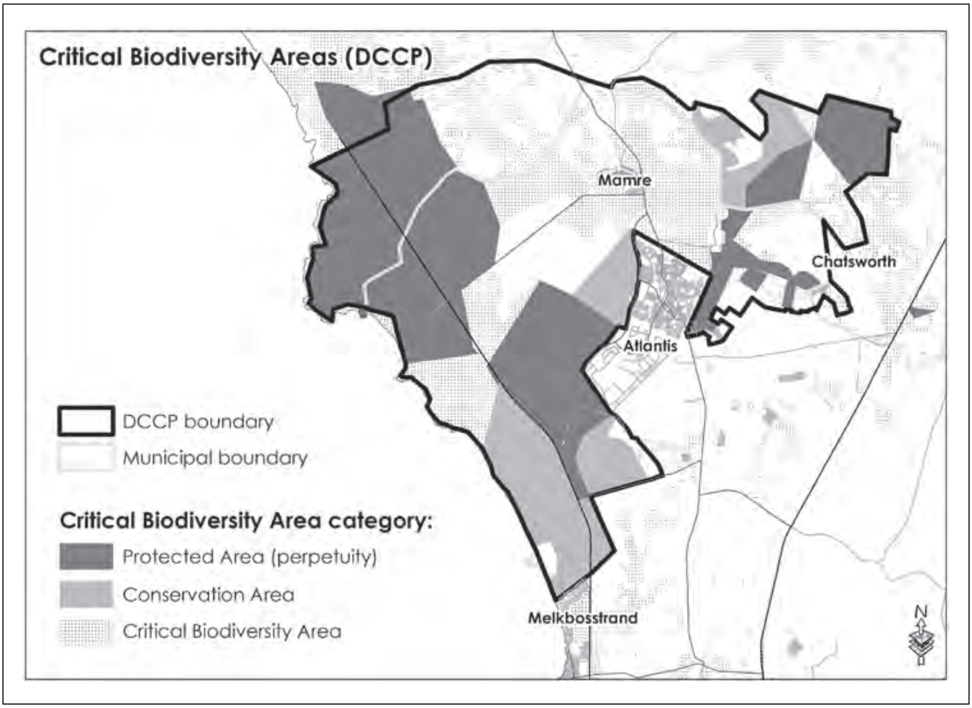

Figure 13.1: Critical Biodiversity Areas within the DCCP
Data source: J. van der Merwe, CCT, map drawn for this chapter

The importance of this source of water and the vulnerability of Cape Town in relation to the recent droughts have been used by the partnership to garner further support for the initiative. The presence of this aquifer alone is good enough reason to protect the critical recharge areas. The partnership has been supportive of the establishment of a Water Fund in partnership with The Nature Conservancy, which shows significant potential for securing resources from both public and private sectors to protect the quality and quantity of water extracted from this aquifer.[7] This will be made possible by the funding of critical ecological management interventions and creation of numerous green job opportunities.[8]

7 The Nature Conservancy is a leading international conservation organisation working around the world to protect ecologically important lands and waters for nature and people. See www.nature.org, accessed 19 January 2019.

8 'Green jobs' involve work that contributes substantially to preserving or restoring environmental quality, for example, jobs that help to protect ecosystems and biodiversity; reduce energy, materials, and water consumption; de-carbonise the economy; and minimise waste and pollution. See https://www.environment.gov.za/projectsprogrammes/greeneconomy/about, accessed 19 January 2019.

The need for protection: socio-economic opportunities provided by the DCCP

The DCCP considers the communities in and around the Dassenberg coastal catchment area as a priority for economic and social upliftment (CCT 2012a) as the corridor where it is located is a 'live-in' area, with some of the highest unemployment figures in the city; Atlantis, for example, has a 26,58 per cent unemployment rate (CCT 2013a). The DCCP has embraced the biosphere concept in that all types of land use need to be accommodated, which means that land needs to be available for industrial, residential, intensive agriculture and other uses that are able to provide jobs. If the DCCP is to succeed, conservation authorities need to demonstrate that conservation is a viable land use that can contribute to the socio-economic development of the area.

Forms of protection

In line with the change in the policy landscape and with the DCCP's own objectives (discussed in more detail below), the forms of protection that the DCCP seeks to use cannot be limited to formally protected areas. In addition to the mandate of conserving threatened ecosystems, there is an increasing imperative to adopt an ecosystem-based approach to adapting to climate change in this context.

The shifts in policy towards an ecosystem-based approach to adaptation reflect a departure from the country's historic 'protectionist' approach to biodiversity conservation, which was dominant in the latter half of the 20th century (Ramutsindela 2004). This approach focused predominantly on state protection of individual species and isolated and fragmented parcels of state-owned land within protected areas situated in rural areas (Neumann 2004), and often excluded areas of high biological importance (DEAT 2005a, 2005b; Kumleben et al. 1998).

In 2000, Cape Action for People and the Environment (CAPE) initiated a 20-year strategy and partnership with government and civil society aimed at conserving and restoring the biodiversity pattern and ecological processes in large landscapes of the Cape Floristic Region and the adjacent marine environment, while delivering significant benefits to the people of the region (Ashwell et al. 2006; CAPE 2000; Cowling et al. 2003).[9] The inclusive nature of this programme was intended to ensure that all stakeholders benefitted from the conservation of our natural heritage. CAPE is a partnership involving a wide range of departments from the three spheres of government as well as a diversity of NGOs. This 'conservation and society' approach, which did not initially include climate change adaptation, is considered as the 'business as usual' approach to biodiversity conservation nationally and in the Cape Floristic Region (Palmer et al. 2015). In addition, the CCT produced its first ground-truthed fine-scale conservation plan, the

9 See www.capeaction.org.za, accessed 19 January 2019.

Biodiversity Network (BioNet), in 2002 (Holmes et al. 2012).[10] With the growing importance of climate change, landscape initiatives in South Africa, including the BioNet (see Chapter 8 of this book), have recently shifted to incorporate the objectives of climate change mitigation and adaptation into their strategies, with a focus on promoting the resilience of ecosystems (DEA 2013a; SANBI 2011).

In light of the above, the DCCP has implemented a number of innovative tools to increase both the area of biodiversity under conservation stewardship and the formal protected area estate. Of importance in the governance of the corridor is the partnership's engagement in expanding the involvement of stakeholders in the corridor through innovative stewardship options, in order to increase the conservation and governance of biodiversity. It has also strengthened its role in the protection of the aquifer recharge zone through supporting the creation of the Water Fund and of opportunities for 'green jobs' in the corridor as mentioned above, thus contributing to development in the area.

Governance approach

Within the field of adaptation to climate change there is a growing interest in governance and a recognition of the need for actors that interact and collaborate together across different scales (local, provincial and national) to engage with the environment in order to 'realise adaptive capacity' (Ziervogel & Parnell 2012: 225). The DCCP as a partnership is such a multi-scalar governance mechanism, which aims to fulfil the goals of ecosystem-based adaptation in a complex, rapidly urbanising city. Here, the municipality is positioned as one actor among a range of actors participating in a collaborative process to set goals to guide the implementation of interventions that will increase adaptive capacity, given the existing institutional constraints and political pressures.

Addressing threats to biodiversity and the protection and conservation of biodiversity is a strategy of adaptation to climate change. Therefore the institutional arrangements related to biodiversity conservation, which include the governance actors, their policies and management strategies, are critical in climate change research (Latour 2014; Ziervogel & Parnell 2012). It is argued in this chapter that understanding how the governance of climate change landscape initiatives occurs is critical to effectively implementing ecosystem-based climate change adaptation.

There are many definitions of, and approaches to understanding, governance. The literature shows how the shift from government to governance has involved a shift from top-down, state decision-making to the inclusion of non-state actors in decision-making processes (Driessen et al. 2012; Gupta et al. 2015). In cities, urban governance is referred to alternatively as 'the multiple [ways] through which diverse actors intervene in controlling and managing the city' (Castán Broto et al. 2015: 572) and as transforming the city into a more desirable state (Pelling 2010).

10 'Ground-truthing' involves physically assessing the ecological condition of a given area.

Of relevance here is the definition of environmental governance as 'all kinds of measure[s] deliberately taken to prevent, reduce and/or mitigate harmful effects on the environment [such as] the depletion of resources, biodiversity loss and climate change' (Driessen et al. 2012: 144).

A central focus when examining governance is the set of interdependent 'actors' that are involved, and how they reflexively interact and negotiate to produce joint decisions and collective solutions to societal problems in the face of 'diverging interests, worldviews and conceptions' (Sørensen & Torfing 2007: 12). Typically, these actors are multiple and multi-level, that is, they can be at the local, provincial, national or international level (Donaldson et al. 2013). The shift to the governance of ecosystem-based adaptation through multiple partners is evident in the CAPE partnership, which has been flexible enough to allow a range of governance arrangements to be adopted (Ashwell et al. 2006).

The DCCP and the context in which it is located

Location of the DCCP, land ownership and management responsibility

While the majority of the DCCP area falls within the CCT, it also lies partially in the neighbouring Swartland Municipality (Figure 13.2). Within the CCT boundaries, the towns of Mamre and Pella are included in the DCCP while the town of Atlantis is surrounded by it on three sides. In the Swartland Municipality, the towns of Chatsworth, Riverlands and Kalbaskraal are in close proximity.

The DCCP is a unique landscape initiative as it is entirely located in the lowlands, the biodiversity of which is far more threatened than that of mountainous areas due to the pressure of agricultural and urban expansion and economic development. The DCCP project area encompasses approximately 34 000 hectares. Of this, 39 per cent is owned by the state, 12 per cent by the CCT, 20 per cent by the Mamre community and administered by the Mamre Community Property Association, and 29 per cent is privately owned (Figure 13.3). Towards the coast there are two large private properties with limited agricultural potential, which are still in extremely good ecological condition. The northern portion of the corridor comprises a number of large commercial farms which have been extensively transformed by intensive agriculture, but include high-quality vegetation remnants of conservation significance. The series of hills in the west of the DCCP corridor, known as the Dassenberg, is subdivided into numerous smallholdings used for agricultural activities and lifestyle residences.

The Mamre community land, comprising approximately 6 460 hectares, lies in the centre of the DCCP corridor. Portions of this land are of critical importance to the corridor as they create the only viable link connecting the inland Riverlands and Klein Dassenberg sections to the coastal Witzands and Ganzekraal sections.

Figure 13.2: The location of the DCCP in Cape Town
Data source: J. van der Merwe, CCT, map drawn for this chapter

The significance of the land ownership of the DCCP corridor is discussed later in this chapter.

As the partnership has progressed, the governance arrangements have included sharing of the management of public land by the partners, specifically the CCT and CapeNature. The CCT is the responsible management authority for the Witzands and Klein Dassenberg sections, and CapeNature for the Ganzekraal and Riverlands sections. Eskom, as a parastatal, is responsible for the 3 000-hectare Koeberg Nature Reserve (Figure 13.4). The CCT manages four Provincial Department of Public Works properties vested with CapeNature. In addition, private landowners manage various stewardship sites. This shared management responsibility ensures a pragmatic approach and the most efficient use of resources across the corridor, and has cemented the partnership.

The establishment and function of the DCCP

As discussed above, the DCCP has its origins in the implementation of the BioNet, the fine-scale conservation plan for the city (CCT 2006: Item 39/12/06, 2015: Item C43/08/15) that indicates which parcels of land are classified as Critical Biodiversity Areas (CBAs) and have to be conserved to meet national conservation targets

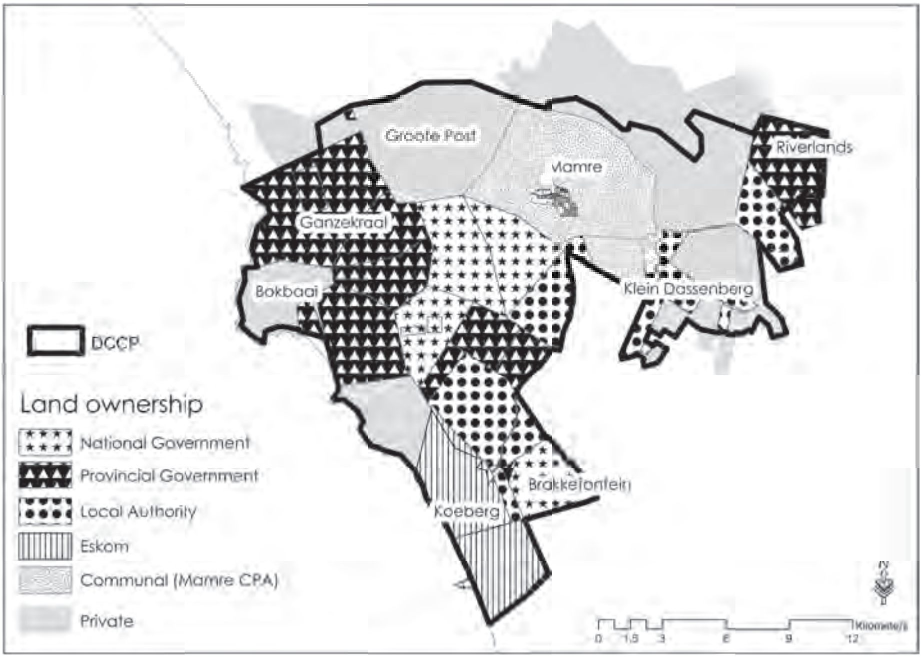

Figure 13.3: Land ownership in the DCCP
Data source: J. van der Merwe, CCT

(Rebelo et al. 2011).[11] The BioNet Implementation Committee was set up in 2010 as a governance mechanism to implement the BioNet. This committee comprised three levels of state authorities, namely SANParks (the national protected area authority), CapeNature (the provincial conservation authority) and the CCT (the local authority), as well as the Cape West Coast Biosphere Reserve (CWCBR).[12] The BioNet Implementation Committee partners signed a memorandum of understanding which detailed each of the authorities' obligations in respect of the implementation of the BioNet (CCT et al. 2011).

The BioNet shows that there is a large concentration of unprotected CBAs in the north-western portion of the city, indicating that many of the priority

11 See http://www.capetown.gov.za/Departments/Environmental%20Management%20Department, accessed 23 January 2019.

12 The UNESCO World Network of Biosphere Reserves covers internationally designated protected areas, known as biosphere reserves, that are meant to demonstrate a balanced relationship between people and nature. The Cape West Coast Biosphere stretches northward from Diep River in Cape Town to the Berg River and covers 378 000 hectares of coastal lowland plains. See https://www.capebiosphere.co.za/, accessed 10 January 2019.

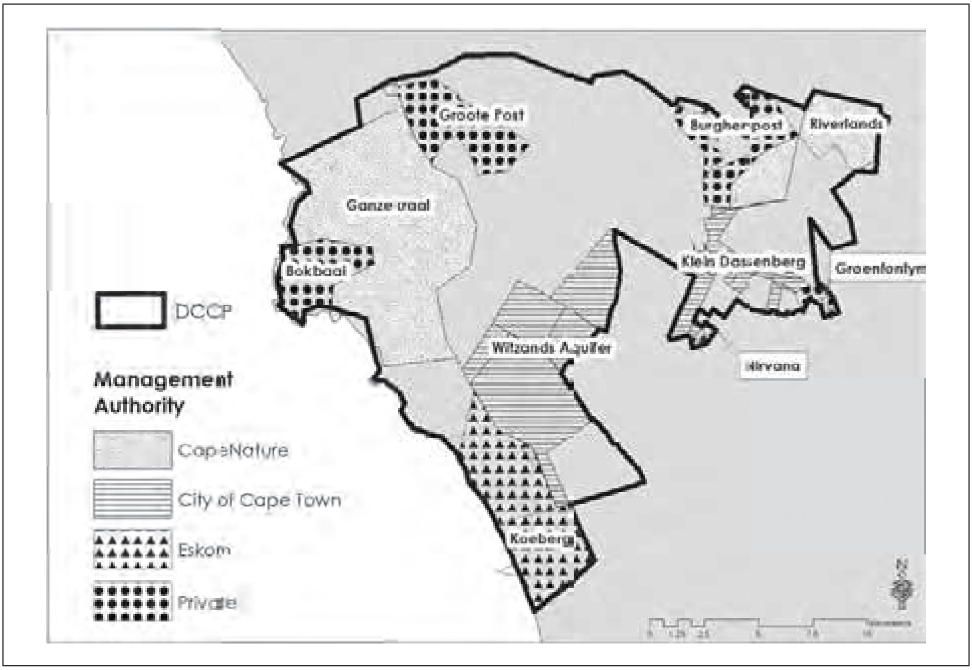

Figure 13.4: Protected areas management authorities
Data source: J. van der Merwe, CCT, map drawn for this chapter

properties for conservation action lie in this area (see Figure 13.1). Since the early 1980s, conservationists have motivated for the establishment of a greater protected area in this region (Daines & Low 1993; Jarman 1986; Kilian 1995; Purnell et al. 2010). In 2009, Pence identified the Riverlands–Pella–Bokbaai corridor as one of the two highest-priority climate change corridors in the province (Pence 2009). This situation provided the impetus for the BioNet partners to undertake a project to try to protect this corridor. At a special meeting on 5 March 2012, the conservation partners present (the CCT, CapeNature, the World Wide Fund for Nature (WWF), the Table Mountain Fund (TMF)[13], the South African National Biodiversity Institute (SANBI) and the Wilderness Foundation) agreed to the objectives of the landscape initiative.[14] Given its location, physical characteristics and the need for engagement between multiple actors, it was named the Dassenberg Coastal Catchment Partnership. The term ‘coastal catchment’ was used

13 The TMF is a capital trust fund set up by the WWF to fund conservation projects (see www.thetablemountainfund.org.za), accessed 19 January 2019.

14 The Wilderness Foundation is a conservation organisation whose mission is to protect and sustain wilderness areas and wildlands through integrated conservation and education programmes. See www.wildernessfoundation.co.za, accessed 19 January 2019.

as a way of highlighting the Witzands Aquifer which is a significant feature of this corridor.

The objectives of the DCCP as agreed to by the partners are:

a) to protect critical ecological infrastructure, particularly the Witzands Aquifer
b) to deliver socio-economic opportunities to the communities of Atlantis, Mamre, Pella, Chatsworth and Riverlands
c) to ensure the protection of the identified critical climate change adaptation and mitigation corridor
d) to protect and promote the valuable natural and cultural heritage of the area (DCCP n.d.).

The DCCP partnership and other institutional arrangements

The original partners of the DCCP were joined by other actors with an interest in conserving the corridor. In 2013 the Provincial Department of Environmental Affairs and Development Planning (DEA&DP), responsible for the approval of development within the corridor, joined as it is the competent authority of the National Environmental Management Act (NEMA, No. 57 of 2003) and was supportive of a landscape initiative in such a threatened region. Since Eskom owns and manages the 3 000-hectare Koeberg Nature Reserve which is part of the DCCP, it was also in its interest to be a member of the partnership, which it cemented in 2014. Due to the ecological significance of the project, CAPE recently elevated the DCCP to be one of its important landscape initiative projects.

The participation of these influential partners (two national-level state departments, a national parastatal, two provincial authorities, a local authority, three national conservation NGOs and one international conservation NGO) is evidence of the high profile and importance of the DCCP. Furthermore, the organisations that are partners in the DCCP are members of other networks, increasing the linkages and strength of the DCCP. Of the partner organisations, the CCT contributed the most resources until the receipt of Global Environmental Facility (GEF) funding during the GEF 5 process in August 2016, which is administered by CapeNature on behalf of the partnership.[15] Decision-making takes place through deliberation among the partners on issues of concern, with decisions being made by mutual agreement. However, it is believed that the partnership works largely due to individuals who are committed rather than to institutional frameworks.[16] Partnership meetings are held four times a year and facilitated by the CCT. However, the operational staff of the CCT and CapeNature engage in implementation work on a regular basis.

15 The GEF works with partners to tackle the planet's biggest environmental issues. See www.thegef.org, accessed 19 January 2019.

16 This view is based on the experience of one of the authors of this chapter, Clifford Dorse, who works with the DCCP on behalf of the CCT.

The DCCP has working relationships with communities in the region, developed by working through existing community structures, and a communications strategy which ensures regular feedback is given to these communities (DCCP 2015). Local community participation is also a cornerstone of the Protected Areas Advisory Committees of the proclaimed nature reserves located in the corridor (Witzands and Riverlands).

Governance of the DCCP

The DCCP is an example of a multi-level partnership, and there is mounting evidence of a growing number of such partnerships for climate change-related governance in cities around the world (Bulkeley 2010; Bulkeley & Castán Broto 2013). The range of different actors involved results in wide variation in the perception of problems and their solutions (Sørensen & Torfing 2007). The multiple actors also provide the benefit of increased resources and capacity to address problems together. A partnership is a narrower form of a network, as all parties are committed to the realisation of a shared objective, in this case the implementation of a set of tools to enlarge the protected area and conserve biodiversity in order to increase resilience and hence adapt to climate change.[17] Partnerships are able to form cooperative linkages across scales, and this:

> *in the context of climate change, [is] important because partnerships offer the opportunity to link the actions of diverse actors with different scales of operation, and thus they may be flexible enough to deal with uncertain futures and changing development demands (Castán Broto et al. 2015: 45).*

It is important to note that the use of a multi-stakeholder partnership to involve and benefit local communities is integral to the landscape initiative approach. Since cities and their regions are increasingly conceptualised as integrated socio-ecological networks, there is a need to include both environmental and development goals in the work of partnerships, particularly in cities of the global South (Simon & Leck 2015; Wakefield & Braun 2014).

Initially, the partnership did not have 'rules' of interaction by which to operate, as the partners all came from different institutional contexts. However, the central role played by the CCT and the provincial conservation authority, CapeNature, and their mandates to protect biodiversity and advance ecosystem-based adaptation, have provided a high level of stability in the DCCP. As the members have engaged over time, they have built trust, shared viewpoints and

17 A network is created through the coordination of interactions among a set of actors (state and non-state), facilitated by information technology for a given purpose. This is opposed to a more bureaucratic structure of interaction based on formal rules (Castells 2000).

developed a joint understanding of how they will operate in order to fulfil their joint objectives. Since most of the partners are in the biodiversity conservation and ecosystem-based climate change adaptation sector, a shared understanding of the conservation issues in the corridor provides a solid foundation for joint policy-making and action.

The conservation community in the fynbos biome, where the DCCP corridor is located, has had a long history of collaboration through organisations such as the Fynbos Biome Programme, the Fynbos Forum and, more recently, CAPE. It is the realisation that they need each other in order to work out effective solutions to problems that often drives these new constellations of actors to collaborate (Driessen et al. 2012; Hajer & Versteeg 2005). Through their experience in these organisations, trust and collaborative ways of working were well established among the partners.

The DCCP is a relatively young partnership, having only been established in 2012, and is largely state-led, but has made significant progress in implementing a range of tools to secure the DCCP and expand its coverage and membership. The DCCP has also had a core team of passionate champions, an essential ingredient for successful partnerships (Ashwell et al. 2006). A sense of identity and pride has been derived by the fact that the DCCP corridor was identified as one of the key TMF-WWF climate change corridors in 2010.

Tools used by the DCCP to facilitate implementation

All the CAPE landscape initiatives are different and unique, as each has a set of different issues and landscapes to deal with (Palmer et al. 2015). CAPE and SANBI continue to provide a set of tools which each initiative has used and modified to suit its needs (Cadman et al. 2010). This section presents some of the main processes and tools that have been instrumental in the DCCP landscape initiative becoming a reality. The majority of the tools originate from the CAPE partnership but others, such as the land banking mechanism, have not been widely used or are unique to the DCCP.

Mainstreaming the DCCP into the CCT's policies and plans

On 18 September 2012, the Executive Mayor together with the Mayoral Committee of the CCT resolved that 'the DCCP initiative be recognised and supported as an important multi-stakeholder project that can bring benefits to the region' (CCT 2012b: Item MIC, 09/09/12). The DCCP was included in the City's Integrated Development Plan (IDP) as an important project (CCT 2015/2016) and is aligned with the Cape Town Spatial Development Framework (CCT 2012c) and the Blaauwberg District Plan (CCT 2012a). It is also included in the latest draft Local Biodiversity Strategy and Action Plan (CCT 2016b), and forms part of the City's annual performance scorecards such as the CCT Environmental Management

Department's Strategic Business and Implementation Plan (CCT 2016a) and the Mayor's Dashboard (CCT 2016c). In this way the DCCP has become mainstreamed in the CCT's policy and practice. This increases the chance that budget will be allocated to implement the DCCP objectives of biodiversity conservation and ecosystem-based adaptation.

Development facilitation through land banking

Approximately 906 hectares of the vacant land in the Atlantis urban edge and industrial area contain critically endangered Atlantis sand fynbos or endangered Cape Flats dune strandveld vegetation (CCT 2016a). The NEMA Environmental Impact Assessment (EIA) regulations require that environmental authorisation be obtained for the clearance or removal of an area of 300 square metres or more of endangered or critically endangered vegetation. As a result, new developments which contain vegetation remnants in Atlantis will require a time-consuming botanical assessment as part of the EIA process. In addition, the conditions of approval may require complex and costly mitigation measures and offsets to moderate the loss of biodiversity. This delay and the potential mitigation costs are often viewed as a deterrent to investment and development in Atlantis. The CCT is proactively acquiring, managing and retaining important biodiversity land outside the urban edge and in the DCCP corridor as a mechanism to facilitate development in Atlantis. In May 2013, the CCT approved the Atlantis Industrial Incentives Scheme (CCT 2013b). One of the suite of incentives approved was that of holding land outside of Atlantis in order to proactively provide biodiversity offsets. There is no cost to the developer, and the CCT covers both the acquisition and management costs of the land acquired.

This land banking mechanism is a form of biodiversity offsetting. The national policy on biodiversity offsets is currently going through a process of approval (DEA 2016). This proactive method of mitigating for the future loss of terrestrial biodiversity has been supported by the competent authorities, DEA&DP and CapeNature. It is important to note that the loss of the remnant biodiversity in Atlantis can be mitigated at this stage as sufficient high-quality vegetation remains outside the urban edge to meet national conservation targets for the vegetation types in question.

This pragmatic and innovative approach has much potential to facilitate development while ensuring that priority land is added to the conservation estate, thereby securing biodiversity resources and the vital ecosystem services they deliver. To date the City has purchased 11 properties totalling 873 hectares. So far this has been used to facilitate four developments totalling 95,5 hectares. The land acquired through purchase could not have been secured through conservation stewardship, and without this proactive land banking mechanism these critical properties would not have been added to the conservation estate.

The use of conservation stewardship programmes

Approximately 14 per cent of land in South Africa is state-owned, with the remaining 86 per cent falling under private and communal ownership (Department of Rural Development and Land Reform 2014). This has compelled partnerships such as CAPE to fashion new approaches to promoting conservation on private and communal land (Ashwell et al. 2006). Conservation stewardship is such an approach, which has been used extensively in South Africa to promote voluntary biodiversity conservation (Cadman et al. 2010). In recent years, conservation stewardship has been seen as a practical and cost-effective way of growing the protected areas network. In the Western Cape, CapeNature has been running an extremely successful stewardship programme that has secured over 181 292 hectares of private land in the conservation estate since its inception in 2003.[18] The programme provides a suite of financial incentives which can be offered to landowners. Incentives vary according to the level of landowner commitment. Benefits include financial ones (property rates exemption for nature reserves), management assistance (in dealing with alien vegetation and fire, for example) and ecological advice where needed.

In 2009, the TMF supported an application to fund the testing of conservation stewardship in the CCT. Based on the success of this programme, the CCT now has a dedicated Conservation Stewardship Officer who works closely with the CapeNature Stewardship Programme. Twenty out of the 54 private landowners in the DCCP corridor have been approached by the DCCP partners with regard to the stewardship programme. At the time of writing, owners of three properties, totalling 1 050 hectares, have signed stewardship agreements and negotiations are continuing with an additional eight owners.

In addition to this stewardship programme, the DCCP partners have met with the Mamre Community Property Association with regard to the signing of a stewardship agreement. The Mamre community owns a large area of land (6 703 hectares) in the centre of the DCCP corridor. Without the inclusion of some of their land, the corridor will not become a reality.

The Mamre Community Property Association has to consider many critically needed land uses within Mamre, ranging from agriculture to future urban development. These needs are of critical importance in shaping their decision to consider conservation as a viable land use through a conservation stewardship agreement. However, the Mamre community has long had close ties to the natural environment. The town has historically had an open space called '*Natuurtuin*' (Nature Garden) and there is also an annual Mamre Heritage and Wild Flower Show (*Lente Fees*) in spring where the spectacular flora of the area is celebrated.

Negotiations with the Mamre Community Property Association are still under way and while the exact area that may be subjected to some form of conservation

18 Monique Keys, legal advisor to CapeNature, personal communication, 18 May 2017.

agreement has yet to be determined, it is likely to centre on the Nature Garden and the renosterveld hills.

Protected areas expansion

The fact that about one half (17 500 hectares) of the total DCCP corridor is in public ownership is paramount in making the DCCP a viable reality. However, prior to 2010, only CapeNature's Riverlands Nature Reserve and Eskom's Koeberg Nature Reserve had been proclaimed nature reserves. The City's Witzands Nature Reserve was, for all practical purposes, recognised as a conservation area even though it has only recently been through the proclamation process and will be formally gazetted as nature reserve during 2017. Also of immense significance was the vesting of over 7 260 hectares of Provincial Public Works Department land in CapeNature for conservation purposes (CapeNature 2014). In addition, 11 properties comprising 873 hectares of critical biodiversity land have been purchased by the CCT as part of the proactive land banking initiative described above. Finally, as discussed in the previous section, there have been conservation stewardship discussions with the majority of the private landowners in the DCCP corridor. Taking into account all of the above, to date 15 565 hectares (45,7 per cent) of the total corridor area of 34 000 hectares is considered secured for conservation.

Socio-economic interventions by the DCCP

Since 2012, the conservation partners have spent over R20 million and created work opportunities that amounted to more than 97 000 days of work for the local communities on conservation-related activities in the DCCP corridor. In addition, a 'Working on Fire' team of 22 people has also been established and is based in Mamre. While the majority of the jobs are temporary, permanent work opportunities related to DCCP reserve and infrastructure management have already resulted in a small number of permanent jobs. There is great potential to enhance the numerous existing recreation and tourism activities that take place in the DCCP area, for example the Mamre Flower Show. Furthermore, given the close proximity of the DCCP corridor to Cape Town and the West Coast tourism route, there are many opportunities to establish new recreational and tourism activities.

The DCCP affords many opportunities for the facilitation of environmental education programmes. Many awareness and formal environmental education programmes have been undertaken in the nature reserves and in the local communities of Mamre, Atlantis, Pella and Chatsworth. Recently, the Cape Town Environmental Education Trust has become involved in providing environmental programmes in Bokbaai, a private conservation estate.

The public access points to the coast at Ganzekraal and Silverstroomstrand are highly significant regional recreation nodes with great potential for enhancement. These are extremely important social elements of the DCCP corridor and their benefit and use must be optimised.

The water crisis and the presence of critical ecological infrastructure

The 2015 to 2018 drought and water restrictions have highlighted the critical importance of all water resources to the politicians and residents of Cape Town. The valuable contribution of the Witzands Aquifer to Cape Town's water security is now widely recognised. This is being used by the partnership to garner further support for the initiative. Due to the significance of the Witzands Aquifer, the Greater Cape Town Water Fund was established by The Nature Conservancy in 2016. This Water Fund is a valuable new partner of the DCCP which shows significant potential for securing resources to protect the quality and quantity of water extracted from this aquifer. These actions will fund critical ecological management interventions and create numerous green job opportunities.

Challenges to implementation

Despite the good progress that has been made in protecting the DCCP corridor, a number of challenges currently prevent or slow the pace of full implementation.

Lack of dedicated resources

Although a robust partnership, the DCCP has been driven by relatively few officials from the CCT and CapeNature. None of these staff are allocated full-time to the DCCP and this lack of governance capacity prevents the unlocking of the many environmental and socio-economic opportunities that could be developed. This gap has long been realised by the partnership, and the appointment of the GEF 5-funded DCCP coordinator on 1 October 2016 for a three-year term can be considered a huge success. The funds are allocated to CapeNature, which has appointed the DCCP project coordinator until December 2019.

Increasing land values

Land values across South Africa have been increasing dramatically in recent years. This is especially evident in regions close to urban centres such as Cape Town. As such, the price of land in 2016 without any improvements was approximately R12 000 per hectare for the larger farms in the corridor. For the smallholdings this value increased to over R70 000 per hectare, with views adding to the sale prices. Many of the properties critical to protecting biodiversity in the DCCP corridor are smallholdings. While stewardship is the preferred mechanism for protecting these sites, some will need to be acquired through purchase. However, the cost per hectare for these farms makes it a challenge for sufficient funds to be raised through the conservation community. This is why the land banking mechanism and the proposed Water Fund are such important tools in the protection and expansion of this corridor.

Roads and bottlenecks

The ecological functioning and recreational and tourism potential of natural areas is diminished by the presence of major roads and bottlenecks. The DCCP corridor is intersected by several major arterials. The three most significant of these are the West Coast Road (R27), the Dassenberg Road (R307) and the Silverstream Road (M135). These roads are a threat to fauna and also impact on the safety of various potential user groups such as mountain bikers and hikers. Vegetated overpasses in strategic positions have been considered as solutions to this challenge. Underpasses to facilitate faunal movement would also be of value. In addition, roads and infrastructure fundamentally transform natural drainage, infiltration, through flow and surface flow. There is one area between Mamre and Atlantis where the DCCP corridor is at its narrowest and is only 1,4 km wide, and the land here is not currently protected. If this link is not conserved the corridor will not become a reality.

Crime

The high levels of poverty and unemployment in the region have led to an increase in crime. The theft of any infrastructure that can be reused or sold for scrap is prevalent. While many areas of the DCCP corridor will not be fenced, the boundaries still need to be demarcated and livestock and vehicle access needs to be prevented in certain areas. The reality is that when any infrastructure is installed there will have to be a constant monitoring presence to protect it, and while this means that there is potential to create employment, there are limited operational budgets to pay for this needed capacity. There is potential to create green jobs through the Green Wardens programme within the Expanded Public Works Programme (EPWP) that can defend infrastructure that is installed. The Green Wardens Programme is an initiative developed by the CCT using national EPWP funding in an effort to improve open spaces and maintain the gains made by clearing invasive alien vegetation. However, crime is best managed by treating the underlying structural conditions, namely the high levels of poverty and unemployment in the communities. While this is a long-term solution, it is envisaged that the DCCP can contribute to people realising the value of the area by creating jobs and providing venues for recreation, relaxation and environmental education for all local people.

Land invasion

The threat of land invasion into the DCCP corridor is a further challenge to the functioning of the corridor. The threat exists primarily in the vicinity of the Silverstream Road, where approximately 130 informal farmers have been living for many years. While the land does not have high agricultural potential and is sub-optimal for farming, there is a risk that more small farmers will move into the area. In some areas people are not physically moving onto the land but are utilising it as grazing land for their livestock. These issues will be a significant challenge as the partnership goes forward, and the solution is closely tied to resolving the socio-economic challenges in the greater area.

Conclusion

The international and national focus on climate change has enabled the DCCP to gain political and public support because of its role in contributing to climate change adaptation. By adopting an ecosystem-based approach to climate adaptation in the DCCP corridor, the coastal-inland link with large tracts of intact threatened natural vegetation has been achieved, along with the securing of an important aquifer, and provision of ecosystem services. The increase of land under conservation through a range of innovative mechanisms will not only protect threatened biodiversity but will also increase ecosystem resilience in the face of climate change.

Since its inception the DCCP has had great success and, as the partnership has progressed, the main players (the CCT and CapeNature) have become heavily invested in the area as managing authorities. With over 15 000 hectares already conserved, all the conservation partners committed to the initiative and benefits being delivered to the community, the DCCP is an established partnership that is evolving and having positive benefits. The most significant challenges that lie ahead are ensuring that the DCCP increases tangible socio-economic benefits in the area; that a conservation stewardship agreement with the Mamre community is finalised; and that the partnership continues to provide effective governance in both policy formulation and implementation. The recent opportunities that have arisen — namely the appointment of the GEF 5-funded dedicated DCCP coordinator and the establishment of the Water Fund — should strengthen the success of the DCCP markedly.

What sets the DCCP apart from the other landscape initiatives is that it is located adjacent to one of South Africa's largest metropolitan areas, with the CCT as a main driving partner. The urban character of the DCCP makes it critical to facilitate development and to deliver benefits to local communities while conserving the biodiversity of the region and implementing the corridor. This chapter has demonstrated how the DCCP, as a form of governance, has adopted and innovatively implemented a range of new and existing tools and mechanisms, contributing to the expansion of areas of biodiversity conservation, and delivering benefits to the local communities. Through its work the partnership is contributing to climate change adaptation in the city by protecting water supplies through protection of the aquifer, and to biodiversity conservation via the expansion of the conservation estate. Since interventions to implement the DCCP are now embedded in the City's IDP and a range of policies and performance plans, it also serves as an example of the mainstreaming of biodiversity conservation, as a climate change adaptation approach, into CCT planning.

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CHAPTER 14

Environmental fiscal reform: efforts at co-producing the transition to a climate-resilient economy in Cape Town

Anton Cartwright and David Savage

An emerging global narrative, captured in the Sustainable Development Goals of 2015, recognises climate change as having its origins and its potential solutions in economic activity and human development (NCE 2014; Sagoff 2012). This narrative highlights the role of the world's urban centres as sources of greenhouse gas pollution (Rosenzweig et al. 2011; Satterthwaite et al. 2009), places where climate change risks coalesce (Cartwright et al. 2012; UN-Habitat 2008; WEF 2016), and the likely loci of the adaptation and innovation required to respond positively to climate change (Cartwright 2015; Djalante et al. 2011; Glaeser 2011; LSE Cities 2012; Robert et al. 2014; Stern et al. 2011). The Global Warming of 1,5 °C Special Report prepared by the Intergovernmental Panel on Climate Change (IPCC), for example, is explicit in linking climate change, development and cities (IPCC 2018).

Progressive cities have been quick to embrace this narrative in order to attract investment, protect citizens and gain competitive advantage in low-carbon sectors (LSE Cities 2013; Parnell 2015). For cities looking to realise these benefits, the question becomes, 'How to go about it?' In theory, local authorities are able to marshal their fiscal, legislative and leadership power to effect change (Rode et al. 2014). In reality their actual economic influence is often over-estimated (Harrison et al. 2015). This is particularly true in African countries where the devolution of decision-making power and budgets has been slow, and where local authority is frequently contested or captured by vested interests (Boex & Edwards 2014; Jaglin 2015; Taylor et al. 2014).

This chapter aims to present the City of Cape Town's Environmental Fiscal Reform programme, which is a product of the co-produced efforts of a South African municipality to use its budget to influence a transition to urban climate resilience. The chapter suggests that such fiscal innovation is potentially powerful, but risky and insufficient on its own.

Co-producing a fiscal approach to transitioning an urban economy

The climate change literature has been effective in highlighting costs and benefits and in calculating the need for investment. It has, however, paid very little attention to the role of municipal resource allocations — both people and money — in influencing the required changes (Boex & Edwards 2014; Rode et al. 2014). In the process an important policy tool has been lost (Keefer & Khemani 2005).

The lack of attention given to fiscal approaches, and budget allocations in particular, mean there are very few precedents on which officials looking to support a climate-resilient urban economy are able to draw. For the City of Cape Town Municipality (CCT, also referred to as the City), the process of environmental fiscal reform was novel, experimental and precarious — all the more precarious because of the legislative constraints under which Cape Town's budget is allocated, and the inevitable risk that accompanies any economic transition.

It was for this reason that the CCT engaged in a one-year co-production process, beginning in October 2012, aimed at making a judicious and context-appropriate shift in the City's budget allocation. Co-production involved an academic specialising in the green economy working from a desk within the local municipality. The academic was charged with exploring ideas and options with the City's budget team. Importantly, this exploratory process had to take place within the confines of the urban bureaucracy — a complex legal and institutional system that has evolved over time, and which is unfamiliar to people who do not work within it.

Understanding the Cape Town context

Cape Town has changed dramatically over the past two decades. One of the more visible changes was confirmed by Census 2011 data; the city's population grew by 847 782 (roughly 25 per cent) between 2001 and 2011 (Statistics South Africa 2012). The growth was accelerated by the estimated 33 000 people who moved to the city annually over this period from within and outside South Africa (CCT 2014). Not everyone moving to Cape Town found formal housing and secure employment. Informal settlements have grown over the past two decades, and 21,3 per cent of job seekers and 49,4 per cent of the 15–24-year-olds that were actively looking for work were unemployed in Cape Town in the second quarter of 2015 (CCT 2018).

Exclusion from Cape Town's urban economy has been exacerbated by the inability to redress South Africa's capital-labour ratio in favour of employment.

This structural impediment to economic participation has been compounded by education sector failure, and by a mismatch between the skills required to advance the economy and those available to the labour market, and a replication of the apartheid space-economy in urban areas (Bloch 2011; Modisaotsile 2012; Pieterse 2013). These structural features of the South African economy have been further exposed by technological and market shifts in the global economy. Against this backdrop the urbanisation of technically unskilled labour into Cape Town has been particularly difficult.

Population growth, urbanisation and a decrease in mean household size from 3,72 to 3,2 between 2001 and 2018 (CCT 2018b) have tested the CCT's infrastructure and service delivery capacity. The need to continue providing infrastructure and services to rate-paying communities while extending services to new indigent communities, many of whom reside in informal settlements and do not pay rates, necessitates tricky budget redistribution and cross-subsidisation. The CCT's ability to strike the required balance is regarded as sophisticated (Bénit-Gbaffou et al. 2008; Gibb 2007; UN-Habitat 2014), but this has not prevented a significant service delivery deficit that itself has replicated inequality. Cape Town has the second-highest mean household income in South Africa (R143 460 per annum) (Statistics South Africa 2012), but a Gini coefficient of 0,61 in 2017 (CCT 2018a).

The implication is that programmes targeting climate change adaptation are most likely to gather political support and succeed where they can simultaneously deliver services and economic opportunities to Cape Town's poorest communities. One of the constant dangers in a city such as Cape Town is that climate initiatives become a luxury good, the domain of an affluent middle class that conflates the goal of a climate-resilient economy with the conservation of beautiful recreation environments. While the goods and services provided by Cape Town's acclaimed natural environment are important to the city's climate change response (Cartwright & Oelofse 2016), the intention of the Environmental Fiscal Reform programme was to go beyond traditional conservation and insert Cape Town's climate change response into the municipal mandate to provide services, support the local economy and foster an inclusive society.

In pursuing an urban climate change programme, the CCT is able to draw on a number of supportive policies and strategies (Taylor et al. 2014). The City has crafted an Integrated Metropolitan Environmental Policy, and has commissioned research that values the goods and services provided by Cape Town's natural assets at between R2 billion and R6 billion per annum, based on an asset value of R43 billion to R81 billion (De Wit et al. 2009). In 2010, the CCT commenced the rollout of an Integrated Rapid Transport system and later linked this system to a process of urban densification. The collective effort has seen Cape Town recognised as a climate change and green economy leader (Siemens 2011; Taylor et al. 2014; UN-Habitat 2014). The regional government of the Western Cape Province has similarly supportive climate policies and the stated ambition of becoming the 'green hub' of the African continent (Zille 2012).

As in many cities, however, it has proven difficult to convert Cape Town's environmental policies into budget allocations, or to reconcile the increasingly fervent calls for environmental protection with existing development priorities (Boex & Edwards 2014). It is one thing to argue that Cape Town possesses the human, biophysical and institutional capacity for a climate-resilient green economy, but another thing altogether to transition from the current economy and realise this potential (Attwell 2013). Cape Town is in many respects the antithesis of a climate-resilient city. High levels of urban poverty co-exist with high levels of carbon emissions and resource consumption. Per capita carbon emissions range between 7,82 tons of carbon dioxide (tCO_2) per annum (Lewis & Jooste 2012) and 5,4 tCO_2 (WCG 2018), depending on the mode of analysis. In spite of dramatic reductions, the city's solid waste amounts to over 670 kg per person per annum and less than 10 per cent of all waste is recycled (Davison 2014).[1] Social exclusion in terms of access to services, structural unemployment, spatial form and ethnic prejudice is an obdurate feature of life for many residents of Cape Town, as is reflected in the income Gini coefficient (CCT 2015a).

Addressing these features of Cape Town's economy would highlight the long-term benefits that are frequently identified in the climate change and green economy literature (Jacobs 2012; NCE 2015; UNEP 2011; World Bank 2012). However, the up-front costs and revenue losses that would be incurred in the transition are difficult to finance in a municipality that is already subject to acute budget constraints and demands for redistribution, and which may not run a deficit budget in terms of South Africa's public finance legislation. While the promise of donor, national government and United Nations' Green Climate Fund resources gains momentum, it is local resources that are most readily available and most easily aligned to existing priorities (Barnard 2015; Kumar 2015; Stren 2012). Furthermore, it is the allocation of locally generated resources that provides the truest indication of a city's values and aspirations (Batley & Harris 2014; Hicks 1961; McCloughlin 2015; Wolf 2009). Unless cities are prepared to spend their own budgets in pursuit of climate resilience there is a real danger that the pursuit of a climate-resilient economy becomes an addendum to their actual urban economies and is adopted opportunistically and inconsistently (Brekke 1997; Jacobs 2012).

In this sense it was conspicuous that Cape Town's climate change ambition was, prior to the Environmental Fiscal Reform programme, difficult to detect in the City's annual budget. Many of the celebrated projects and initiatives were dependent on donor funding and presented no opportunity cost for the CCT budget. Ledger entries show that allocations to the Environmental Resource

1 The annual amount of solid waste per person in Cape Town can be compared with the figure for Addis Abba: 160 kg per person per year.

Management Department (ERMD) by the City have consistently been less than one per cent of total budget, and that in narrow budgetary terms this department contributed much less to the local fiscus than it received.

Co-producing environmental fiscal reform

While the history of successful economic growth is clear with regard to the enabling role that the state has to play in the economy, the same history suggests that this role needs to be exercised with caution and must be alive to unforeseen consequences (North 2010). Certainly Cape Town's particular socio-economic and institutional characteristics render the use of budget allocations to drive an economic transition risky. It was only in 2000 that local government remits were recast in South Africa so as to take up their constitutional responsibility for the economy and a safe environment. For the most part local governments in South Africa, including Cape Town, have been preoccupied with extending and sustaining access to basic services, building an effective civil service, spending the available money and complying with the requirements of public finance legislation. Within this context budget innovation, especially where it involves the retrenching of staff, has not been a priority.

Given the context, senior officials requested that any experimentation with the CCT's budget in support of the transition to a climate-resilient economy be both incremental and guided by a set of economic principles. The Environmental Fiscal Reform process set out to identify projects that, if supported in the budget, would begin to effect the required transition. The hope was that in the process of creating illustrative precedents, Cape Town's climate change ambition would be given meaning in the budget, and the merits of a set of economic principles that could be used to shape the local economy would be demonstrated.

Three categories of green economy projects were defined. The first saved the City money by avoiding costs. The second category of options sought to re-allocate existing budgets to activities that were better for the environment and for people. The third category of options required additional expenditure, but unlocked environmental and economic benefits that exceeded the cost of the initial expenditure. The inherent problem for cities pursuing the third category is that many of the benefits that are identified require direct expenditure by the municipality but yield benefits to the broader society. They produce a set of positive externalities that need to be internalised by the municipality in order to be fiscally sustainable, but this internalisation takes longer than the 12-month budget cycle.

In addition, new service delivery technologies or approaches at the city scale do not always negate the need for the existing service system, and it is quite possible for a city to end up paying for parallel services during the transition, which can be protracted. The push to increase solid waste recycling in Cape Town has, for example, seen some households presented with a 'clear bag' used to separate the recyclable fraction at source. The cost of rolling out this recycling system across Cape Town would add an estimated R1,2 billion to the municipality's annual solid waste management costs (De Wit et al. 2009). In the long run this cost would decline, and it is less than the cost of building and managing new landfill systems. In the short term, however, the rollout would not eliminate the need to keep managing existing landfills, or the need to keep collecting some material to send to landfill.

To a certain extent, Cape Town's rapid expansion has minimised this problem as the obligation to extend services to new communities on greenfield sites presents opportunities for innovation without duplication. Nonetheless, concerns regarding duplicate service delivery systems were a feature of the Environmental Fiscal Reform programme.

To avoid these difficulties, the programme began with projects in the first and second category; that is, projects that provided the City with immediate savings and better municipal services.

Developing principles for project selection and budget reform

Having agreed on the need to commence with options that reduced or avoided costs, the co-producers of the CCT's Environmental Fiscal Reform programme compiled a set of principles intended to provide the transition with an internal coherence and consistency. Past projects, developed without reference to these principles, had generated contradictions and proven difficult to sustain. For example, the proposed by-law enforcing the requirement for affluent Cape Town households to install solar water heaters (a quintessentially climate-smart technology) would have saved an estimated 2 tCO_2 per household per annum (Froestad et al. 2012). It would also, however, have deprived the City of roughly R1 400 per household per year in revenue, given the margin that is earned by the municipality when selling electricity to affluent households. Understandably, the by-law was not supported by City officials responsible for the budget, and was never passed.

The process of developing principles took place in formal committees, and informally between officials, academics and finance experts. What transpired was the consensus that meaningful climate change interventions in Cape Town would have to simultaneously address the city's definitive socio-economic challenges of unemployment, inequality and municipal revenue, while also reducing environmental risk and climate change risk in particular (UN-Habitat 2014).

The principles developed to guide this approach, and to ensure consistency and relevance across the CCT's climate change and green economy projects, required that these projects met the following conditions:

a) *They were within mandate and addressing a market failure:* In deciding where to allocate its budget, it was important that the CCT act within the legal remit of metropolitan municipalities in South Africa (De Visser 2011). In South Africa's three-sphere government system, local governments have wide-ranging responsibilities but are not, for example, responsible for electricity generation, housing budgets or all aspects of public transport. The implications of legal and institutional contexts are often missed in the generalised climate change prescripts that assume all cities have the same mandates and opportunities (Taylor et al. 2014).

   As with any government intervention in the economy, it was important to be clear on the rationale for the intervention (Resnick et al. 2012; Rode et al. 2014). The Environmental Fiscal Reform programme prioritised projects that either provided a clear public good or addressed market failures associated with common resources, public goods and natural monopolies (Burger et al. 2012).

b) *They were creating new pathways to employment:* While the international literature points out that environmental protection is ultimately good for poverty alleviation (Cooke et al. 2010), in Cape Town a more direct and short-term link between the climate and green economy projects and poverty alleviation was sought. For this reason, projects that employed jobless citizens of Cape Town in the provision of services were prioritised. Implicit in this approach was the view that meaningful work or employment offers an important way out of poverty, and that addressing the country's skewed capital-labour ratio in favour of labour was important for inclusive economic development.

   Cape Town has an employment crisis that manifests itself in the growing number of people considered 'unemployable' by the private sector.[2] While the long-term solution lies in education sector reform, when the current economy grows it is unable to create the amount and types of employment and opportunities that lift unemployed people out of poverty. The CCT's Environmental Fiscal Reform programme set out to correct this labour market failure through a process of deliberately labour-intensive interventions aimed at enhancing natural and built environment assets and improving the flow of services to local communities. Critical to these services is that they generated work in or near communities, that the work was relatively insulated from

2 At the launch of the Western Cape's Economic Development Partnership on 26 April 2012, the CEO of Pan African Holdings, Dr Iraj Abedian, stated, 'We do not have an unemployment problem. We have an unemployability problem. Our system generates unemployability ... So many people out there are unemployable, and someone has to account for that.'

commodity price competition from emerging markets such as China, and that it provided valuable economic goods and services to the city.

c) *They were generating new opportunities for growth and risk reduction:* Cape Town has a valuable set of natural resource assets that supports the local tourism and property markets, protects built infrastructure from floods and storm surges and provides critical economic services including water provision, pollution remediation and cultural identities (Cartwright & Oelofse 2016; De Wit et al. 2009).[3] Degradation of these resources compounds the country's well-documented national infrastructure and services deficit (FFC 2017; World Bank 2014). This in turn foregoes economic opportunity, increases the cost of municipal service provision and infrastructure maintenance, and traps poor communities (in particular) in vicious cycles of exposure to environmental risk and poverty (Lorentzen et al. 2010; Turok 2013).

    The CCT's Environmental Fiscal Reform programme recognised that the public and private goods on which all urban economies depend are not perfect substitutes for each other (Vatn & Bromley 1994), and sought projects that provided a stimulus while reducing risks and creating employment. The hope was that stimuli delivered through investment in labour-intensive enhancement of Cape Town's natural capital would generate economic multipliers in the 1,4–2,0 range. This range is considered possible in South Africa but is seldom achieved (NPC 2012). In this way the Environmental Fiscal Reform programme looked to prevent the haemorrhaging of past fiscal stimuli due, in part, to the inability of infrastructure investments to absorb labour or redress capital-intensive modes of service delivery.

d) *They were fiscally efficient:* The CCT's prevailing budget constraints meant that it was important to prioritise projects that could save the City money as part of the Environmental Fiscal Reform programme.

    Projects that generated savings by drawing on goods and services from the natural environment, or enhancing the complementarity between environmental and municipal benefits, were particularly desirable (Culwick & Bobbins 2016; De Wit et al. 2009).

    Similarly, climate-resilient modes of service delivery such as waste-picking or biodigesting toilets that were cheaper than the prevailing mode of service delivery, or which reduced the burden on the centrally coordinated provision of services, were considered favourably.

e) *They had demonstration effects:* The CCT's Environmental Fiscal Reform programme recognised the need for experimentation and associated learning as part of the transition. Given the exacting legal environment imposed by South Africa's Municipal Finance Management Act (No. 56 of 2003),

3 De Wit et al. (2009) estimate tourism revenue resulting from Cape Town's natural environment to be between R965 million and R2,95 billion per annum.

> this recognition was unusual for a local authority finance department. The intention was to prioritise projects that offered the opportunity for replication, and that demonstrated the benefits of a climate-resilient economy to the private sector and to a broader set of City officials. In this way it was hoped that the inclusion of new considerations and deliberations conducted under the Environmental Fiscal Reform programme would enhance economic decision-making within the CCT.

Once agreed on, the five principles described above were distributed to all operational line departments in the CCT, with an accompanying note and an invitation to propose projects for budget support that City officials felt complied with the principles. The result was a list of 59 projects from a range of departments that had a chance of qualifying for what was termed 'green economy budget' by officials (Figure 14.1).

The five principles were converted into criteria that were used in an evaluation of the 59 options. This resulted in identifying a 'top-10' set of projects that was

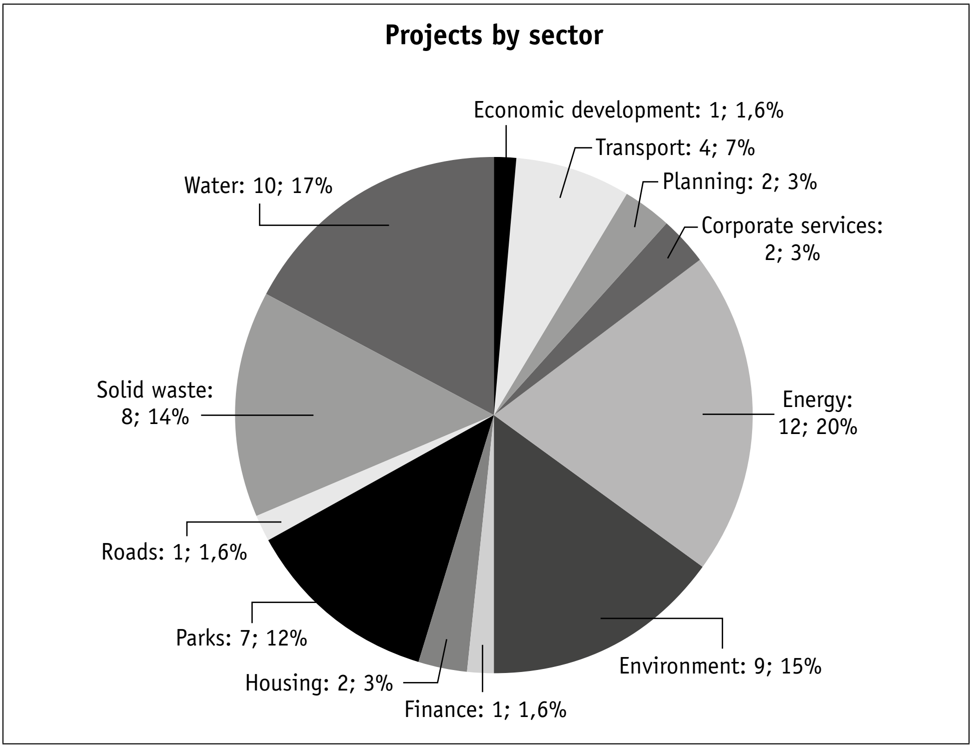

Figure 14.1: Number and proportion of the 59 solicited projects in the CCT's Environmental Fiscal Reform programme, by department

Source: Adapted from Savage & Cartwright 2013: Slide 8.

further narrowed down to 'four emblematic projects' in a process of deliberation with the City's six most senior officials. This narrowing down to four projects was potentially at odds with the principled and quasi-quantitative multi-criteria selection that had been applied to identify projects and develop the shortlist of ten. The officials, however, were apprised of the principles and strategic intent of the Environmental Fiscal Reform programme, and the approach relied on the ability of a proven group of experienced and accountable officials to take decisions in the City's best interests.

The four selected projects, their objectives and anticipated results from these projects are summarised in Table 14.1.

Table 14.1: The four initial projects selected for budget support under the CCT's Environmental Fiscal Reform programme

Project	Department	Rationale	Expected results at the outset
Implementation of a Dune and Beachfront Management Strategy for Hout Bay	Environmental Resource Management	Having built houses on a wind-blown sand dune in the 1970s, the City now has to manage the sand that collects in Hout Bay infrastructure and restore a vegetated dune buffer.	• Reduced operational costs in managing the 'cut-off' dune and associated damage to infrastructure on the Hout Bay beachfront • Rising property values in dune shadow • 20–25 long-term employment opportunities created
Following an initial pilot, the rollout of composting toilets to replace existing expenditure on portaloos.	Water and Sanitation	The City provides temporary mobile toilets to make up for the sanitation deficit in informal settlements where water-borne provision is not possible. These 'portaloos' provide a poor service and have become expensive to rent.	• Household and public acceptance and subsequent demand for biodigesting sanitation options • Improved level of sanitation services for informal settlements and public facilities • Less cost to the City per capita of sanitation services provided

Project	Department	Rationale	Expected results at the outset
			• Increased speed of sanitation service installation due to obviated need for bulk infrastructure • Reduced energy and water requirements per capita of sanitation services provided
Kommetjie Recycling Cooperative	Solid Waste Management	Recycling material from the City's remote suburbs is costly, and foregoes the option for local waste management strategies that could become local enterprises.	• Facility commissioned and recycling 2 000 tons of material in the first year • Estimated saving of R600/ton, leading to growth in tariff margins • Sorted waste sold into the recycling and up-cycling markets • Improved waste collection from informal settlements and townships near Kommetjie • Work for at least 15 people created in 2013/14 in waste collection and sorting • Awareness-raising and training to ensure recycling and safe handling of waste • Quantified reduction in greenhouse gas emissions and waste to landfill • Cleaner local environment with less damage to stormwater equipment

Project	Department	Rationale	Expected results at the outset
Clarifying the biodiversity off-set strategy	Environmental Resource Management	The City, in collaboration with the Western Cape Government, operates a 'biodiversity off-set' programme that allows property developers to incur some environmental damage in non-critical regions in exchange for investing in the environmental integrity of critical regions. To date, however, the programme has been applied inconsistently and has not yielded due returns to the City.	• Better use of Cape Town's Biodiversity Network to identify land to be forfeited and land to be acquired • Identification of a framework for setting consistent off-set requirement of developers and cost of managing off-set land • Identification of a process for securing and using off-set revenue for strategic biodiversity conservation

Source: Savage & Cartwright 2013: 7

For each of the four projects an implementing department and responsible person was identified. In collaboration with that person and the City's budget team, a detailed budget request was drawn up.

The budget request submitted for each project paid special attention to the format and content that the CCT's Finance Department required. This included attention to the spread of investment over the three-year Medium Term Revenue and Expenditure Framework. A criticism of the ERMD made by the budget team was that, while strong on advocacy and strategy, environmental officials seldom produced the type of budget requests, timeously and duly motivated, that enabled the finance team to take a considered opinion on whether or not to allocate budget (Froestad et al. 2012).[4] The Environmental Fiscal Reform co-production process, which involved many conversations between the respective teams, proved a suitable means for addressing this, and assisted in demystifying the budget allocation process for environmental officials and for less experienced officials in particular.

In total almost R12,5 million of budget was requested to support the four projects. In a vote of confidence, the Finance Department allocated the projects a larger amount than requested in the Medium Term Expenditure Framework.

4 J. Steyl, Director of Budgets, CCT, personal communications, 2013.

Conclusion: reflections on the co-production of fiscal reform

The CCT has struggled to convert its climate change ambition into sensible budget allocations and transformative projects. Historically, it has been difficult to discern anything of the City's climate change response in budget allocations.

The Environmental Fiscal Reform programme sought to take advantage of the opportunity created by the growing recognition of climate change as both an economic problem and an opportunity (Parnell 2015; Prins et al. 2010). The Environmental Fiscal Reform process was based on the notion that budget reallocations at the local scale, as opposed to donor funds and transfers from national government, offer an under-utilised and potentially powerful means of influencing the necessary economic change (Jacobs 2012; Zhengelis 2012).

In collaboration with the City's budget team, the process raised budget requests from a range of line departments for projects that simultaneously reduced climate change risk and addressed the city's structural labour market shortcomings, ensured higher economic multipliers on fiscal allocations, and generated virtuous economic cycles of labour absorption, cost savings, new revenue streams and a safer living environment. The CCT's effort was novel at the time, but this approach is now widely advocated by the global climate change community (Hallegatte & Mach 2016). In addressing mayors at the 22nd Conference of Parties to the United Nations Framework Convention on Climate Change, for example, Eduardo Paes, the chair of the C40 Alliance, reiterated that '[p]rosperity means conciliating economic development with social equality and environmental preservation' (Paes 2016).

With the benefit of some ensuing time since the Environmental Fiscal Reform programme, it has to be noted that in spite of a co-produced process, a bottom-up solicitation of projects and adequate budget allocation, the departments that were allocated budget in the Environmental Fiscal Reform process struggled to spend the money in the envisaged manner. As such, Cape Town's transition to a climate-resilient urban economy remains nascent and poorly supported by the City's budget. This reveals that environmental fiscal reform is a necessary, but insufficient, component of the development of a climate-resilient urban economy. It also speaks to the difficulty of using inherently conservative bureaucratic institutions in a process of change and innovation (Froestad et al. 2012; Roberts & O'Donoghue 2013).

The CCT is widely regarded as an innovative municipality. In spite of this, it proved difficult to change the day-to-day work habits of City officials, or to introduce new modes of service delivery that required new technologies or unfamiliar work habits, even when budget was available. Based on the City's experience, the international literature that identifies urban centres as places of innovation and climate change opportunity also under-reports the profound difficulties involved in 'changing a city' (Mockus 2015). In particular, there appear to be innate tensions between operating a stable and reliable local municipality and responding to the rapidly evolving international agenda on climate change, and calls for transformation.

Cape Town's experiences suggest that budget reform can be tricky and contested, especially where budget allocations determine the number of people employed by respective departments and affect fiscal stability. This experience is not unique to Cape Town, even in the South African context. The City of Johannesburg has a similarly ambitious reform agenda in its 'Corridors of Freedom' and 'Jozi@ Work' programmes (Cartwright & Marrengane 2016), but both initiatives have been slower than anticipated in gaining traction and private sector support.

This is an important finding for the growing number of calls on city leaders and mayors to take up climate change leadership. To be sure, cities have a critical role to play in tackling climate change. Equally, effectively crafted climate change responses can provide cities with a more prosperous, inclusive and competitive economy (Cartwright 2015; NCE 2014; Rodin 2014; Satterthwaite 2011). However, the lack of attention paid to budget influence and implications represents something of a blind spot among advocates of the economic potential offered by a climate-resilient economy, too few of whom detail the financial process whereby cities might realise this potential (LSE Cities 2013; Rodin 2014; WRI 2016).

The CCT's Environmental Fiscal Reform programme was important in terms of shaping economic policy and decision-making in the City, and in highlighting the importance of fiscal strategy in urban development. It also revealed that fiscal strategy is not, on its own, definitive and that spending budget appropriately is as important as, and possibly more difficult than, raising budget. This finding reiterates the notion that cities are complex spaces, comprised of multiple institutional layers. While a climate-resilient urban economy undeniably requires a supportive fiscal strategy, a single policy intervention was always unlikely to provide a complete solution to urban challenges (Jaglin 2015). Something that became apparent to the authors is that co-production processes aimed at institutional reform need to consider carefully 'who' they engage with, and the depth and breadth of their engagement. Working with a small group of leaders may be insufficient if the desired impact is contingent upon broad institutional reform. A second suggestion is that a one-year process may be insufficient to impact upon a complex bureaucracy.

Realising climate change's potential to act as a catalyst for much-needed transformation is important if rapidly evolving African cities are to 'leap-frog' to low-carbon, climate-resilient development pathways consistent with the global target of keeping warming to 1,5 °C above pre-industrial levels (Cartwright 2015; IPCC 2018). While there is certainly greater scope for the use of this instrument, the CCT's experience suggests that fiscal reform without changes to organisational culture is likely to prove inadequate in realising the proposed benefits that a low-carbon, climate-resilient city may offer.

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CHAPTER 15

Reflections on the mainstreaming of climate change in urban development decision-making in the City of Cape Town

Dianne Scott, Anna Taylor, Helen Davies and Mark New

This book provides insight into the variety of ways in which climate change is being integrated into the form and functioning of the City of Cape Town (CCT, also referred to as the City) to make development decision-making in the City more resilient to both current and future climate conditions, i.e. to facilitate climate-compatible development. Some officials and departments within the CCT have been working to advance the climate change agenda for well over a decade and have made significant headway in framing the problem in a local context and in experimenting with various strategies and measures for addressing the climate change mitigation and adaptation challenges. This book documents these as of the end of 2016, with some updates provided as at the beginning of 2019. Others have only recently started to grapple with the implications of climate change for their work. The 10 substantive chapters in the book showcase several initiatives that are pursuing the integration of climate change and track a shift from 'business as usual' practices to those that take climate change into account. Apart from Chapter 5, which deals with climate change mitigation (that is, reducing greenhouse gas emissions), the chapters mainly report on efforts to adapt to climate change (that is, reducing climate impacts). Chapters 7 and 14 deal with aspects of both adaptation and mitigation in a more integrated way by tackling issues of compact spatial form and public budgetary reform through a climate change lens. While the CCT has undertaken and continues to work towards climate change mitigation, much of this work has been reported on in the previous co-produced book between the CCT and UCT *Climate Change at the City Scale: Impacts, Mitigation and Adaptation in Cape Town* (2012) and other papers. Through all these chapters, the book provides a range of reflections on the mainstreaming of climate change into urban development decision-making from the perspective of a city in the global

South. These reflections on what it takes to depart from 'business as usual' and develop in ways that are more sustainable and resilient to changes in the climate, provide guidance on climate mainstreaming to those in other cities across South Africa and internationally who are grappling with how to initiate and undertake a similar process. This concluding chapter of the book revisits the question of what it means to mainstream climate change into local government decision-making in cities and, based on reviews of the substantive chapters, suggests three types of mainstreaming that are being undertaken: conceptual, experimental and systemic mainstreaming.

What does it mean to mainstream climate change into local government?

Uittenbroek et al. (2014) distinguish between a *dedicated* approach and a *mainstreaming* approach to organising municipal efforts to address climate change. They characterise the dedicated approach as one in which there is political commitment, resourcing and policy development (including the creation of new organisational structures) targeting climate change adaptation and/or mitigation as a new policy domain and stand-alone goal. In taking a dedicated approach, responding to climate change is positioned as a separate and additional priority and area of work. By contrast, the mainstreaming approach relies on integrating climate change adaptation and/or climate change mitigation into existing policy domains (such as spatial planning, public housing provision, water management and disaster management). This integration, or mainstreaming, is undertaken by institutional entrepreneurs (or champions) who frame the problem and solutions in ways that highlight synergies with and added value to the primary policy goal, existing institutional structures and resource flows. Making this distinction is not to say that these two approaches cannot coexist.

Having investigated municipal efforts at climate change adaptation in two Dutch cities, Uittenbroek et al. (2014) find that the dedicated approach can lead to targeted outcomes and more rapid implementation. However, having climate change as a stand-alone goal and policy domain runs the risk of it being discontinued in subsequent political terms and creating uncertainty in other policy domains (especially if climate change policy conflicts with other policy objectives). The mainstreaming approach offers the promise of continuity but achieving this requires strategic framing and periodic reframing to ensure that climate change adaptation and mitigation have relevance to and synergies with the primary policy objectives, and that contradictions and trade-offs are confronted and dealt with. Mainstreaming requires policy entrepreneurs or champions to mobilise actors and resources to address climate change. And it requires the reallocation of existing resources and a change in the practices or routines of existing institutional structures. The mainstreaming approach can take longer as it involves showing and convincing multiple parties of the value added by climate resilient development, but through this gradual buy-in, the mainstreaming approach has an increased likelihood of achieving more effective climate change resilience in the long term. Uittenbroek et al. (2014) conclude that both the dedicated and the mainstreaming approaches are needed in combination to make effective and sustained progress in tackling climate change at the city scale. The experiences from Cape Town presented in the preceding chapters support this conclusion. While the CCT's approach of having a dedicated climate change policy (2017) may be considered as a dedicated approach, the policy provides the framing for what is largely a mainstreaming approach.

In this book, we develop the thinking of Uittenbroek et al. (2014) further by identifying a continuum of types of mainstreaming, with three main types that municipalities can adopt, and use the terms 'systemic', 'experimental' and 'conceptual' to differentiate these. Systemic mainstreaming describes areas and activities where climate change has been made a central component of the work, that is, a policy, programme or project where climate considerations have been integrated into the core logic and design such that it is difficult to lose or remove the climate component. By contrast, experimental mainstreaming describes areas and activities that are in the early stages of testing what the integration of climate change entails in practice, usually on a small or limited scale, before any commitment is made to systemic mainstreaming. Conceptual mainstreaming describes a situation in which actors are beginning to consider the idea and implications of integrating climate change into their thinking, but not yet into action. Where only experimental or conceptual mainstreaming has occurred, there remains the danger that climate change may easily drop off the agenda again as priorities change, policies and plans are reframed, and both attention and resources are diverted to other areas of concern.

The Cape Town context framing the City's climate change approach

Cape Town, as the second-largest metropolitan area in middle-income South Africa, shares many features with other African cities (including high levels of informality, high levels of inequality, and a colonial legacy), and has local, contextual elements that influence its development pathway. It has a fast-growing population and has experienced a large increase in population over the last 20 years primarily due to the dramatic rural-to-urban movement of people into the city. It is a highly unequal city with a Gini co-efficient of 0,61. With its particular colonial and apartheid past, socio-economic inequalities are deeply racialised in Cape Town. There is a deep divide between the affluent and white-dominated areas located mainly around the city centre and the southern suburbs and other nodes and the Cape Flats where most coloured and black townships are located.[1] About 10 per cent of people live in informal houses or backyard dwellings, and 25 per cent of people are involved in informal sector activities (Western Cape Provincial Government 2016). This context presents enormous challenges to development in the city. With only 14 per cent of its GDP derived from manufacturing, the city relies economically on commercial services (60 per cent) and government, community, social and personal services (27 per cent) (Western Cape Provincial Government 2016); many of these services are oriented towards the tourism sector which depends to a large extent on the environmental assets of the city and its environs.

The learnings from this book therefore need to be understood in this context. Cape Town is somewhat different from many other African cities in that it has significant environmental assets within its urban borders (notably large lowland and mountain ecosystems that are rich in endemic biodiversity), and its local government is relatively well-financed and resourced compared to other African cities, with a constitutional mandate to fulfil the role of the 'developmental state' (Burger 2015: 4). Being a South African city, where the powers of the state are highly decentralised, Cape Town has a much higher level of governance capacity and autonomy than most African cities but does still experience low capacity and resourcing in some realms and a lack of climate change knowledge in many of the implementing sectors of local government (Pasquini et al. 2013; Tait & Euston-Brown 2017).

The climate change journey

Cape Town's metropolitan municipality began developing a local climate change agenda as far back as 2002 when it formulated a draft Energy and Climate Change Strategy, and so has a relatively long track record of grappling with and addressing the implications of climate change in its work, in comparison to most other African cities, with the notable exception of Durban (Taylor 2016; Taylor et al. 2014).

While the CCT has included the concept of climate change in its Integrated Development Plan (IDP) since 2007, the full understanding of more resilient, future-proofed development is often still seen to be at odds with the need to deliver much-needed basic public services and enable economic and social development in the near term (Davison et al. 2016; Scott et al. 2014). This perception has proved a significant stumbling block to the mainstreaming of climate change, which has

1 Under apartheid, residential areas were populated in terms of race classifications imposed by the state, and these demographic features have continued to characterise these suburbs and townships even though there is no longer any legal validity to the race classifications.

been seen by many as an environmental issue that is separate from and secondary to developmental challenges and priorities in South African cities.

Although there has been technical interest within certain departments of the CCT's administration in including climate change considerations in the policies and practices of the CCT since the mid-2000s, framed first in terms of a sustainable development agenda and then as part of a resilience agenda, there has only much more recently been a growing political interest (emerging in about 2015) in addressing climate change, furthered by political buy-in to the concept of resilience (Taylor & Scott n.d.).

Progress made includes the drafting, approval and implementation of numerous strategies and plans that include climate change mitigation and adaptation considerations and measures, and the adoption of a dedicated Climate Change Policy in 2017, as detailed in Chapter 3. Despite this relatively long track record, Colenbrander and Bavinck (2016: 35) argue that in the case of CCT the 'bureaucracy reduces the scope for innovation, flexibility and collaboration necessary for climate change adaptation'. They argue that the mainstreaming of climate change requires multi-scalar and horizontal engagement of well-informed governance actors in more flexible and purposive arrangements.

The barriers to mainstreaming include financial processes and financing availability, regulatory hurdles, the prevalence of short-term development time horizons, differing cultural norms and unresponsive bureaucracies (Colenbrander & Bavinck 2016; Pasquini et al. 2013). The forging of relationships with the African Centre for Cities (ACC) at the University of Cape Town (UCT) in 2008, through the Climate Change Think Tank which included multiple external experts, catalysed the municipality to consider climate change more seriously (Anderson et al. 2013).

Global institutions, policy processes and agreements have also played an important role in influencing the mainstreaming of climate change into local government policies, programmes and plans. Currently, the Sustainable Development Goals (SDGs) formulated by the United Nations, which came into force in January 2016, and the 'New Urban Agenda' launched in October 2016 by Habitat International, provide global governance frameworks that recognise cities as the main centres of climate change adaptation and mitigation (CCT 2015: 15).[2] These have been highly significant in influencing the mainstreaming of climate change into urban development decision-making. South Africa's ratification of the United Nations Convention on Climate Change in 1997, the signing of the Kyoto Protocol in 2002, the adoption of the Sendai Framework for Disaster Risk

2 In September 2000 world leaders working through the United Nations agreed on the Millennium Development Goals, which set targets to be met by 2015. These have been replaced by the SDGs. There are 17 goals, one of which is an Urban SDG which sets out the need to make cities more climate-resilient (Parnell 2016).

Reduction in March 2015 and commitment to the Paris Agreement of 2016 have also played a significant role in this regard. The powerful concepts and approaches contained in these initiatives and frameworks have 'travelled' to cities worldwide, including Cape Town, and have been translated into national and local contexts, playing an important role in the mainstreaming of climate change into urban development goals (McCann 2011; Weisser et al. 2014).

The National Climate Change Response White Paper, published in 2011 (Department of Environmental Affairs and Tourism 2011), was one of several national responses to the need to address climate change, as was the inclusion of climate change in the National Development Plan as a developmentally important issue (National Planning Commission 2012). In 2014, Cape Town, as a member of the C40 Climate Leadership Group, signed the Compact of Mayors to take decisive action on climate change, and was selected as one of the 100 Resilient Cities in May 2016, thereby joining this global network funded by the Rockefeller Foundation. A Chief Resilience Officer has been appointed to develop the City's Resilience Strategy (Cape Argus 2017; Mail and Guardian 2017).

Climate change mainstreaming as a means of contributing to building resilience and moving towards sustainable development

The CCT has a long history of working towards sustainable development, driven by its Integrated Metropolitan Environmental Policy (IMEP) initially drafted in 2001, and reviewed in 2008 and 2015,[3] and this remains a holistic framework for urban development in the city. Resilience has emerged relatively recently as an additional concept to guide development; some argue that it is becoming a dominant contemporary framework for urban development while others view it as a step towards sustainability. This is evident in the City Development Strategy, approved in 2012, and the 2012–2019 IDP, both of which promote sustainability and resilience as core goals. The inclusion of Cape Town in the 100 Resilient Cities network since 2016 will further advance the use of a resilience framework in relation to the mainstreaming of climate change concerns. The newly approved Climate Change Policy (CCT 2017) is positioned within both sustainability and resilience frameworks.

Given the above framing, the City positioned the call for papers for this book as having the goal of documenting 'mainstreaming of climate change to create a more resilient city', that is, improving the resilience of Cape Town's communities, natural systems and economy.

3 In 2015 the IMEP was renamed the Environmental Strategy.

The core chapters of this book were written during 2015 and 2016, at a 'moment' in the City's development when CCT officials had the opportunity to contribute to the book using the co-production approach of the Mistra Urban Futures Programme, in partnership with academic counterparts at UCT. Since the writing of these chapters was completed, several important changes have occurred, which need to be recognised. These include the selection of Cape Town as one of the Rockefeller 100 Resilient Cities in May 2016, the adoption and rollout of a significant organisational restructuring process by the CCT, the Council's approval of the Climate Change Policy in July 2017 (CCT 2017), and the ongoing recent drought of 2015 to 2018 associated with severe water scarcity. Each of these 'events' has further shifted the development trajectory and affected the climate mainstreaming process in Cape Town beyond what is reflected in this book, highlighting the importance of taking stock and documenting the progress of mainstreaming climate change at regular intervals.

The responses to these events have implications for the CCT's climate change journey. The severe drought has created a heightened awareness of 'the new normal', which is how the the response to the water crisis was framed by the CCT. It has resulted in a much more proactive response from the CCT in terms of both water demand management (WDM) and debating and developing new conventional and non-conventional water sources well ahead of existing plans for these developments. Chapter 6 describes the CCT's response to WDM during the drought in more detail, an important aspect of which was building adaptive capacity in the city's civil society and businesses. The demonstration of the power of building adaptive capacity stresses the role of government as one of many players in adapting to climate change, with government's role being that of a catalyser, i.e. to mainstream climate change beyond the borders of the institution and facilitate systemic mainstreaming. However, the response to the recent drought also highlights the higher cost of crisis interventions, and therefore further makes the case for increased mainstreaming of climate change responses in a proactive and progressive manner.

Institutional challenges to mainstreaming climate change

Despite almost 20 years of environmental policy reform, the CCT's institutional structure does not reflect the ideal institutional arrangements necessary to implement sustainable development goals as a city-wide undertaking (Davison et al. 2016). The reason for this is that the mandate to mainstream sustainable development has remained located in what was the Environmental Resource Management Department (ERMD). With the ERMD being positioned alongside other service delivery line functions in the organisational hierarchy (that is, not in a strategic cross-cutting or coordinating position), the implementation of sustainable development as a 'whole city' policy has been a challenge. However, the selection of Cape Town as a member of the C40 and 100 Resilient Cities networks has been influential and has led to the positioning of the resilience function in the CCT as a centralised, cross-cutting function in the Mayor's Office, which shows promise for future mainstreaming of climate change, sustainable development and resilience of the city as a whole. It will be interesting to see to what extent this resilience function will facilitate the mainstreaming of climate change into the resilience strategy of the City. Experience from other members of the 100 Resilient Cities network provides evidence that this does not always occur, so CCT will need to focus on how to make this happen. In a way, the drought and water crisis provided the impetus to highlight climate change and the need for effective mitigation and adaptation, hopefully improving climate change mainstreaming in the City and beyond.

Furthermore, on 24 August 2016 the CCT adopted a City-wide restructuring process termed the Organisational Development and Transformation Plan (ODTP), with the goal of 'reversing the legacy of apartheid spatial planning, modernising government, and improving service delivery' according to the then Mayor Patricia De Lille (De Lille 2017). Theoretically, the ODTP represents an ongoing 'transversal approach' aimed at breaking down the isolation of departments and encouraging collaboration towards a sustainable transition (CCT 2016).[4] This set of transversal working arrangements is also aimed at addressing 'wicked problems'—those problems 'which lack clear definitions, boundaries and definitive solutions' and cannot be solved by 'traditional, single issue policy responses' (Davison et al. 2016: 1066), which is clearly the case in regard to challenges related to sustainable development, resilience and climate change. The increased complexity of the problems to be addressed and the diversity of stakeholders who need to have a say in policy responses have served to increase the difficulties faced by policy-makers in addressing these issues. It is too early to determine the success of the ODTP towards meeting its stated goals (Appendix A and B).[5]

What does this book tell us about the mainstreaming of climate change into the CCT?

This book contains 10 substantive or case study chapters for which CCT officials provided the empirical content, each describing an activity that has contributed to

4 The revised CCT structure includes the following directorates: Transport and Urban Development, Energy, Assets and Facilities Management; Corporate Services; Finance; Informal Settlements, Water and Waste Services; Safety and Security; and Social Services (see Appendix B).

5 In 2019 the CCT has instigated a further organisational restructuring process.

building climate resilience in the city, or will do in the future. The fact that these officials responded to the CCT's call to participate in this writing process signifies that they believe that their sector or function is moving or needs to move beyond the 'business as usual' approach. Their receptivity to the necessity for climate change mitigation and adaptation responses places these officials in what could be termed a 'community of practice' whose members have enabled changes to take place in their sector systemically or have undertaken experimental processes to test out the mainstreaming of climate change, or have contributed conceptually with influential ideas about how changes might take place — as to how the City might move forward from 'business as usual'. Table 15.1 presents the mainstreaming approaches adopted in each of the substantive chapters of the book.

Table 15.1: The mainstreaming approach to climate change adopted in the case study in each chapter

Chapter	Mainstreaming approach	Theme
5. Building energy efficiency in City of Cape Town operations: the role of the energy intermediary	Systemic	Resource management
6. Water demand management in Cape Town: managing water security in a changing climate	Systemic	
7. Overcoming urban sprawl: exploring the potential and challenges of implementing social housing in Cape Town	Conceptual	Spatial planning
8. Conservation planning for climate change in a rapidly developing city: two case studies	Experimental	
9. The sea change of coastal risk management in the City of Cape Town: towards a new paradigm of collaborative governance	Systemic	Risk management
10. Reframing urban flood responses: gravel platforms as a means to address emergency flood relief and climate change adaptation?	Experimental	
11. Managing storm water and flood risk in a changing climate: charting urban adaptation pathways	Systemic	

→

12. Assessing the management effectiveness of the City of Cape Town's protected areas as a tool for climate change resilience	Experimental	Governance
13. The Dassenberg Coastal Catchment Partnership: a governance approach to promoting ecosystem-based adaptation and climate-resilient protected areas expansion in Cape Town	Experimental	
14. Environmental fiscal reform: efforts at co-producing the transition to a climate-resilient green economy in Cape Town	Experimental/ Conceptual	

Source: The authors

Most, if not all, of these case studies involved more than one department, illustrating the value of transversal working. While increasing the number of stakeholders in a project/area of work brings increasing complexity and can increase the time to effect change, it also leads to increased buy-in and more effective mainstreaming.

Chapters 5 and 6 illustrate the systemic mainstreaming of climate change in the policy domains of energy and water, and contribute to the theme of *resource management*. Chapter 5, 'Building energy efficiency in City of Cape Town operations: the role of the energy intermediary', demonstrates how energy efficiency has been increased by the addition of an institutional structure — an 'energy intermediary'. The authors focus on the governance of energy provision in CCT, and how a change in institutional arrangements can significantly create a more efficient system of energy delivery. Chapter 6, 'Water demand management in Cape Town: managing water security in a changing climate', shows how the early introduction of WDM in the City, and the creation of a WDM policy in 2007 and an institutional home with staffing and budget for WDM, have contributed to the stabilisation of water demand in the face of high levels of urbanisation, constituting a strong case for the mainstreaming of climate change adaptation. The chapter presents a case of 'systemic' mainstreaming of climate change in water management that has become even more crucial in the context of the recent drought. Had the WDM programme not been as advanced at the onset of the drought (i.e. systematised), the water crisis would have been far more severe. The case provides an example of an economic rationale for the conservation of water and the introduction of the tool of blocked water tariffs.

Chapters 7 and 8 are categorised under the theme of *spatial planning*. Chapter 7, 'Overcoming urban sprawl: exploring the potential and challenges of implementing social housing in Cape Town', provides an innovative argument for linking the provision of social housing to the policy goal of climate adaptation and mitigation through a process of densification and the creation of a compact city. The authors conclude that there is a need to 'recognise the real constraints [to social housing] while continually pushing for more radical and innovative agendas [linking social housing to climate change]'. This represents an innovative conceptual mainstreaming approach, which entails reframing an existing policy domain to highlight synergies with the climate change agenda. The ODTP restructuring created a directorate of Transport and Urban Development, within which Spatial Planning was located. This new institutional structure is aimed at providing an organisational structure within which such ideas might more easily be taken up and eventually systematised.

The mainstreaming of climate change into conservation planning is described in Chapter 8, 'Conservation planning for climate change in a rapidly developing city: two case studies'. The chapter interprets biodiversity loss as the loss of ecological infrastructure and climate services 'critical to developing a sustainable city resilient to climate change'. The authors, in undertaking a pilot project in the Strandveld Conservation Implementation Plan, demonstrated that a proactive climate-resilient approach to the prevention of loss of biodiversity, ecological infrastructure and environmental services allows for ensuring resilience and facilitating urban development in rapidly urbanising areas. This chapter is classified as an experimental or exploratory response to mainstreaming, since the authors describe two pilot projects that include climate change responses. The challenge officials now have to deal with is how to use the illustrated value add from these pilot studies to scale them up towards mainstreaming conservation planning and the role of ecological infrastructure into city planning.

Chapters 9 to 11 fall into the theme of *risk management* and demonstrate how the mainstreaming of climate change into this discipline has and is taking place. Chapter 9, 'The sea change of coastal risk management in the City of Cape Town: towards a new paradigm of collaborative governance', shows that the CCT is moving towards a novel form of 'negotiated decision-making' within the coastal space. The chapter argues that there is 'a shift in the CCT's silo mentality — towards deliberative, multi- and interdisciplinary knowledge-building discourses and practices'. This shift in the governance approach towards a transversal approach mirrors the new ODTP institutional arrangement of the CCT, which seeks to break down the silos between departments and advance mainstreaming, partly through recognising and changing decision making pathways (see Appendix B). The chapter is therefore classified here as demonstrating a systemic approach to mainstreaming.

Chapter 10, 'Reframing urban flood responses: gravel platforms as a means to address emergency flood relief and climate change adaptation?', describes the experimental process of the construction of gravel platforms in an informal settlement. While the intervention was implemented as an emergency response to reduce immediate flood risk, it is also regarded by the authors as a first step in long-term flood alleviation. The chapter argues that the humanitarian goal of responding to an emergency and the risk to human life and property aligns with the climate change adaptation goal of reducing risks for vulnerable people.

It suggests that 'reframing flood responses as both a humanitarian and climate change adaptation response could have co-benefits that could help households and communities to reduce their flood risk which address both socio-economic and climate change adaptation goals'. With its argument for 'reframing' the chapter illustrates an experimental or exploratory approach to mainstreaming. The holistic, transversal approach of the new ODTP to restructuring the institutional arrangements of the municipality has the potential to open up spaces for this reframing of existing practices that can lead to the mainstreaming of climate change in new policy arenas, but this possibility is yet to materialise (see Appendix B). Chapter 11, 'Managing stormwater and flood risk in a changing climate: charting urban adaptation pathways', interrogates the extensive work undertaken by the Stormwater Branch of the CCT in mainstreaming climate change into its policy and practice, to the extent that responding to climate change is now part of its core business. The chapter uses an 'adaptation pathways' approach to explore decision-making in the management of stormwater and flood risk. It highlights how shifting from a transition to a transformative pathway would necessitate closer engagement between technical and political actors, both within and beyond the CCT to ensure the understanding of the need for buy-in to a more radical approach. The approach documented in the chapter is classified as systemic mainstreaming, in that climate change projections have been integrated into the flood risk modelling that underpins decisions on infrastructure management and property development regulations pertaining to land adjacent to waterways and water bodies. The work done by the branch also illustrates the application of climate science research by practitioners, motivating for increased linkages between academics and practitioners towards understanding the need for and use of good quality research data.

Governance is the theme of Chapters 12 to 14. Chapter 12, 'Assessing the management effectiveness of the City of Cape Town's protected areas as a tool for climate change resilience', presents 'an overview of the emergence of the Management Effectiveness Tracking Tool (METT) in the City of Cape Town (CCT) and how this innovative reporting practice was mainstreamed into the City's and South Africa's protected areas in two case studies'. With the emerging importance of climate change in the City, the METT is analysed to reveal how and to what extent it has been revised to increase the effectiveness of assessing how resilient protected areas in the city are to climate change. The authors note that the CCT 'is busy reviewing and refining its entire monitoring and evaluation system to ensure that a simple method for ecological integrity measurement and monitoring climate change resilience can be devised and included in the METT'. As such, the METT is an experimental or exploratory approach to mainstreaming, as climate change is not yet a core component of the designation and management of protected areas.
Chapter 13, 'The Dassenberg Coastal Catchment Partnership: a governance approach to promoting ecosystem-based adaptation and climate-resilient protected

areas expansion in Cape Town' illustrates how, by adopting an ecosystem-based approach to climate adaptation and through the partnership between the CCT and CapeNature (the two state partners) and several NGOs and community-based organisations, climate change has been mainstreamed into the CCT's policy domain of protected area expansion and biodiversity conservation. This chapter reflects experimental mainstreaming as this form of partnership approach has not yet been used across multiple areas of the City's work.

Finally, Chapter 14, 'Environmental fiscal reform: efforts at co-producing the transition to a climate resilient green economy in Cape Town', interrogates how the City's Environmental Fiscal Reform programme identified that budget reallocations at the local scale towards climate change resilience 'offer an under-utilised and potentially powerful means of affecting the required economic change', showing a clear role for environmental fiscal reform and an alternative approach to budgetary decision making. The innovative argument for 'environmental economic reform' illustrates both conceptual and experimental or exploratory climate change mainstreaming.

Assessing the progress of climate change mainstreaming in Cape Town

From the above analysis of the different responses to climate change presented in the chapters in this book, we can see that the CCT's approach to addressing climate change at the city scale contains elements of both dedicated and mainstreaming approaches. The fact that the CCT was involved in the setting up of a Climate Change Think Tank in 2008 and has adopted a stand-alone Climate Change Policy (2017), shows that local government in Cape Town is establishing climate change as a new policy domain and has put climate change on its agenda, both of which are evidence of a dedicated approach. The dedicated approach helps to indicate what to focus on when framing mainstreaming efforts, by providing criteria to be used in the process. The chapters show that over time a more dominant mainstreaming approach is emerging. Climate change is, to varying degrees, being factored in to biodiversity conservation partnerships, coastal and water management, social housing, disaster management, energy management and financial planning. In these cases, individuals within broader networks have played an important role in identifying and promoting synergies between climate change-related actions and line function areas of responsibility, mostly using the same resources and institutional structures. Similarly, the establishment of transversal management forums that link climate change adaptation and mitigation with other policy agendas, for example the Green Economy, Energy and Climate Change Working

Group, demonstrates an institutional effort to mainstream climate change within the CCT.[6]

While the evidence presented in this book shows that considerable progress has been made in mobilising the mainstreaming of climate change into a range of domains, albeit in an ad hoc manner, there is still much to be done to achieve full integration and to address deep contradictions and difficult trade-offs. For example, there are trade-offs between protecting coastal land for ecosystem functioning, both to conserve endangered endemic species and to act as a buffer against storm surges causing inundation and erosion, and making coastal land available for property development that stimulates economic growth, creates employment, makes prime residential land accessible to many (particularly along the False Bay coast) and raises much-needed public revenue through rates and taxes.

The book reveals many of the risks identified by Uittenbroek et al. (2014) as inherent in the mainstreaming approach. Most notable is the risk of policy entrepreneurs or champions leaving their positions in the municipality with no succession plans in place. Existing organisational structures and routines do need to change for climate adaptation and mitigation to come to fruition, which requires direct political commitment on the part of political leadership (Uittenbroek et al. 2014). While the chapters in the book are written from the perspective of officials, political principles have been involved in most of this work to varying degrees. It is noted that while political buy-in is sometimes needed to systematise climate change mainstreaming, the conceptual and experimental forms of mainstreaming are usually needed to gain this initial buy-in. In addition, successful integration of climate change adaptation and mitigation into other existing policy domains and thereby attaining indirect political commitment from a wider set of actors, including senior officials, financial managers and civil society representatives, is also necessary for the sustainability of the climate change agenda and the adaptation (and transformation) process. Hence, the transition from conceptual and experimental to systemic mainstreaming is critical until such time as systemic mainstreaming becomes everyday practice. Uittenbroek et al. (2014) conclude that some hybrid of the two approaches is required for a municipality to be most effective in achieving climate change adaptation and mitigation outcomes. This suggests that the CCT is in a strong position, having made considerable progress with both approaches due to the innovative technical work of many officials, the fostering of partnerships and strategic alliances across numerous domains, as well as growing political commitment.

6 The Green Economy, Energy and Climate Change Working Group is now the Green Procurement, Green Economy, Atlantis Special Economic Zone, Climate Change Adaptation and Climate Change Mitigation working group (GEACC).

Co-production of the book

As well as providing an understanding of and reflections from the CCT on how various departments in the municipality have gone about mainstreaming climate change into their policies and practices, this book has also set out to expand the learning about knowledge co-production that can be transferred to other knowledge production spaces and policy-making contexts. It therefore also includes some reflections on the process whereby the chapters for the book were co-produced.

As a backdrop, Chapter 4, 'Responding to climate change and urban development through the co-production of knowledge', provides a literature review of the process of knowledge co-production, a history of how the CCT and UCT have engaged in knowledge co-production over the past decade, and a critical overview of the previous knowledge co-production processes in the City. To understand the success of the knowledge co-production methodology being used in the context of the CCT in producing 'socially embedded knowledge', the editors of this book asked the contributing authors how they experienced the process and responded to the challenges.

As one author noted, the method of co-production has led authors 'to take time out from daily work and step back to review how things could be done differently to improve effectiveness and resilience'. It has created an opportunity 'to arouse a slightly different awareness of the problems and situations mobilising us', both for the officials and for the researchers involved (Stengers, quoted in Lane 2017: 91). The method used in this book recognises and appreciates the power of the experience of practitioners. It is an experimental way of examining the mainstreaming of climate change into CCT policy and practice that draws on the knowledge and experiences of both practitioners and researchers to produce a new understanding through a transdisciplinary process (Taylor et al. 2017).

After the three introductory workshops described in Chapter 4, the authors set about co-producing each chapter. The short online survey showed that a variety of approaches were being used by the authors:[7]

1. The academic as supervisor — the official doing the initial writing, then to be reviewed and augmented by the academic.
2. The interview approach — the academic commencing the writing based on initial discussions with the official.
3. The conventional co-authoring approach — each author writing different sections and putting their pieces together.

7 A set of questions was sent to both officials and academics. The responses were analysed thematically (Braun & Clark 2006).

4. The 'iterative, constructive engagement approach' — the writing team conceptualising the topic, structure and narrative flow, and writing together.[8]

The fourth approach, adopted by only two of the ten writing teams, revealed that co-production had taken place from the start of the writing process. The first three approaches all started with a binary or hierarchical binary of 'supervisor/student', interviewer/interviewee, and official/academic writing separately, but experience shows that as the teams implemented their approaches they shifted into a more 'constructive engagement' and co-productive mode.

There is a sense that, while those who were involved in this project did so for different reasons, everyone experienced something that helped them to learn and understand their work differently in some way. For many officials, writing their chapters opened their eyes to the latest related research, but also made them realise that they had insights, experiences and knowledge to share that could help others learn about how governments function (or don't). It also helped them to gain perspective as to what they had achieved through their work and what new directions they should explore. For many academics, writing their chapters helped them to better understand the complexities of working in the public sector/local government, particularly in regard to how changes are made, which may enable them to better position and contextualise future research that could then be of use to the public sector. For us as editors, the collation of this book has enabled us to learn more about how to work with a large and highly diverse group of people; keep all aligned with the central theme of climate change; and attempt to ensure that, as a collective output, the book provides insight into the varied and innovative ideas that exist about how to mainstream climate change in a city's functioning.

Responses to the drought — a glimpse of things to come?

At the time of producing this book, Cape Town was suffering a severe drought with three consecutive years of well below normal rainfall during the 2015–2018 period, and water supplies at an all-time low. There was much controversy regarding how the City should have responded to the drought. However, the CCT, in May 2017, stated that it had shifted its approach to dealing with the drought from one of coping with and waiting out an extreme event in the short term, to addressing the drought as an event for which resilience needs to be built over the longer term. This involved improved transparency and collaboration with external stakeholders, such as civil society and businesses to collectively tackle the challenge of reducing water demand and a realisation that building adaptive capacity to climate change requires partnerships, trust and scenario planning, among others. This suggests

8 There is not scope here to go into detail about these approaches. See Hyman et al. 2019, which captures the responses of the authors of the chapters.

that the process of mainstreaming climate change could be more strongly taking effect in the core development decision-making of Cape Town's local government.

Despite the best efforts to reduce water demand in the city, on 31 October 2017 the CCT announced that 'the City of Cape Town has activated water rationing to forcibly lower water usage in line with water restrictions across the metro as phase 1 of its critical water shortages disaster plan'.[9] In addition to the CCT announcements as to when the City would need to switch off large parts of the water reticulation network, i.e. 'Day Zero' would occur, climate scientists have also delivered authoritative interpretations of aspects of the drought in the media and online (Olivier 2017; Wolski 2017; Ziervogel 2017) and continue to do so. The drought in Cape Town triggered a heightened awareness of climate change not only at the technical and political levels, among City officials and councillors, but also in the media and among the public and businesses in the city, as the drought reflected what the reality of climate change may be (Africa News Network 2017; Neilson 2017; Payne 2017) and surprised many with how quickly climate change could cause significant changes and impacts. While much of the rhetoric relates to the dam levels in the region, the focus has increasingly been to diversify water supply sources including groundwater sources, desalination and wastewater treatment[10] to address further projected climatic change — related both to rainfall and also to increased temperatures and wind speeds that adversely affect evaporation. However, there has not yet been a thorough public discussion about the potential for a fundamental move away from the default focus on a centralised and government owned and controlled approach to water supply, and towards a more decentralised approach which allows for and encourages the involvement of households and businesses. On the demand management side, the work by all parties to lower consumption and increase the efficiency of water usage is strengthened the adaptive capacity of many communities and businesses.

It is important to know that the core chapters of this book pre-date these events, but that the work described in these chapters has played a critical role in providing the platform for how the CCT dealt with the drought. The water crisis confronting Cape Town in 2018, together with the City's involvement in international commitments and networks, has drawn considerable political attention and commitment to addressing climate change. But the question remains: how sustained will this commitment be now that the water crisis is over and as political terms in the municipality end?

9 CCT, email to all account-paying residents in the city, 31 October 2017.

10 The main dams providing water for Cape Town are the Wemmershoek, Voëlvlei, Steenbras (Upper and Lower), Theewaterskloof and Berg River dams.

Conclusion

The book offers a multi-dimensional view of the institutional changes being undertaken, or identified as being needed, to navigate the dynamic interplay between urban development, inequality and climate change. The book presents a new framework for analysing climate change mainstreaming, but also examines the enactment of different forms of governance to manage climate change and urban development, highlighting various practical constraints and possibilities. By presenting many forms of institutional innovation and experimentation — including the role of intermediaries, internal champions and polycentric networks — it is a book both about mainstreaming and beyond mainstreaming.

By documenting a range of knowledge, activities and experiences, this book contributes to sustaining the momentum behind integrating the climate change and urban development agendas in Cape Town and beyond, to creating a new 'business as usual' that is climate-resilient, low-carbon, inclusive and equitable, and most importantly sustainable. The core lesson emerging from this book is that, in addition to distinguishing between dedicated and mainstreaming approaches to addressing climate change in cities, there is value in differentiating between the steps along the continuum of mainstreaming — conceptual, experimental and systemic mainstreaming. The role of officials will continue to be reminding all of the impacts of climate change, such as those experienced in the drought, and to continue to build the business case for adapting to climate change to ensure systemic mainstreaming towards long-term climate resilient development. This can only be done with the support of the research community building the localised evidence base of climate conditions, impacts and efficacy of various adaptation and mitigation measures. By being intentional and explicit about how each area of work will evolve through the mainstreaming continuum, the City can more strategically and holistically address climate change in all its functions and decision making, while catalysing other actors operating at the city scale to do the same through engaging in various forms and modes of governing.

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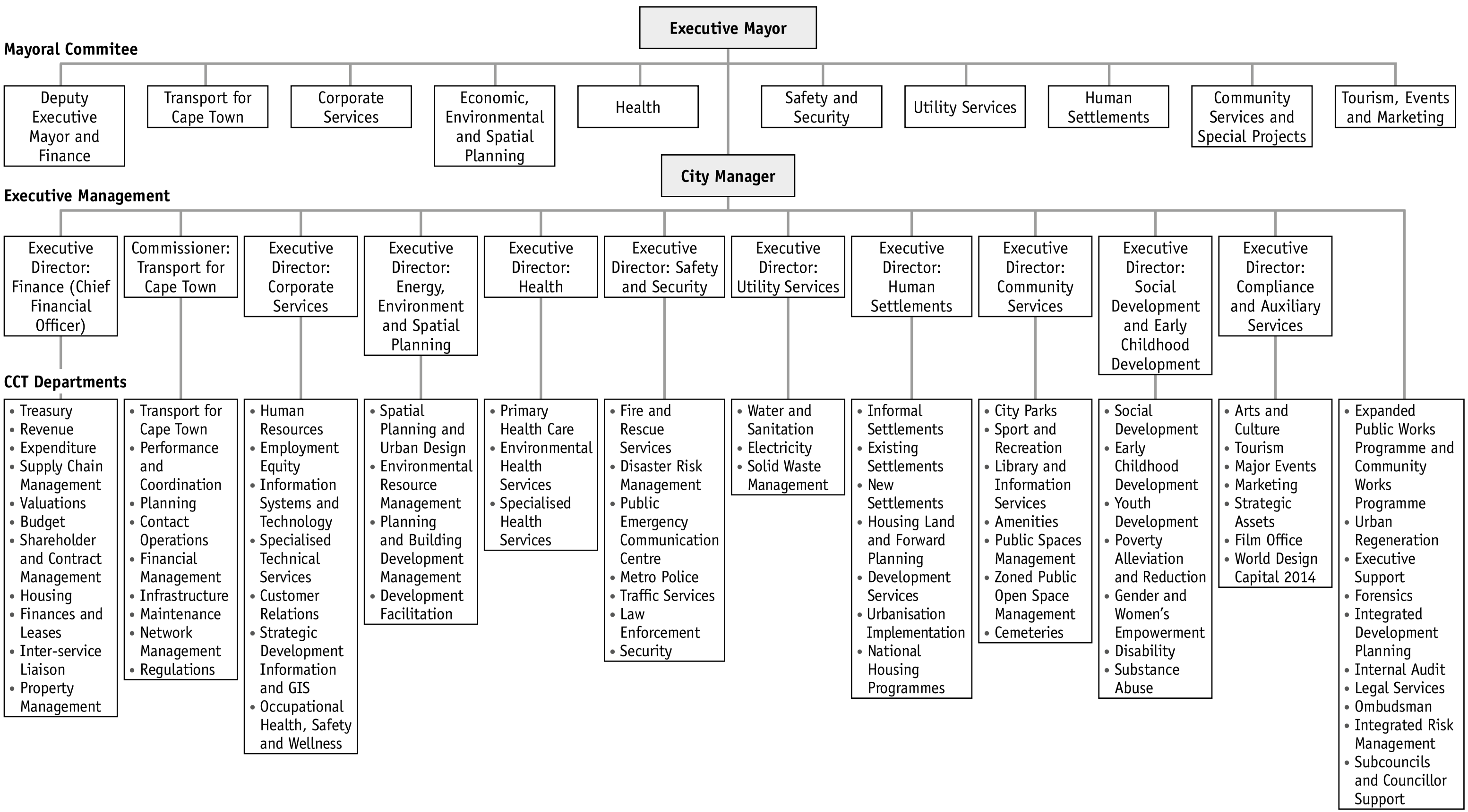
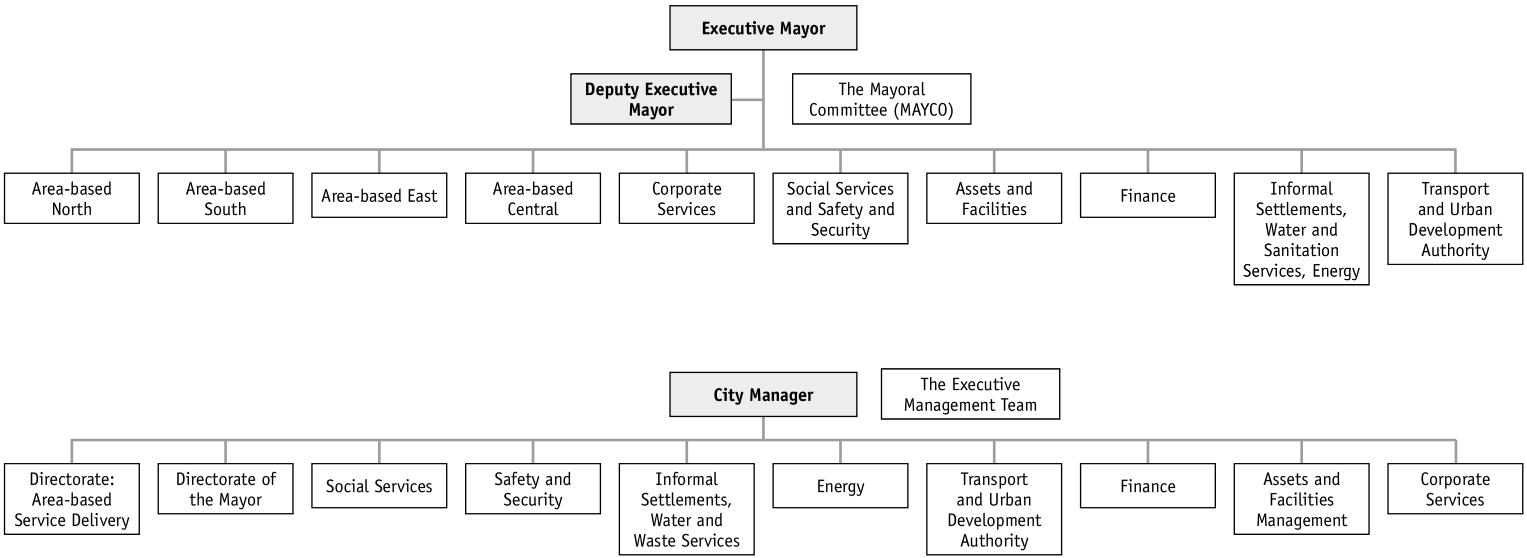
Appendix A: The institutional structure of the City of Cape Town municipality prior to the institution of the Organisational Development Transformation Plan in August 2017

Source: Colenbrander, D. R. 2018. 'Governing coastal risk: new pathways in developing city-scale contexts, Cape Town, South Africa'. PhD thesis, University of Amsterdam, Netherlands.



Appendix B: City of Cape Town Executive Structure Organogram as part of the Organisational Development and Transformation Plan (ODTP)

Source: City of Cape Town. 2017. *Five-year Integrated Development Plan July 2017–June 2022*. Cape Town: City of Cape Town.



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